2. J. F. Campbell Esq. from the Author

ADDRESS

DELIVERED AT

THE ANNIVERSARY MEETING

OF THE

GEOLOGICAL SOCIETY OF LONDON,

On the 16*th of* FEBRUARY, 1866;

PREFACED BY

THE ANNOUNCEMENT OF THE AWARD

OF

THE WOLLASTON MEDAL

AND PROCEEDS OF THE DONATION-FUND

FOR THE SAME YEAR.

BY WILLIAM JOHN HAMILTON, ESQ., F.R.S.,

PRESIDENT OF THE SOCIETY.

LONDON:

PRINTED BY TAYLOR AND FRANCIS,

RED LION COURT, FLEET STREET.

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PROCEEDINGS

AT THE

ANNUAL GENERAL MEETING,

16TH FEBRUARY, 1866.

Award of the Wollaston Medal.

The Reports of the Council and Committees having been read, the President, William John Hamilton, Esq., F.R.S., delivered the Wollaston Medal to Sir Charles Lyell, addressing him as follows:—

Sir Charles Lyell,—I need hardly say that it is with very great satisfaction that I find it has fallen to my lot to be the means of placing in your hands this Wollaston Medal, which the Council have unanimously awarded to you in recognition of the highly important services you have rendered to the study of Geology by your various original works, and for the masterly and philosophical manner in which you have treated the subject, both in developing the principles and in expounding the elements on which the science of Geology is founded.

More than five-and-thirty years have now elapsed since you published the first edition of the 'Principles of Geology,' in which you attempted to explain the former changes of the earth's surface by reference to causes now in operation, and by giving a full and detailed view of the modern changes of the earth and its inhabitants. During this period you have published no less than nine editions of this work. In 1838 you published the first edition of the 'Elements of Geology,' consisting of an expansion of the 4th Book of the 'Principles of Geology,' and containing a description of the monuments of *ancient* changes, Geology in the strictest sense, namely, a detailed account of the successive formations of the earth's crust and their imbedded fossils from the oldest crystalline rocks to the beds of the Post-tertiary epoch. Of these 'Elements' you published the sixth edition last year, and I need not here repeat what I stated on a former occasion respecting the vast amount of additional information it contains as compared with former editions. Indeed, considering the rapid progress of geological study and the close attention you have always paid to every new discovery in all quarters of the globe, it could not well be otherwise. It is impossible to calculate the effect produced by these numerous publications; but it is

interesting to record the fact that I have read on more than one occasion that a perusal of Lyell's 'Elements' has been the first means of calling the attention of persons previously unacquainted with the subject to the study of this branch of science and to the eager investigation of the geological features of the country where they resided.

I must also take this opportunity of alluding to the great services you have rendered to the study of Tertiary Geology in helping to clear away the uncertainty which prevailed before 1830 respecting the true chronological sequence of those fossiliferous beds which in England, France, and Italy overlie the chalk formation, and in many of which a greater or less number of species are found identical with recent or living forms. With the assistance of M. Deshayes you prepared comparative lists of the fossil shells found in the different Tertiary formations, and of the identical living species, and you ascertained that in proportion to their greater antiquity they invariably contained a smaller percentage of living forms. On this you founded that peculiar classification with which your name must ever be associated. The terms Eocene, Miocene, Pliocene, and Post-pliocene will always remain as a memorial of the services you have rendered to geological science. And although subsequent discoveries have shown that the lines of demarcation between these groups cannot be so sharply drawn as was at first supposed, and that the breaks previously believed to exist have been filled up by newly discovered groups of strata, it must not be forgotten that you always anticipated that such would be the case; you never admitted the doctrine maintained by some geologists that these breaks, both in the Tertiary and in the older formations, were the marks of real interruptions and catastrophes breaking the regular series of events in the geological history of the crust of the earth and of its inhabitants. The nomenclature which you introduced has been of immense service in enabling us to arrange and coordinate the different groups of Tertiary deposits which occur in so many localities of the European area as well as in other portions of the earth's surface.

Allow me once more to express the sincere pleasure and satisfaction I experience in placing this Medal in your hands.

Sir Charles Lyell, on receiving the Medal, replied as follows:—

The list of British and foreign geologists who have received the Wollaston Medal during the last thirty years has been honoured by so many distinguished names that I cannot but feel highly gratified that the Council has thought mine worthy of being added to the number. I acknowledge with sincere thanks the flattering terms in which you have spoken of my scientific labours and writings, and I only trust that you have not greatly overrated their value. I can at least assure you that as I grow older I become more and more conscious of my inability to keep pace with the ever-increasing rate at which geology is expanding, together with the numerous sciences which are so intimately connected with it.

Award of the Wollaston Donation-fund.

The President then addressed Mr. H. Woodward, as follows :—

Mr. Woodward,—I have much pleasure in handing to you the balance of the proceeds of the Wollaston Fund, which the Council have awarded to you with the view of assisting you in your researches on the fossil Crustacea. The evidences of industry and zeal which you have already shown in this field of palæontological research, both in the many interesting communications which you have made to this Society and in your other publications, lead us to expect still more important results from your continued investigations. It is this division of labour which tends finally to perfection. And while Mr. Davidson has taken the fossil Brachiopoda under his special charge, Dr. Wright the Echinoderms, and Mr. Salter has done the same with the Trilobites, we gladly leave the remaining Crustacea in your hands, in the confident hope that you will treat them with the same success, and work out their natural affinities and geological limitations with the same credit to yourself and benefit to science, which they have already manifested in their respective fields of operation. While assuring you of my own entire satisfaction at this award, I will only add the expression of my sincere wishes for your future prosperity and success.

Mr. Woodward replied as follows :—

Mr. President,—In returning thanks to you and to the Council for the honour conferred upon me, I cannot but recall the names of the many able and distinguished geologists who in former years have received the Wollaston Fund, and feel sure it is owing more to your friendly consideration than to my own desert that I am thus favoured.

Palæontologists have never had greater opportunities for work than at the present time, when so many fresh districts are being explored, yielding new series of organisms dissimilar from, but related to, the living forms around us.

We younger naturalists and geologists have an immense advantage over our predecessors, for we enjoy the results of their labours, and find that they have made the way light and the path smooth beneath our feet. New fossils, however, turn up continually, and must be described; and better examples of old ones, furnishing fresh material for comparison, need to be examined.

With the encouragement which you have been pleased to bestow, I hope to add some useful material to the ancient history of the Crustacea, which it is my pleasant task to investigate.

THE ANNIVERSARY ADDRESS OF THE PRESIDENT,

WILLIAM JOHN HAMILTON, ESQ., F.R.S.

I now proceed, in accordance with the practice hitherto observed by my predecessors, and before entering on those observations respecting the recent progress of geological investigation which it is my duty to lay before you, to read the Obituary Notices of some of those Fellows of the Society whom we have lost during the past year.

Mr. HENRY CHRISTY was the second son of the late Mr. William Miller Christy, of Woodbines, Kingston-upon-Thames, and was born on the 26th of July, 1810. His early life was devoted to business, and he succeeded his father as a Director of the London Joint-Stock Bank. A taste for antiquarian researches led him, however, at an early period to undertake many extensive journeys and expeditions with the view of studying the antiquarian remains of various districts, and the primitive habits and customs of the more remote tribes of the human race.

In 1856 he accompanied Mr. Edward Tylor to Mexico. The result of their travels was published by Mr. Tylor in 1861 in a work called 'Anahuac.' He subsequently visited the United States, Canada, and British Columbia, picking up information wherever he could find it respecting the habits of the wilder tribes and the earlier inhabitants. Subsequently he visited the East, Algeria, and the north of Africa, Spain, Italy, France, and the Scandinavian kingdom.

It was at a later period, however, that he turned his attention to that branch of his antiquarian pursuits which brought him into close relationship with this Society, of which he became a Member in 1858. Carrying back his researches into the antiquity of man's presence on the earth, he was brought into close contact with the relics of the last period of geological history, when Mammalia, now extinct, appear to have lived during the Postglacial period as the cotemporaneous inhabitants in caves and forests of the first tribes of the human race which dwelt in Western Europe.

The discoveries of Abbeville and of Amiens which had been so ably worked out by Mr. Prestwich, induced Mr. Christy to enter upon a new field of inquiry; and, in conjunction with his friend M. Lartêt, he turned his attention to the caves in the south of France, to which several French geologists had recently been devoting their time and thoughts, and were endeavouring to unravel the mystery which at first attached to the discovery of undoubted human implements, and the works of human hands, in close juxta-position with the remains of extinct Mammalia.

Mr. Christy's exertions were chiefly directed to the examination, with his friend M. Lartêt, of the numerous caves which are to be found along the banks of the Vezère in the Department of the Dordogne. The enormous collection of materials obtained from these

caves, consisting of flint instruments of an entirely different character from those of Amiens and Abbeville, of bones of Reindeer, Bos, and other animals, would appear incredible to those who had not witnessed the actual discovery and the immense stores collected on the spot. They have been distributed, with the greatest liberality, by Mr. Christy and M. Lartêt to the various public museums and private collections in Europe.

In the spring of last year Mr. Christy proceeded, with other Members of the Geological Society, to visit some interesting caves of the same character as those in the Dordogne, which had been recently discovered in Belgium, near Dinant on the Meuse; and it was whilst proceeding thence to Switzerland, with M. and Madame Lartêt, that he was attacked by inflammation of the lungs, which carried him off in a few days. He died on the 4th of May, at La Palisse, Allier, at the age of 54. He will be long regretted by all who knew him for his social qualities no less than for his scientific attainments.

Sir John William Lubbock, the son of Sir John W. Lubbock, was born on the 26th March, 1803. He was educated at Eton and at Trinity College, Cambridge, where he took his degree in 1825. He was a first-rate mathematician, and for many years was devoted to the pursuit of science, particularly that of astronomy, in connexion with which he investigated many questions respecting the action of the tides, the theory of the moon and the perturbation of the planets, and the determination of the distance of a comet from the earth, and the elements of its orbit. He was Treasurer to the Royal Society from 1830 to 1835, and again from 1838 to 1845, and was for many years Vice-Chancellor of the University of London. In 1834 the Royal Society awarded him one of their Royal Medals for his paper "On the Tides," and in 1848 the Astronomical Society gave him a testimonial for his "Researches on the Theory of Perturbation." In 1836 he delivered the Bakerian Lecture "On the Tides at the Port of London." He was elected a Fellow of this Society in 1848. He contributed many papers on scientific subjects to most of the learned Societies in England, which were published in the Philosophical Transactions, the Memoirs of the Royal Astronomical Society, the Philosophical Magazine, the Transactions of the Cambridge Philosophical Society, and the Reports of the British Association.

In addition to these communications he published several important works on astronomical and mathematical subjects between the years 1830 and 1840, including 'A Treatise on Probability' and an 'Elementary Treatise on the computation of Eclipses and Occultations,' in 1835; 'Remarks on the Classification of the different branches of Human Knowledge,' in 1838; an 'Elementary Treatise on the Tides,' in 1839; and 'On the Heat of Vapour,' and on 'Astronomical Refraction,' in 1840. In this year he succeeded to the Baronetcy on the death of his father, and from this period appears to have withdrawn himself somewhat from the active pursuit of scientific investigations. That they were not altogether given up is proved by

the fact that he became a Fellow of this Society in 1848, in which year he also communicated to the Society an interesting paper "On change of Climate resulting from a change in the Earth's Axis of Rotation." This paper, which derives additional interest from the discussions which have been recently carried on, was fully discussed by Sir H. Delabeche in his Anniversary Address of the same year *. Sir John Lubbock died at High Elm, Farnboro', Kent, on the 20th of June, 1865, at the age of 62.

Mr. Nicholas Wood was born in 1795. Having from an early age directed his attention to mining engineering, he became one of the most distinguished colliery-viewers in the north of England. This did not prevent his pursuing many branches of scientific investigation, amongst the most important of which was the encouragement he gave from a very early date to the introduction of the railway system. He it was who first wrote upon the subject, and showed how the tramways which had been used for local purposes might be made available for more general travelling. Under his auspices the Stephensons became famous and the locomotive engine was perfected, and he will ever hold high rank wherever the science of the nineteenth century, in the development of which he took so great a share, is known.

In 1831 he read before the Natural History Society of Newcastle-on-Tyne a paper "On the Geology of Northumberland and Cumberland," illustrated by a map and numerous sections, exhibiting the true coal-fields, the Millstone-grit, and Mountain-limestone districts. He also pointed out the effect of a remarkable dyke in dislocating or throwing down a portion of the Newcastle coal-field so as to render it available for mining in a district where, in the ordinary range of the strata, no coal would otherwise have been found. The value of these illustrations was great in a practical point of view, and the merit of such researches was enhanced by the comparative infancy of the science.

In 1844 Mr. Wood proposed at a meeting at Newcastle the registration of mining operations, the importance of which, in a geological no less than a commercial point of view, can hardly be exaggerated. In founding the Northern Institute of Mining Engineers at Newcastle in September 1852, Mr. Wood delivered an address which comprises a review of many of the most important subjects connected with practical coal-winning. He was eminently practical in his views, and it is worthy of special notice that in this address he placed geology in a prominent position. He said that the study of Geology and all its concomitant branches of science—Mineralogy, Chemistry, Mechanical Philosophy, Pneumatics, and Mechanics—are all subjects which might usefully and profitably occupy the time and attention of all the members of the Institution, and of the meetings of the Institution collectively. He also added suggestions for the collection of plans and records as a means of cultivating and extending geological science.

* See Quart. Journ. Geol. Soc. vol. v. pp. 4 and lxxxiv.

In November 1855 he advocated the formation of a mining school, in which naturally his attention was chiefly absorbed by the local attractions of the North of England Coal-fields. At the same time he recorded his due acknowledgment of the efforts made to establish an Office of Mining Records in London, which, first taken up by Sir Henry Delabeche, and subsequently promoted by Sir R. Murchison, was then ripening into what it has since become—a valuable school of mining science.

In 1855 he gave an excellent account of the sinking for coal through the Magnesian Limestone, accompanied by detailed sections. In 1863, together with Mr. Boyd, he prepared a geological paper on the Wash or Drift in the county of Durham, tracing the denudation over a great extent of country. He was elected a Fellow of this Society in 1843, and was also a Fellow of the Royal Society. He died on the 19th December 1865, in his 71st year.

Mr. Lovell Reeve, the son of Mr. Thomas Reeve, of Ludgate Hill, was born April 19, 1814. After distinguishing himself at school by his proficiency in Greek and Latin, he was at the age of 13 bound apprentice to a grocer on Ludgate Hill, where the accidental arrival of a sailor with a handkerchief of shells, of which he became the purchaser, led to his becoming an ardent student of natural history. From this small beginning his collection gradually increased, and in this he was assisted and encouraged by forming an acquaintance with a Mr. Walker, a compositor, also a zealous conchologist, as well as with Dr. Gray of the British Museum. In 1833 he attended the third meeting of the British Association at Cambridge, and in the Natural-History Section he was appointed Conchologist to a general exploring-expedition into the fens between Cambridge and Ely.

When his seven years of apprenticeship were over he proceeded to Paris, where he made his first contribution to the literature of Conchology, in the form of a paper "On the Classification of the Mollusca." This was read at a meeting of the Academy of Sciences. On his return to London he devoted himself with increased earnestness to his favourite study, and in a short time produced his 'Conchologia Systematica,' in two 4to volumes, illustrated by 300 plates of shells, published by Messrs. Longman in 1840–41. But the cost of publishing this expensive work exhausted his funds, even to the sacrifice of his share in his deceased father's property.

About this time the fortunate and almost accidental purchase of a valuable collection of shells at Rotterdam, made with great care at the Moluccas by the Dutch Governor, General von Ryder, enabled Mr. Reeve to return to his favourite occupation. By these and other means he was soon enabled to undertake the publication of an illustrated work on the species of shells, entitled 'Conchologia Iconica,' the value of which has been recognized by every palæontologist who is aware of the importance of accurate delineation of living species for the purpose of comparison with specimens of extinct forms. It was a fortunate moment when Mr. Lovell Reeve undertook this

work. Mr. Hugh Cuming had just returned home from his long expedition round the world, bringing with him vast stores of Mollusca collected during his years of wandering; many of these were altogether new to science, and the publication of them was looked forward to with the greatest interest both by palæontologists and conchologists. This great work has been continued with almost uninterrupted regularity since 1843 down to the present time.

In 1850 Mr. Lovell Reeve published a useful elementary work entitled 'Elements of Conchology, an introduction to the Natural History of Shells and of the Animals which form them.' He subsequently became, on his removal to Henrietta Street, Covent Garden, the publisher of many other works on natural history, and was afterwards the proprietor of the 'Literary Gazette,' which he edited with great ability from 1850 to 1856. He became a Fellow of this Society in 1853, and regularly presented to our Library the successive Monographs of the 'Conchologia Iconica.' His last, and by some considered his best, work, on the 'Land and Freshwater Mollusks of the British Isles,' was published in 1863. It contains much useful information "on the geographical distribution in other parts of the world of the species indigenous to this country, and on the relation which this distribution bears to climate, soil, and other local circumstances." He was a man of a most amiable disposition, and bore with exemplary patience for eighteen months the acute sufferings caused by a most painful illness. He died on the 18th of November, 1865.

Dr. S. P. Woodward, the son of Mr. Samuel Woodward of Norwich, was born September 17th, 1821. By his death the Society has experienced a very serious loss. His sound knowledge and assistance, both as a naturalist and a palæontologist, were always at the service of the Society or of its Fellows. From his earliest infancy his constitution was weak and delicate, and he showed his inclination for the study of natural history by beginning to form a collection of insects before he was eight years old; and when he had scarcely attained the age of ten years he assisted in publishing an account of the *Trichiosoma lucorum* in Loudon's 'Magazine of Natural History,' with an engraving of the insect in all its stages. In the following year he began the study of land and freshwater shells, and commenced the formation of his father's collection. To these pursuits he soon added the study of botany, after which entomology was given up, and he became a constant and zealous cultivator of botany and malacology, which were never relinquished.

In 1838 he came to London to complete his education at the London University, and soon obtained an appointment in the Library of the British Museum. In 1839 he succeeded Mr. Searles Wood, whose health had compelled him to resign, as Sub-Curator in the museum of this society, under Mr. Lonsdale. From this time he added palæontology to his other studies, and laboured assiduously in the arrangement of our collections and the improvement of the museum until 1845, when he was appointed Professor of Botany

and Natural History, including Geology, at the Royal Agricultural College at Cirencester.

He was one of the founders of the Cotteswold Naturalists' Field Club, and in 1848 was appointed First-class Assistant in the Department of Geology and Mineralogy in the British Museum. He subsequently received the appointment of Examiner for the Council of Military Education, as well as Examiner in Geology to the University of London. He was a constant contributor to various scientific and literary periodicals, and the pages of our own journal contain many valuable productions from his pen. In 1854 he communicated to this society a highly interesting paper "On the Structure and Affinities of the Hippuritidæ," in which many of the peculiar characters of these remarkable fossils were for the first time clearly brought together. With regard to the fossils to which they may be said to bear the closest resemblance, Mr. Woodward showed, while repudiating the doctrine of transmutation, that it might be assumed that the Cretaceous *Hippurites* are connected with the Oolitic *Dicerata* and Tertiary *Chamæ*. After describing the structure of the *Hippurites* and other allied genera, of which numerous woodcuts and plates of engravings serve as illustrations, he proceeds to give their affinities. He points out the successive opinions of various palæontologists, from Parkinson and others, who considered them as *Orthoceratites*, to the time when Prof. Quenstedt placed them in a more natural position, between the *Chamaceæ* and the *Cardiadæ*, The fact of their being bivalves had already been satisfactorily established.

In 1856 he gave us a description of a new *Orthoceras* from China, one specimen of which measured 29 inches in length. They, however, occurred only as longitudinal sections in thin plates of limestone, artificially worked down for some artistic or domestic purpose, and brought from some place distant 200 miles from Shanghae. Enough, however, of the shell remained to enable Mr. Woodward to describe its structure and to ascertain the series of changes which it had undergone.

In 1860 he assisted Capt. Spratt in naming the recent shells from Bessarabia, as well as the fossil shells from the lower freshwater deposits of Bessarabia, lists of which are published in our journal of that year.

He also contributed several papers to the 'Proceedings of the Zoological Society,' to the 'Intellectual Observer,' and to the 'Annals of Natural History.' The article on Volcanos in the 'Encyclopædia Britannica' was written by him; and for many years he prepared Reports on the Proceedings of the Geological Section of the British Association.

But, perhaps, the most important and valuable work which he contributed to science is the 'Manual of Recent and Fossil Shells,' published 1851 to 1856. It is an excellent text-book, and full of original matter. The Supplement, containing a detailed account of the geographical distribution of living Mollusca, as well as of the distribution in time of the fossil species, is deserving of the highest

commendation. He also assisted Prof. Owen in the preparation of that portion of his 'Palæontology' which comprises the Invertebrata.

His health had been gradually declining for the last few years, and he died at Herne Bay, July 11th, 1865.

Mr. George Roberts was born at Kidderminster, and for upwards of five years held the office of Clerk to this Society, of which he became a Fellow in 1864. He was the author of numerous papers both on geological and other interesting subjects. These he communicated to the Geological Society, the 'Geological Magazine,' and other periodicals; many of them showed great talent and boldness in taking up original views. He died at Kidderminster, 20th December, 1865.

We have also to deplore the loss of other Members of the Society, amongst whom I may mention the names of Samuel Cartwright, Col. Sampson, Thomas Young, J. R. Macdonnell, F. W. Simms, W. B. Mitchell, and T. Hutton.

Amongst the Foreign Members whom we have lost I must mention the name of Dr. Christian Pander, who was born at Riga on the $\frac{12}{24}$th July, 1794. He was the son of a wealthy banker. His education was commenced in the Gymnasium of his native town. In 1812 he entered the University of Dorpat to study medicine, but left in 1814, in order, like so many of his countrymen, to complete his education at Berlin and Göttingen. With his great love for natural history he became so engrossed in the study of the preliminary sciences that he never reached the point of practical medicine. He devoted himself to original investigations, and established a chemical laboratory in his own house. In 1816 he went to Würzburg, and there began his remarkable investigations respecting the development of the chick in the egg, which led the way to a long series of microscopical investigations respecting the general course of the development of animal bodies. Professors Döllinger and D'Alton were his collaborateurs in this great work. On its completion he undertook, with Prof. D'Alton, a long journey through France, Spain, Holland, and England, principally with the view of visiting the great anatomical museums of Europe, but also for the purpose of collecting marine animals on the sea coast. On his return home Pander was attached as naturalist to the Embassy sent to Bokhara in 1820 under the direction of Baron Meyendorff. In 1822 he was attached to the Imperial Academy of Sciences of St. Petersburg, and in 1823 he became a regular member of it in the zoological branch. While employed in systematically arranging the objects of the zoological collection, he undertook the examination of the geological formations in the neighbourhood of St. Petersburg, as well as their fossil remains. He thus became, by his work entitled 'Contributions to the Geognosy of the Russian Empire' (1831), the founder of our knowledge of those formations, now called Silurian, to which Strangways and

Eichwald had first called the attention of geologists. In 1827 he resigned his appointment and withdrew to his paternal property of Zarnikau in Livonia. But even here he could not resist the attractions of natural history. The sandy soil of Livonia contains numerous remains of the scales and teeth of animals of a very early period, of which the determination was most difficult. Pander collected great quantities of these teeth and other fragments, and was the first to recognize that they must have belonged to lost species of cartilaginous fishes. But the difficulties of the position in which he was placed, in a district where the publication of his plates was almost impossible, and where his only object was the satisfaction of his own scientific inclinations, led to his being anticipated by Sir R. Murchison in making known the character of this Devonian formation with its cartilaginous fishes.

In 1842 he was appointed to the School of Mines and settled in St. Petersburg, whence he carried out several geological expeditions in Livonia, Esthonia, Central Russia, and in the Ural, the chief object of which was to study the palæontological character of the older formations, and to select the best spots for establishing experimental works for coal after fixing the geological horizon of the coal-beds of Russia. We are also indebted to Pander for the important and practical explanations respecting the beds and contents of the Ural coal-field. He died on the $\frac{10\text{th}}{22\text{nd}}$ September, 1865, after long suffering from a painful disorder. He will be long regretted as one of the truest of friends and most simple-minded and unselfish of scientific men. Science was to him the love of his heart, and he never could be induced to use it for the furtherance or improvement of his own position.

Karl von Raumer was born at Wörlitz, near Dessau, on the 9th April, 1783. In 1797 he attended the Joachimsthal Gymnasium in Berlin, and was at this early age distinguished for his love of art and poetry as well as science. In 1801 he commenced his academical career at Göttingen, where, contrary to his own inclinations, he devoted himself to his legal studies. At the same time he attended Blumenbach's lectures, and became a great proficient in music. He worked and read hard, and his education was at this time literary rather than scientific. In 1803 he removed to Halle. Here he remained a year longer than the parental programme had originally contemplated, for the purpose of attending the lectures of Prof. Steffens. This first awoke his love for natural history, which subsequently became the ruling passion of his life. Deeply interested by Steffens's lectures on the internal history of the earth (this was in 1805), he was greatly excited by the grand idea therein developed, that the earth also had its history. He now learnt, for the first time, that Werner had founded his history of the development of the earth on his observations on existing mountain forms. In 1805 he went to Freiberg to attend Werner's lectures, where the great naturalist gradually weaned him from his philosophical and historical inclinations to the earnest and engros-

ing study of mineralogy. He remained at Freiberg until 1808. At this period of his life, at the age of twenty-three, he is described as a most engaging and fascinating person. He became intimate with Varnhagen and Schleiermacher, and was the constant companion of Schubert and of Engelhardt.

The battle of Jena produced a great effect on his outer and inner life. Overwhelmed by the sad fate of his country, he looked for consolation, first, to his mineralogical studies, and then began his geological explorations with Engelhardt, exploring the Erzgebirge and the mountains on the Rhine between Cologne and Strasbourg, and subsequently the formations in the neighbourhood of Paris. Here a remarkable change took place in his ideas. His hatred towards the conquerors of his country, and the reading of the works of Pestalozzi and others, engendered the idea of exerting himself for the improvement of the education of young Germany, and of raising a more fertile produce from the rotten soil.

After another visit to the Syenitic formation of the Erzgebirge, he proceeded to visit Pestalozzi, at Yverdon, and became a teacher in his establishment. But here a sad disappointment awaited him. Only a few weeks had passed away before he was undeceived and became aware of the total want of method in the system, and of the germs of destruction and decay which it contained; Pestalozzi confessed it himself, and in May 1810 Raumer left him a sadder but a wiser man. In Nürnberg he again met Schubert, who encouraged him to publish the results of his former explorations under the title of 'Geognostical Fragments.' The unexpected success of this, his first publication, led to his being appointed Professor of Mineralogy at Breslau, in 1811, and councillor of the mining establishment there. But this publication also bore bitter fruit, and led to a temporary estrangement between him and his beloved teacher Werner. He had proved in this work that the sequence of the beds of the older rocks which Werner had laid down was by no means of universal application, and that this very Erzgebirge, which Werner had considered as the type of all mountain-formations, was itself a remarkable exception. He was himself astonished at the result, but the followers of Werner were indignant. The quarrel was made up in 1814.

The commencement of his duties in Breslau, notwithstanding the fact that his brother, the historian, Frederic v. Raumer, was one of his colleagues, was attended with great difficulties, for want of a good mineralogical collection. The investigation of the Silesian mountains, in 1812, was a more agreeable occupation, and in 1813 he published his work 'On the Granite of the Riesengebirge.' But the spring of this year brought another change. The appeal of the king to arms for the liberation of the country found an echo in his heart. He entered the Landwehr, became aide-de-camp to General Gneisenau, took part in the battle of Leipzig and other minor engagements, and was employed on many important and confidential missions. On the 4th of May, 1814, he was most honourably dismissed by the king, and a few days afterwards was decorated with the Order of the Iron Cross.

He returned to his duties at Breslau, where he spent several happy years, until the unfortunate events of 1817 and the excesses of some of the Burschenschafts again caused troubles in his happy circle. Raumer had ever taken a lively interest in the development of young men, and had encouraged the use of gymnastics, or "Turnen;" and as some of the excesses of the times were connected with the gymnastic societies, Karl v. Raumer was most unjustly looked upon with suspicion even by some of his most intimate friends.

This led him to seek another appointment, and in 1819 he was named Professor of Mineralogy at the University of Halle. He had now completed his most important geological work, 'The Mountains of Lower Silesia, of the County Glatz, of part of Bohemia and Oberlausitz, geologically represented.' The merits of this work have been fully recognized by all subsequent competent observers. He remained at Halle until 1823, but even here his position was not altogether satisfactory. This was the period of the reactionary persecution of the so-called demagogic tendencies of the students of the German Universities. Much as Raumer had encouraged the development of youthful energies, no one was more opposed than he was to their excesses; and it grieved him to see what was, in fact, only occasional excrescences of the new growth looked upon as the main object of the new movement. But his protection of the students was of no avail, and he himself was looked upon with suspicion; this determined him to leave Halle, and for a time he undertook the management of a private school at Nürnberg. Here he was again disappointed; circumstances over which he had no control led to the breaking up of the institution in 1826, and Raumer again found himself without a post. But in the following year Schubert's removal to Munich opened the way to his appointment at the University of Erlangen, where he passed a happy and honourable existence for the remainder of his life. His influence over the students was great, and amongst his colleagues were many who had been his pupils in former years. Here he published his 'Manual of Universal Geography' ('Lehrbuch der allgemeinen Geographie'), so highly prized by Alexander v. Humboldt; his 'Palæstina,' no less highly spoken of by Karl Ritter; and his 'History of Pædagogik (or science of education) from the restoration of Classical Studies,' a work of universal estimation. His principal duties at Erlangen were to lecture on natural history and mineralogy, for the latter of which he formed an excellent collection. He retained his faculties, both of body and mind, almost to the last moment of his life, and died on the 2nd of June, 1865, beloved and regretted by all who knew him.

Having as yet failed in obtaining any obituary notice respecting the other Foreign Members whom we have lost, I can here only mention their names:—Charles v. Oeynhausen of Westphalia, who will be well remembered by many of our older geologists as having visited this country upwards of thirty-five years ago, when he explored the highlands of Scotland and the Isle of Sky under the guidance of

Prof. Sedgwick and Sir Roderick Murchison; Dr. Forchhammer of Copenhagen, born at Husum in 1794 (he was President of the Polytechnicum in Copenhagen, and died on the 14th December, 1863); and Dr. Oppel of Munich, who was elected a Foreign Correspondent only two years ago: he was a Member of the Academy of Sciences, and Conservator of the Palæontological Museum of Munich; he died on the 23rd of December, 1865.

I shall now proceed to lay before you some account of the progress of our science during the past year, and of the principal works which have been published at home and abroad bearing in any way upon the advance of geological knowledge. But here, at the very outset of my task, I find it necessary to claim your indulgence. Were I to allude, however briefly, to every work and every memoir to be found in the many scientific publications of Europe and America, every one of which contains new and interesting matter, you would only have to listen to a dry and uninteresting catalogue. I have therefore been compelled to make a selection of such as appeared to me most interesting or important; and here it is that I must claim your indulgence, if I have failed in the due appreciation of their relative merits. I cannot but fear that I may have overlooked many works of great value, while I may possibly have given undue attention to others less deserving of such notice. I will only add that I have endeavoured, as far as possible, to arrange the different notices according to geological chronology, beginning with the oldest formations.

I must, however, preface my remarks with an account of some of the Geological Surveys which have been carried on in different parts of the world.

Geological Survey of the United Kingdom.

I learn from Sir Roderick Murchison that, with respect to England, the progress made by the Geological Survey under Prof. Ramsay chiefly relates to the south-eastern and northern counties, 483 square miles having been surveyed in the former, and 510 in the latter. In Scotland 332 square miles have been surveyed; for the most part in the Carboniferous strata, and in that highly metamorphosed and difficult ground occupied by Old Red Sandstone and Silurian, south of Ayr and Dalmellington. These areas, with tracts of minor extent in detached parts of England, make a total of 1500 square miles for Great Britain.

The publication of the maps relating to the geology of England has necessarily been delayed by the insertion in the old copper-plates of the lines of railroad and other additions, which the public have called for. The sanction of the Treasury having at length been obtained, Sir Henry James is now occupied in improving the topography of the electrotype-plates for the Geological Survey, and inserting thereon the lines of all railways and the degrees of latitude and longitude.

In Ireland, Mr. Jukes reports that 1037 square miles have been surveyed, and that four new sheets have been issued, making the total number that have been published 102.

On what may be viewed as an important new feature in classification, it will interest geologists to know that, in considerable tracts, extending over large parts of Somersetshire and Gloucestershire, the Rhætic or Penarth beds are being elaborately laid down by Mr. Bristow; whilst, as is well known to the Society, Mr. Dawkins and Mr. Etheridge have completed sections which accurately define the contents and succession of the fossil remains in this peculiar deposit.

Amongst the memoirs published by the Geological Survey, none perhaps will be found more useful than the 'Catalogue of the Collection of fossils in the Museum of Practical Geology,' by Professor Huxley and Mr. Etheridge, published during the past year, with an explanatory introduction by Prof. Huxley. I would gladly have given some account of this most interesting preface, containing a clear exposition of some principles of natural history, as well as the application of natural history to the study and elucidation of fossils, or palæontology; but to do justice to such a subject it would be necessary to quote almost every line of every page. Such a proceeding would be impossible; it would also, I trust, be unnecessary, for the book itself must find its way into the hands of every British geologist at least. I must therefore content myself with recommending it to your special notice, not only on account of the matter it contains, but for its close and logical reasoning, and the pleasing style in which it is written.

Geological Survey of Canada.

As the Geological Survey of Canada progresses, under the direction of Sir W. E. Logan, the exertions of the surveyors have been rewarded by the discovery of many new forms of animal life. These have been described and published from time to time by Mr. Billings, the palæontologist to the Survey. The volume for 1865, now before me, contains amongst other matter several articles on the discovery of these fossils, viz. new species of fossils from the limestones of the Quebec group, from Point Lévis and other localities in Canada East. Amongst the new fossils here described is a new *Orthis*, a new genus called *Clisospira*, *Ophileta* 2 species, *Murchisonia* 3 sp., *Pleurotomaria* 1 sp., *Cyrtoceras* 4 sp., *Dikelocephalus* 7 sp., *Olenus* 1 sp., *Bathyurus* 3 sp., and *Cheirurus* 1 sp. The next article is on new species of fossils from the Quebec group in the northern part of Newfoundland. The north-western coast of Newfoundland, from Cape Norman to Bonne Bay, on the Gulf of the St. Lawrence, a distance of about 180 miles, is composed altogether of Lower Silurian limestones, slates, quartzites, and sandstones. The width of this belt of Silurian rocks is from five to ten miles. The fossils show that these rocks belong to the Potsdam and Quebec groups, the former having a thickness of about 2000 feet, while the Quebec group is about 6600 feet in thickness.

The author gives a table of the different members of this series of

rocks abridged from the measured sections published in the 'Geology of Canada.' Amongst the principal fossils here described, beginning with the Protozoa, are *Calathium*, a new genus, 4 sp., *Trachyum* 2 sp., *Stomatopora* 2 sp., fragments of *Crinoidea*, *Stenaster Huxleyi*, *Lingula* 3 sp., *Acrotreta* 1 sp., *Orthis* 3 sp., with portions of others, *Strophomena* 2 sp., *Camarella* 3 sp., *Rhynchonella* 1 sp., *Euchasma* 1 sp., *Eopteria* 1 sp., *Ctenodonta* 1 sp. Amongst the Gasteropoda are *Holopea* 1 sp., *Straparollina* 1 sp., *Subulites* 1 sp., *Pleurotomaria* 12 sp., *Murchisonia* 9 sp., *Maclurea* 11 sp., and opercula of three more, *Ophileta* 2 sp., *Helicotoma* 4 sp., *Exculiomphalus* 3 sp., *Metoptoma* 1 sp. Of Cephalopoda, *Orthoceras* 8 sp., *Piloceras* 3 sp. Of *Nautilus* 4 new species are provisionally named. Amongst the new species of Crustacea are *Bathyurus* 4 sp., *Bathyurellus* 6 sp., *Dolichometopus* 2 sp., *Asaphus* 3 sp., *Nileus* 3 sp., *Illænus* 5 sp., *Harpides* 2 sp., *Lichas* 1 sp., *Shumardia* 1, *Cheirurus* 6 sp., *Amphion* 3 sp., *Triarthrus* 1, *Telephus* 1, *Encrinurus*(?) 1, *Remopleurides* 2, *Ampyx* 4, *Agnostus* 2. Entomostraca: *Leperditia* 3, *Beyrichia* 1.

The next article or memoir contains a description of new fossils from the Quebec group in Eastern Canada, with some others previously described, and some from other formations. Most of these species were discovered after the former memoir, describing the new fossils from Point Lévis, &c. had been printed. The new species are—*Lingula* 1, *Orthis* 4, *Camarella* 3, *Eopteria* 2, *Murchisonia* 1, *Metoptoma* 1, *Helicotoma* 1, *Ophileta* 1, *Bellerophon* 1, *Orthoceras* 10, *Cyrtoceras* 1, *Asaphus* 2, *Bathyurellus* 3, *Amphion* 2, *Cheirurus* 4, *Remopleurides* 1, *Harpes* 1, *Illænus* 4, *Harpides* 1, *Calathium* 1. Other species still remain to be described; but even the list which I have given above will suffice to show how rich a mine of Silurian forms still remains to be worked out in these old formations, and how far we still are from a complete knowledge of their fossils.

Another interesting work which has reached us from the other side of the Atlantic is 'A Preliminary Report on the Geology of New Brunswick, together with a Special Report on the distribution of the Quebec Group in that Province,' by Henry Youle Hind, formerly Professor of Chemistry and Geology in the University of Trinity College, Toronto. After giving in the introductory chapter a detailed statement of all that had been hitherto published by other geological explorers in the province, Mr. Youle Hind briefly states the result of the last season's work.

1. He describes the approximate breadth of the Quebec group, the great metalliferous formation of North America, in various localities.

2. Having paid particular attention to the circumstances under which the Albertite in Albert County has originated, he has come to the conclusion that it is an inspissated petroleum, and that it has originated from underlying Devonian rocks, probably of the same age as those yielding the vast stores of petroleum in Canada and the United States.

3. The ascertained existence of the true Coal-measures within the limits of the province is very important.

4. The view formerly entertained respecting the granite belt passing through the province must be greatly modified. Instead of one broad belt it consists of a series of very narrow belts, with intervening schists and metalliferous slates. This granite is of Devonian age, and it is probably not an intrusive rock, but consists of highly altered sedimentary strata. The same remark applies to much of the granite in Charlotte, King's, and Saint John counties, which are also probably metamorphosed sedimentary rocks.

These views, with others of great interest, are more fully detailed in the work itself, the first chapter of which describes the leading geographical features of the province, while the second contains a geological sketch of the same region. The sedimentary rocks of New Brunswick belong to the following great divisions:—1, Recent and Post-pliocene; then a great break to 2. Triassic (?); 3, Carboniferous; 4, Devonian; 5, Upper Silurian; 6, Middle Silurian; 7, Lower Silurian. All the beds below the Carboniferous have been very much disturbed. This chapter also contains some interesting observations respecting the origin of granite and the different characters of the granite belts traversing the province, many of which, while admitting the intrusive character of others, the author supposes to be metamorphosed or altered sedimentary strata belonging to the Quebec group. Mr. Hind says, p. 50, "They have probably been altered in position, and belong to the class named by Professor Hunt 'Indigenous rocks;' and there are valid reasons for supposing that much of the granite of New Brunswick consists of altered sedimentary strata, changed by metamorphism into plastic felspathic sandstones and granitoid gneiss, then, by a further metamorphism, partly into plastic granite and in part retaining traces of the stages of their metamorphism." He also shows, by the presence of graphite, that the metamorphism of many sedimentary rocks was not accompanied by a great elevation of temperature, and he concludes these observations by this statement:—"The opinions which necessarily associate high temperature with the occurrence of crystalline rocks, or of rocks which have undergone metamorphic action, are no longer tenable." However novel these views may appear to many geologists, I cannot refrain from saying that I believe they will ultimately prove to be correct; I have long entertained an opinion that the early plastic state of the earth was due to aqueous rather than to igneous causes. It is a question well deserving consideration, and which, I hope, will soon be taken up by some one whose chemical and physical knowledge will enable him to do justice to such an important question.

The two following chapters are devoted to the consideration of the Carboniferous series. The following details will afford some idea of the Coal-fields of the eastern provinces of British North America:—

1. Upper Coal series, unproductive ..... 3300 feet.
2. Middle Coal series, productive ..... 4000 „
3. Lower Carboniferous or Gypsiferous series.. 6000 „

The base consists of red sandstone interstratified with beds of a coarse

calcareous conglomerate, reposing in many places, nearly horizontally, on granite of Devonian age. Chapter V. is devoted to the consideration of Albertite and the Albert shales. This remarkable mineral, respecting the nature of which such different opinions were entertained some time ago, is now shown to be an inspissated petroleum, occupying fissures in the Lower Carboniferous rocks along the anticlinal axes, and injected from below at two distinct periods under considerable pressure. The author concludes by showing that its source lies beneath the Albert shales—in other words, beneath the Lower Carboniferous series—and that it is consequently of Devonian or prior origin, and probably proceeds from rocks of the same age as those which yield the petroleum of Pennsylvania, Ohio, and Canada.

The sixth chapter describes the rocks of the Devonian series, with a full account of its vast mineral wealth, consisting of iron-ores, copper, and argentiferous galena. These rocks are traversed by many intrusive trap-dykes, having a general course from east to west. Some of these traps are copper-bearing. The seventh chapter contains an account of the Upper and Middle Silurian series, while the eighth describes the Lower Silurian series, of which the Quebec group is the most important. Of this the author says:—"Not only is the Quebec group the great metalliferous formation of North America, but its remarkable thickness (7000 feet) and complexity, coupled with the extraordinary manner in which it was deposited and brought to the surface, all unite to make it one of the most interesting and important formations of the entire geological series, with perhaps the single exception of the Coal-measures. Not only does it comprise a great variety of useful rocks, but it contains in remunerative quantities iron, copper, nickel, cobalt, antimony, lead, zinc, chromium, arsenic, titanium, silver, and gold." There are some interesting remarks respecting the chemical origin of the metals of the Quebec group, taken from Professor Hunt's work 'On some points of American Geology,' in which it is suggested that they were originally brought to the surface in watery solutions, from which they were separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediment in various forms. The intervention of intense heat, sublimation, and similar hypotheses, to explain the origin of metallic ores is considered to be uncalled for, and reference is made to the beautiful experiments of De Senarmont and Daubrée. The different developments and contents of the Quebec group are more fully described in the ninth chapter. In the following chapter much information will be found respecting the effects of glacial action in modifying the surface of the country, in many parts of which boulders of great size and in considerable quantities are found. The rocks, too, are everywhere scratched, striated, and polished. In accounting for these phenomena, Mr. Hind gives the preference to the theory of a glacial covering rather than to the iceberg theory. A comparatively slight elevation of the country, rising gradually to the north, would account for all these phenomena by the theory of a glacial covering more

satisfactorily than the depression necessary to explain them under the iceberg theory. In the latter case a depression of 5000 feet would be required, whereas there is no evidence of any greater depression than about 600 feet having taken place. The direction of the moving mass of ice appears, on the evidence of the *striæ* observed in New Brunswick, to have been nearly north and south; but as these *striæ* can only show us the last record of the moving mass, there is no reason for supposing that its direction may not have varied under different conditions at former periods.

Geological Survey of India.

Under the able superintendence of Professor Oldham, the Geological Survey of India has been prosecuted with as much ardour and zeal as was compatible with the difficulties of the country and the limited means at his disposal; this latter difficulty was, however, reduced by an increased rate of allowance for travelling expenses having been subsequently accorded by the Viceroy. Other difficulties were also caused by several members of the staff being detached for special service.

Amongst the more interesting results of the past season, as appears from the 'Annual Report,' is the discovery, by Mr. Medlicott in Assam, that, to the south of the River Brahma-poutra, there are widely-spread and highly valuable beds of Coal, of most excellent quality, superior to any other known Indian coals, which offer promise of yielding a plentiful supply of good fuel. In Central India, Mr. Mallet has carried out a careful revision of the boundaries of the Vindhyan rocks to the north of the Nerbudda valley, and has extended his survey to the western extremity of the same valley. Mr. Hackett has completed the geological examination of the country included in the first sheet of the Gwalior map. Mr. Mallett and Dr. Stoliczka have been employed in working out the structure of the higher Himalayan regions. The fossils from Spiti and Rupshu had been long known, but much confusion and uncertainty existed respecting the exact localities from which they were obtained; these have now been worked out on the spot, and the results will soon be published. It is, however, already known that undoubted representatives of acknowledged European series—the Silurian, Carboniferous, Triassic, Rhætic, Lower and Middle Lias, Jurassic (probably of three distinct periods), and Cretaceous—have been proved to occur in these mountain heights. The fossils have been carefully examined, and the 200 varieties or so-called species have been reduced to 164. Amongst the Cephalopoda alone no less than 24 out of 54 supposed species must be suppressed, having been already described under different names. In Bombay the progress of the Survey has been delayed by various causes, but much good work has also been done there. The Survey of the Nerbudda valley has been completed, as well as of a large tract of country south of that river. The prevailing surface-rock of the district, except the alluvial deposits, is, as in the Deccan area, trap; the basement or bottom rocks are chiefly granitic or gneissic. Between

these two formations the principal beds are sandstones and limestones of Cretaceous age; and to this series probably belongs the great Mahadeva group of the Puch-murri Hills.

In Madras the examination of the quartzites of the Cudapah and Kurnool districts has been satisfactorily continued by Messrs. King and Foote.

The regular issue, at the stated intervals of three months, of the successive parts of the 'Palæontologia Indica' has been steadily maintained during the past year. The four parts issued have been in continuation of the description of the splendid series of fossil Cephalopoda from the Cretaceous rocks of Southern India. No less than 148 species have been described in this series, thus distributed: *Belemnites* 3 species, *Nautili* 22, *Ammonites* 93, *Scaphites* 3, *Anisoceras* 11, *Helicoceras* 1, *Turrilites* 6, *Hamites* 2, *Hamulina* 1, *Ptychoceras* 3, and *Baculites* 3—a most remarkable fauna from a single district. Of these, 38 are identical with species known in Europe and elsewhere, and of these 38 species not less than 32 belong to the Middle Cretaceous series of Europe.

Amongst the memoirs of the Geological Survey of India I will only further allude to the geological sections across the Himalayan Mountains from Wangtu Bridge on the River Sutlej to Sungdo on the Indus, with an account of the formations in Spiti, accompanied by a revision of all known fossils from that district, by Dr. Ferdinand Stoliczka.

I must also notice, however briefly, an account by Professor Huxley of vertebrate fossils from the Panchet rocks near Ranigunj, in Bengal, also published in the 'Palæontologia Indica;' they consist of numerous fragmentary and sometimes rolled bones, the majority of which are vertebræ. There are, however, some teeth, small portions of crania, with fragments of detached lower jaws. They are of very great interest, as being the first remains of Vertebrata yet discovered in the great group of rocks associated with the coal-bearing formations of Bengal. They were discovered by Messrs. Blanford and Tween in a stratum of conglomerate-sandstone exposed in the Damuda river near Deoli, fifteen miles west of Ranigunj. They appear to have been probably terrestrial, certainly not marine; and Professor Huxley is disposed to consider them as either of Triassic age or as belonging to that fauna which will some day be discovered as filling up the apparent break between the Palæozoic and Mesozoic forms of life—an opinion which coincides with that already expressed by Dr. Oldham and Mr. Blanford.

And while on the subject of Indian geology, I may here allude to an account of the Palæozoic and Secondary fossils collected by Col. Richard Strachey in the Northern Himalaya, recently published by Messrs. Salter and Blanford. They are chiefly derived from Niti and its neighbouring passes. A large proportion of the Silurian fossils are from Gunceljunga in the Chorhoti Pass, at an elevation of 17,000 to 17,500 feet above the sea. The existence of these fossils was first made public by Col. Strachey in a paper read before

the Geological Society in 1851 *, in which the physical features of the mountain district are fully described, and the generic characters of the fossils are indicated by Mr. Salter. In the work now under consideration Mr. Salter says, "With regard to the Palæozoic rocks of India so little was known at the time of Col. Strachey's researches that to have secured a fossiliferous base was a great stride in the geology of India. The list of genera furnished by myself to the paper above quoted sufficiently indicated the presence of a Lower Silurian group, which, while its fossils agreed in general character with those of Europe, was quite distinct in species. This fact supplies another proof of the existence, at this early period, of marine natural-history provinces like those of the present day. The subdivision of the old ocean-fauna, easily recognizable over many areas of Silurian rocks, becomes less conspicuous in the Devonian, especially in the upper part, and had become nearly obliterated in Carboniferous times."

Mr. Salter observes that the Silurian species are all new. Of Trilobites there are eight species, all except one belonging to well-known European genera, the forms resembling those in our own slate rocks; they represent seven genera, one of which, *Prosopiscus*, is new; *Tentaculites* and *Serpulites* also occur. The Cephalopoda are but few, yet their general characters remind us of those of other Silurian regions. Eight species are described, belonging to six genera: *Nautilus* (?), *Cyrtoceras*, *Lituites*, *Orthoceras*, *Theca*, and *Bellerophon*; they are almost all from the Chorhoti Pass. The Gasteropoda comprise ten species, representing six genera, and are also chiefly from the same pass. The Lamellibranchiata are but few, and represent three or four species of the genus *Ctenodonta*. The Brachiopoda are here also, as Mr. Salter observes, the most abundant shells of the Silurian deposit; under generic forms familiar to every student of the older rocks, and (although identical with none of them) representing even the common species of Wales and Shropshire, they stamp the formation as accurately as if we could trace the connexion of the beds themselves. This coincidence of numerous genera, and, so far as we know, of specific groups peculiar to the Lower Silurian, is very remarkable and satisfactory when such remote districts are compared. Twenty-six species are here described, belonging to the following genera: *Lingula* 2, *Leptæna* 5, *Strophomena* 9, *Orthis* 6, with several varieties of *O. Thakil*, besides other species not sufficiently perfect to admit of a satisfactory description. Bryozoa are also abundant, and appear to have been precisely of the same nature in the Indian as in the European areas: as in our own slate rocks, the narrow bifurcating forms and broad foliaceous species are found together. Two species of *Sphærospongia* occur amongst the Amorphozoa. Crinoid stems of several species have also been found, but none perfect enough to be worth describing. The genera *Chætetes* and *Heliolites* have also been found amongst the Zoophyta.

* Quart. Journ. Geol. Soc. vol. vii. p. 292.

The Carboniferous fossils brought home by Col. Strachey are neither abundant nor well preserved; nor are the collections of M. Gerard and Prof. Oldham much better. These, as well as those collected by Dr. Fleming in the Punjab, have already been described. Mr. Davidson enumerates no less than twenty-eight species of Brachiopoda, of which thirteen are identical with British fossils. Only two new species are here described by Mr. Salter, *Chonetes Vishnu* and *Aviculopecten hyemalis*.

The fossils of the Triassic series are particularly interesting; they are chiefly Cephalopoda, representing the Upper Triassic group so well developed in the Austrian Alps. The extended study of these beds by continental geologists has, as Mr. Salter shows, only confirmed the impression they first gave, that their fossils were an intermediate group between the primary and secondary systems of life. The Himalayan fossils of this age are but few; but the most striking and common forms among them are the species most characteristic of the same strata in the Alps. This opinion of Mr. Salter has been confirmed by Prof. Süss of Vienna, who says that the Hallstadt beds of the Carinthian Alps have a peculiar band of dark shale, tenanted almost exclusively by two fossils, viz. *Halobia* (*Avicula*) *Lommeli*, Münst., and *Ammonites floridus*, Wülfen. It is singular to find that these are the two most conspicuous fossil species in the Himalayan series, mixed with several other decidedly European forms, such as *Ammonites Aon*, *A. Asseeanus*, *A. coangustatus*, and *A. diffisus*, Hauer; and in all these cases the Tyrol and Himalayan specimens have the minutest points of structure identical. The *Natica subglobulosa* and the two species of *Orthoceras* are also identical.

In the case of the Brachiopoda, probably the inhabitants of deeper water, it is shown that the characteristic shells *Athyris Deslongchampsii*, *A. Strohmeyeri*, *Rhynchonella retrocita*, and *Waldheimia Stoppani* are all identifiable, and were easily recognized by Prof. Süss, who has described them. The same forms occur in the Spiti Pass, and Prof. Oldham has found in that region a great distinction between the lower mass of strata inclosing the Triassic fauna and that above it, which is loaded with Oolitic and Triassic types.

Mr. Salter here figures a remarkable fossil brought home in abundance by Dr. Gerard from the same locality, closely allied to, if not identical with, *Spirifera Keilhavii*, Von Buch, a shell characteristic of the Mountain-limestone in Arctic regions.

Thus we find the Triassic rocks of India not only forming, as it were, a link between the Palæozoic and Secondary rocks, but containing many species identical with those of the more northern regions of Europe. Undoubtedly there is much in this to confirm the opinion so often entertained by palæontologists, although it may sometimes have been carried too far and maintained too dogmatically, namely, that in the earlier stages of organic life the same species were more widely distributed than at present, and that over widespread areas there was less variety of form, both of species and of genera, than we meet with now. Nor is it a sufficient answer to this theory to say that the older formations are difficult to explore,

that many forms may have been destroyed by subsequent metamorphism, and that we must be necessarily ignorant of most of the species which existed in the earlier periods of the world's history. To a certain limited extent such may be the case; but if there really existed in the Palæozoic period the same diversity of form in distant areas as we find prevailing in the present day, it would be a strange coincidence, and contrary to every doctrine of probability, to find among the forms which had escaped destruction, and which had come under the notice of the geologist, precisely those which were either identical or analogous in different areas. Is it not, on the other hand, more probable that during the Palæozoic period, when the first sedimentary deposits were formed in the waters of the ocean, the conditions of life were more similar over a larger portion of the earth's surface than during any subsequent period, when partial disturbances, dislocations, and other changes had destroyed that uniformity which at first prevailed?

But I must return to the Himalayan fossils. Mr. Salter publishes a list of the fossils from the Upper Triassic (Keuper) rocks in the Himalayas, with the respective localities in Europe of such as are identical; from which it appears that, out of thirty-six species, fourteen occur in the Keuper beds of the Austrian Alps. Amongst the species described are—*Ammonites* 11 species, *Orthoceras* 1, *Natica* 1, *Monotis* 1, *Pecten* 2, *Lima* 1, *Exogyra* 1, *Athyris* 2, *Rhynchonella* 1, *Waldheimia* 1, *Spirifera* 2. Mr. Salter remarks on the singular fact that scarcely one of the Triassic fossils obtained from the Spiti district, and brought home last year by Prof. Oldham, corresponds with those of the Niti Pass, though 100 miles nearer to the Alps. He suggests that in the Spiti valley we may probably have a different and an older group.

The Cephalopoda of the Jurassic rocks are next described by Prof. Blanford of Calcutta; they consist of nineteen species, of which eighteen are Ammonites and one a Belemnite. The identity of Indian species with those of Europe does not appear so great as in the case of the underlying rocks. The author says that, with the exception of *Ammonites biplex*, Sow., and *A. triplicatus*, Sow., no well-identified European species occurs among Col. Strachey's fossils, although many of the latter are closely allied to European types.

Mr. Salter then proceeds to describe the Gasteropoda and Bivalves from the same range of strata; these, however, are of great thickness, and, as he observes, probably include several members of the Jurassic series. The fossils here described are—*Turbo* 1 sp., *Chemnitzia* 1, *Ostrea* 2, *Avicula* 1, *Monotis* 1, *Pecten* 6, *Lima* 2, *Inoceramus* 1, *Modiola* 1, *Myophoria* 1, *Nucula* 1, *Mactromya* 1, *Cardium* 1, *Astarte* 1, *Cucullæa* 1, *Anatina* 1, *Terebratula* 3, *Rhynchonella* 2. The work concludes with an interesting postscript by Mr. Blanford, referring to the works of Prof. Oppel and Dr. Stoliczka, the latter of whom has recently visited the Spiti valley, and has made a more complete examination of the fossiliferous formations of that part of India than had been accomplished by any pre-

vious visitor; he also corrects some errors of nomenclature which had crept into former notices, and refers to some discussion which had arisen respecting the authenticity of certain specimens. He also observes that the *Spirifera Rajah*, supposed to be identical with *S. Keilhavii*, does *not* occur in the same beds with Triassic Ammonites, but in beds decidedly below them, and is therefore probably of the same relative age as the "Carboniferous" of Europe. The work is illustrated by 23 plates of fossils, in which all the new species are engraved.

Another volume of the works of the Palæontographical Society has been published during the past year (vol. for 1863), containing portions of four monographs. The first is the continuation of Mr. Salter's "Monograph of British Trilobites," and specially the second part, which contains the Silurian and Devonian forms, with 8 plates. The genera here discussed are—*Amphion*, *Staurocephalus* 3 sp., *Deiphon* 1, *Calymene* 9, *Homalonotus* 13. The author then commences the group of the *Asaphidæ*, of which only one species of the genus *Ogygia* is here described.

The next work is the second portion of the sixth part of Mr. Davidson's "Monograph of British Brachiopoda," viz. the Devonian, with 11 plates. The genera described in this part are—*Atrypa* 3 sp., *Rhynchonella* 16, *Camarophoria* 1 (Mr. Davidson is disposed to consider this to be the same species as Prof. Phillips's *Terebratula rhomboidea* and the Permian form *C. globulina*, Schlot.), *Pentamerus* 2, *Davidsonia* 1, *Strophomena* 1, *Streptorhynchus* 4, *Leptæna* 3, *Orthis* 5, *Chonetes* 2, *Strophalosia* 1, *Productus* 4, *Discina* 1, *Lingula* 1, *Calceola* 1. In concluding this monograph Mr. Davidson observes that 91 so-called species have been described and illustrated, but of these only 65 have been named with certainty; 14 more are probably good species, but they are not yet sufficiently made out; the remaining 12, indicated merely for the sake of reference, will probably have to be placed as synonyms of some of the other 79 species. He then points out which of these species extend upwards into the Carboniferous beds, and concludes with some interesting observations on the geological, geographical, and palæontological distribution of the species, and on the sequence of the different beds of the Middle Devonian group, which, as well as those of the Lower Devonian, are extremely complicated.

The third paper in this volume is the commencement of a valuable "Monograph of British Belemnitidæ," by Prof. Phillips. His memoir commences with an historical account of the progress of discovery respecting this group of Cephalopoda from the time when Belemnites were first so called by Georgius Agricola in 1546, when they were considered as of animal origin, down to the period of the more recent discoveries of Buckland, Owen, and Mantell, when their true place in nature, as belonging to the great family of Cephalopoda, was satisfactorily established by the discovery of specimens in which the fossil ink-bag and other characteristic parts of the animal and its sheath have been preserved.

Prof. Phillips then proceeds to describe the structure of the *Be-*

lemnitidæ. The most commonly preserved portion in the fossil state is the posterior or caudal portion of the guard or sheath, which was originally considered as the Belemnite *par excellence*, until it was subsequently discovered that as this guard extended forwards it formed a conical cavity filled with a shell of similar form, gradually expanding forwards, divided by many shelly plates, and pierced by a small pipe or siphuncle near one edge. This is called the phragmocone, and is rarely found complete; when such, however, is the case, it is covered by a thin conical shell distinct from the substance of the guard, and called "conotheca" by Huxley. With regard to the guard itself Prof. Phillips observes, that it is necessary that it should be carefully observed in three distinct aspects, viz. the dorsal and ventral faces, as well as along the axis or apical line. Although specimens are extremely rare in which the phragmocone and guard are found together completely, yet in specimens from the Lias of Lyme Regis and of Yorkshire the structure of the phragmocone in relation to the guard has been sufficiently ascertained to justify a restoration of the whole shell.

The author then proceeds to describe the classification of the Belemnitidæ, but this chapter is unfinished; and no plates or illustrations, except woodcuts, are given in this portion of the monograph.

The next paper is the "Monograph of the Fossil Reptilia of the Liassic formation," by Prof. Owen: part first, Sauropterygia. The work commences with a detailed account of *Plesiosaurus dolichodeirus*, followed by *P. homalospondylus*, *P. rostratus* (Owen), and *P. rugosus* (Owen), and is accompanied by 16 plates. The merit of these osteological papers of Prof. Owen is so well known that it is unnecessary for me to say more than that the detailed description appears to exhaust whatever can be said respecting these extinct reptiles, their mode of entombment, and the resulting positions in which they have been found.

Although I do not, as a rule, purpose alluding to the papers which have been read at our evening meetings, yet there are some which appear to be of sufficient interest to justify my noticing them on the present occasion. The organic structure of the *Eozoön Canadense* to which I alluded last year, has been called in question by Prof. W. King and Dr. Rowney in a paper recently read before the Society. Having examined numerous specimens of Eozoönal Serpentine from various localities, the authors consider that the appearances which Dr. Carpenter and others have pronounced to be organic, and closely to resemble foraminiferal structure, are purely of mineralogical origin. They consider the "skeleton" to be identical with the calcareous matrix of certain minerals, as Chondrodite, Pargasite, &c. The "proper wall" of the chambers is not an independent structure, in their opinion, but only the surface-portion of the granules of chrysotile crystallized into an asbestiform layer. The dendritic and other forms which were described as representing the "canal system," are considered by them to be tufts of metaxite, or some allied variety of chrysotile; and these and other

forms are, in their opinion, nothing but imbedded imitative crystallizations, quite distinct from the foraminiferal structure with which they have been compared. From these and other considerations they conclude that Eozoönal Serpentine is a metamorphic rock, and they throw out the suggestion that it may, in many cases, have also undergone a pseudomorphic change—that is, it may have been converted from a gneissoid calcareous diorite by chemical introductions or eliminations.

Dr. Carpenter maintains the correctness of his former views. In a paper read on the same evening he showed that a recent siliceous cast of *Amphistegina* from the Australian coast exhibited a perfect representation of the "asbestiform layer." He then showed that this asbestiform layer exhibited in *Eozoön* a series of remarkable variations, which can be closely paralleled by those which are found in the course of the "tubuli" in the shells of existing Nummuline foraminifera, and are associated with a structure exactly similar to the lacunar spaces intervening between the outside of the proper wall of the chambers and the intermediate skeleton by which they became overgrown, formerly inferred by the author to exist in *Calcarina*. With regard to the opinions advanced by Prof. King and Dr. Rowney, he stated that even if the dendritic passages hollowed out in the calcareous layers, and the arrangement of the minerals in the Eozoön limestone could be accounted for by inorganic agencies, there still remained the Nummuline structure of the chamber-wall, to which no parallel can be shown in any undoubted mineral product.

The question is certainly one of great importance, and, considering the minute microscopical structure and the mineral as well as metamorphic change which the rocks have undergone, it is still involved in some obscurity. It were much to be desired that the gneissoid rocks from other localities should be carefully examined; for if the organic theory be true in the case of old Laurentian gneiss, we ought to expect a fuller confirmation of it in the gneissic rocks of a still younger age. And though it may perhaps be considered rash in one who has not examined the various specimens microscopically beyond seeing some of Dr. Carpenter's preparations, I am bound to say, almost against my own convictions, that the balance of argument at present is in favour of the views laid down by Dr. Carpenter, Dr. Dawson, and Mr. Sterry Hunt. I should add that Dr. Carpenter also stated that he had recently detected *Eozoön* in a specimen of Ophicalcite from Bohemia, in a specimen of gneiss from near Moldau, and in the serpentinous limestone from Bavaria.

With reference to this subject, Prof. A. Sismonda has published an account of some organic impressions found on a mass of gneiss derived from one of the boulders in the diluvium which overlies the Lias formation north of Rezzago in the Brianza. This block must have been brought down from the Alps, and Prof. Sismonda considers that it probably came from the Valtellina, the mountains of which consist of this same form of gneissic rocks. When first discovered,

some years ago, it was supposed to be an insect; but more careful investigations recently made, particularly by M. Brongniart, whom he consulted, have proved it to be of vegetable origin. M. Brongniart concluded that it was a portion of an *Equisetum*, very analogous to *E. infundibuliforme*, of the Carboniferous period, but possibly a new species. From these considerations Prof. Sismonda concludes that the gneiss in question is a metamorphic rock of the Carboniferous period, and suggests the propriety of further search for fossil remains in these crystalline rocks of the Alps.

M. Barrande has published, during the past year, a second volume of his important work on the Silurian System of the centre of Bohemia. It is the first series of the Cephalopoda, and consists of 107 plates with corresponding explanations. In a short preliminary notice M. Barrande states that the Silurian Cephalopoda of Bohemia will occupy 350 plates; this large quantity of matter renders it necessary to publish them in separate large numbers or livraisons. The present number forms the first series of the plates devoted to this class. It contains about 200 species, representing the ten following genera:—*Goniatites*, *Nothoceras*, *Trochoceras*, *Nautilus*, *Gyroceras*, *Hercoceras*, *Lituites*, *Phragmoceras*, *Gomphoceras*, and *Ascoceras*. The two other genera, *Orthoceras* and *Cyrtoceras*, which complete the family of the Silurian Nautilidæ of Bohemia, are much richer in species, and will fully occupy the plates of the second and third series, with the exception of such as will represent the features of the general study of the Nautilidæ. The text belonging to these ten genera will be shortly published; the author has therefore confined his observations on them, for the present, to a tabular statement pointing out their vertical distribution in the different formations and their principal subdivisions.

One of the most remarkable results of an examination of this tabular statement is the great preponderance of forms which are characteristic of the formation, or *étage*, E. Of 202 species here figured, 155 belong to this formation, and only 47 to G, 8 to F, and 2 to D, and at the other end of the series only 2 to H. Looking at individual genera, out of 70 species of *Gomphoceras*, 61 belong to the formation E. The only remarkable exception to this rule is the genus *Goniatites*; out of 17 species, 15 belong to the formation G, which, with the formations E, F, and H, belong to the Upper Silurian System, and constitute M. Barrande's "faune troisième." Besides this wonderful development of Cephalopoda in this Upper Silurian System of Bohemia, their rapid diminution is no less surprising. Only two species remain in *étage* H, a *Goniatite* and a *Gyroceras*, and these are only found in the lowest subdivision of the *étage*.

M. Barrande has also published during the past year a third part of his work entitled 'Défense des Colonies,' comprising a general consideration of the *étages* G and H, with special reference to the neighbourhood of Hluboçep, near Prague. The necessity for this publication is stated to be the erroneous views entertained by MM. Lipold and Krejci respecting the stratigraphical conditions of the neighbourhood of Hluboçep and Litten. I shall not

presume on this occasion to discuss the general question of M. Barrande's Colonial System, but shall endeavour to confine myself to a general sketch of the contents of the work and of the objects which he has in view. The *étages* G and H, it is well known, represent the upper portions of the Upper Silurian formation, or the "faune troisième" of M. Barrande. The work is divided into two parts; the first is devoted to the general description of the *étages* G and H on the surface of the Bohemian basin. The first two chapters give the results of his stratigraphical and palæontological investigations with regard to these two groups and their subdivisions. In the third chapter he points out their topographical extent, and shows their horizontal and vertical relations by means of two sections across the upper division and the zone of the colonies, the one following the valley from Tachlovitz to Radotin, and the other through the quarries of Dvoretz and Branik, near Prague. In the fourth chapter the author endeavours to ascertain whether the *étages* G and H are represented in the Silurian basins of other countries; and in the fifth chapter he discusses the connexions which exist between the fauna of the *étages* G and H and the Devonian fauna. The second part contains an account of his special observations respecting the phenomena of the *étages* G and H in the neighbourhood of Hluboçep, with remarks on the adverse criticisms of MM. Lipold and Krejci respecting the stratigraphical arrangement of the beds in question.

The colonial system of M. Barrande is too well known to geologists to render it necessary for me to make any further allusion to it than to refer you to the last edition of Sir R. I. Murchison's 'Siluria,' p. 400. The anticolonial argument which MM. Krejci and Lipold have brought forward, founded on the stratigraphical appearances of the different formations in the neighbourhood of Hluboçep, is thus stated by the author:—

1. There are evident dislocations at Hluboçep in the *étages* G and H.

2. These dislocations have produced a mechanical intercalation of the schistose beds of H amongst the limestones of G, showing appearances perfectly resembling those of the colonies.

3. The colonies are therefore naturally explained by simple dislocations and mechanical intercalations.

These statements M. Barrande emphatically denies. He shows that the supposed existence of these dislocations is solely founded on a want of careful observation. Independently of the synclinal fold already pointed out, along the axis of the basin, and the anticlinal fold, now described in the heights of Divçi Hrady, these pretended dislocations and their supposed effects are purely imaginary.

Nor does the locality of Hluboçep offer any intercalation whatever of the schists of H amongst the limestones of G; on the contrary, this locality shows on each side of the synclinal axis of the valley the regular and symmetrical series of the formations of the *étages* G and H, without any appearance of mechanical origin which could reproduce the stratigraphical and palæontological alternation of the colonies. The series of formations near Hluboçep is of

a purely sedimentary and normal origin, independent of all dislocation or disturbance of the ground.

The process by which the author supports his views may be succinctly stated as follows:—He shows, in the first place, that the *étage* G consists of three subdivisions, the lowest, *g* 1, being a purely calcareous bed, *g* 2 being a band of argillaceous schists with calcareous nodules, passing, by a gradual increase of the calcareous element, into the overlying bed *g* 3, consisting of limestone resembling altogether the bed *g* 1, the whole forming such a complete system of superposition and gradual passing of one into the other, as altogether to preclude the possibility of the bed *g* 2 being an intercalation of the overlying *étage* H, which consists entirely of argillaceous schists. This *étage* is also separated into three subdivisions, *h* 1, *h* 2, and *h* 3, in which the calcareous element appears to be altogether wanting. There is no gradual passage between G and H; the transition is sharp and well defined.

The author then proceeds to describe the palæontological contents of the *étages* G and H, and their subdivisions. By these means he has been enabled to point out the true distinction of the different beds, for which the petrographical and stratigraphical evidence alone was not sufficient. Thus the two calcareous bands *g* 1 and *g* 3, so closely resembling each other in a petrographical point of view, are shown, by the numerous tabular statements of their respective faunas, to be entirely distinct. These tables show that, with the exception of the Cephalopoda, all the classes (p. 55), including the Fish, Crustacea, Pteropoda, Gasteropoda, Brachiopoda, Acephala, Radiata, and Vegetables, are represented by a much larger number of species in *g* 1 than in *g* 3. On the other hand, the Cephalopoda are more numerous in *g* 3 than in *g* 1 in the proportion of 3 to 2; and, moreover, in bed *g* 3 the Cephalopoda alone contain about four times as many forms as all the other classes together in the same bed; besides which these two beds contain very few species common to both.

With regard to the four schistose beds, *g* 2, *h* 1, *h* 2, and *h* 3, the distinction is equally clear; *h* 2 and *h* 3, being unfossiliferous, are easily separated from the others; and with regard to *g* 2 and *h* 1, although they contain eleven species common to both, a much greater number of species are peculiar to each.

	Peculiar to *g* 2.		Peculiar to *h* 1.
Trilobites	3	.....	0
Cephalopoda	4	.....	1
Pteropoda	1	.....	0
Gasteropoda	2	.....	0
Brachiopoda	6	.....	1
Acephala	7	.....	3
Radiata	4	.....	0
Vegetables	0	.....	2
	27		7

But these two formations are also easily distinguished by their rocks; the schists of *g* 2 contain numerous calcareous nodules of a light colour, which are altogether wanting in the bed *h* 1, where the calcareous element only appears at its base in thin bands, and with an entirely different petrographical character from that of the nodules above mentioned. Thus there is sufficient evidence to prevent the possibility of mistaking these two beds, *g* 2 and *h* 1.

In the next chapter (3rd) the author describes the stratigraphical relations between the *étages* G and H and the other *étages* of the Bohemian basin. The different sections from various localities are given in great detail, and several faults are described, the explanation of which, when the adjacent beds were unfossiliferous, was a work of much labour and time. I must refer you to the work itself (p. 102) for an account of the fault of Branik and the adjacent colony of Branik, where, in the midst of the *étage* D 5, consisting of unfossiliferous beds of grey schists and quartzites of great thickness, thin fossiliferous bands occur, more or less charged with calcareous matter, containing several species of fossils, which peculiarly characterize the lower beds of *étage* G; thus, according to Mr. Barrande's theory, foreshadowing by colonization the future characteristic population of the overlying beds. Other colonial appearances are described, as well as a section showing the complete series of the thin bands of *étage* G, with the overlying *étage* H, in regular conformable stratification.

In the fourth chapter the author enters into a detailed consideration as to how far the *étages* G and H are represented in other Silurian basins. The countries thus noticed are England, Russia, Sweden, Norway, Thuringia, Saxony, Franconia, the Harz, France, Spain, Sardinia, and the United States of America.

M. Barrande observes that he still adheres to the opinion, published in his 'Notice préliminaire,' and confirmed twelve years ago in his 'Esquisse Géologique' (Syst. Sil. &c., Book I.), that, although there was a complete general correspondence between the great Silurian divisions of Bohemia and England, a more detailed comparison of local forms proves that the different *étages* in each country did not correspond with each other. Comparing the Upper Silurian formation of England with the *faune troisième* of Bohemia, viz. the *étages* E, F, G, H, he says that the fossils which characterize the upper division in England and in Bohemia, taken as a whole, constitute, both by their analogies and their identities, whether generic or specific, one simple general fauna, which he calls "faune troisième." At its commencement in each country this fauna shows a close and intimate resemblance; but, owing to local conditions, or other unknown causes, it has undergone in each country a different development, as is shown both by the unequal distribution of each class and by the modifications caused by the extinction and progressive renewal of species. The consequence of this divergence gradually increasing in time has been, that the beds which form the upper portion of the upper division are connected together by a *minimum* of palæontological relations, so that no individual paral-

lelism can be established between them, although they all belong to the same period of time, during the deposition of the Silurian system.

The author then gives a table showing the vertical distribution of 57 Upper Silurian species which have been recognized as identical in the two countries, and shows that out of this number belonging to the "faune troisième," 32 had already existed in the lower division, or "faune seconde," of England, whereas none of them are found in the "faune seconde" of Bohemia; this fact alone he considers sufficient to prove the possibility of his colonies, as these 32 species coexisting with the "faune seconde" of Bohemia might have immigrated into the Bohemian basin and have dwelt there temporarily during the existence of this fauna. Of these 57 species, 50 occur in the Wenlock beds and 27 extend into the Ludlow beds, whereas in Bohemia 51 of them are found in the *étage* E, and only 12 appear in *étage* F; only five extend into *étage* G and one into H. Thus showing that *étage* E contains almost all the palæontological connexions hitherto recognized between the "faune troisième" of England and Bohemia, whereas the few identities occurring in the three *étages* F, G, and H, merely serve to show that they are really constituent parts of the same Upper Silurian division.

After describing the different connexions between the "faune troisième" of Bohemia and the other countries mentioned above, the author observes that these comparative statements are the only means available for ascertaining how far the last phase of the Bohemian "faune troisième" contained in the *étages* G and H is represented in other countries. By way of comparison, he enounces the chief distinctive characters of this phase as follows:—

1. Intermittent or sporadic presence of fish, and particularly the armoured type, the first appearance of which belongs to *étage* F.

2. Predominance of the genera *Dalmanites* and *Bronteus* amongst the Trilobites, and the presence of the genus *Calymene*. The genus *Dalmanites* is only represented by the group of *D. Hausmanni*.

3. The reappearance and relatively new development of the nautiliform Cephalopods generally, and particularly of the genera *Phragmoceras* and *Gomphoceras*, characterized by their contracted opening.

4. Development of the group of *Nautilina*, representing the genus *Goniatites*, which made its first appearance in the *étage* F.

5. Sporadic appearance of *Cardiola retrostriata* in the *étage* H.

These characters are nowhere found all together in any horizon of the Upper Silurian division in the Palæozoic regions of the two continents; but their absence shows itself in very different degrees in the different countries compared with Bohemia. In the neighbouring regions of Saxony, Thuringia, and Franconia no trace has hitherto been found of the last phase of the "faune troisième," whereas the earlier phase has now been distinctly recognized. The Silurian deposits of these regions appear to belong to the great Palæozoic zone of the north, as England, Russia, and the Harz, the faunas of which, notwithstanding their greater distance, bear a very marked resemblance to the phase of the *étages* G and H. Sweden and Nor-

way are in the same category. France, Spain, and Sardinia, although showing clear evidence of the existence of the first phase, are also deficient of all trace of the last phase, only in France the formations which are classed as Lower Devonian contain numerous fossils similar to the forms found in the different *étages* E, F, and G.

In England, the Isle of Oesel, and the Harz, the characters of the fauna of the *étages* G and H are partially represented; but in England, amongst the six genera of fish found in the Ludlow and Passage-beds, there are none of the *cuirassés* or armoured types. The Trilobites are almost entirely wanting; the Dalmanites of the groups *D. Hausmanni* and *Bronteus* are not represented. The same is the case with the Nautilidæ with the contracted mouth. Goniatites are unknown, as well as *Cardiola retrostriata*.

The United States of America form another category, showing the principal characters which distinguish the fauna of the *étages* G and H, viz., the sporadic appearance of the armoured fish, the existence of the genus *Calymene* amongst the Trilobites, a greater development of the Dalmanites type, and the reappearance and relative abundance of the Nautilidæ; thus the most complete representative hitherto known of the *étages* G and H is found in the State of New York.

The fifth chapter is devoted to the consideration of the connexion between the *étages* F, G, and H of the Silurian basin of Bohemia and the Devonian formations. After alluding to the evidence which he has given that the lower calcareous *étage* E contains by itself a fauna almost as complete as that which is distributed in different beds in other countries between the Lower Silurian and the Devonian, the author proceeds to show that it would be a great error to suppose that the upper *étages* F, G, H could belong, at least partially, to the Devonian period. He shows, by carefully analyzing the different classes of fossils contained in these three *étages*, that, although they certainly do contain some species common to the Devonian fauna, they are totally deficient in those forms which have hitherto been considered as essentially characteristic of the three subdivisions of the Devonian system, and that, on the other hand, they contain many forms of a true Silurian character.

The result of this examination shows that although the typical forms of many Devonian species made their first appearance in the Silurian formation, and although, as in the case of the Nautilidæ, the analogies brought forward would appear to show a greater connexion between the Devonian faunas and the *étage* E than with the *étage* G, no identical species, either of Trilobites, Nautilidæ, or Goniatites, occur in the two formations; the same may be said of Pteropoda and Gasteropoda. Of Brachiopoda there are 2 species common to *étage* G and the Devonian beds. *Cardiola retrostriata* is a remarkable instance of connexion between the Devonian phase and the youngest Silurian phase, as well as between the older and younger phases of the Upper Silurian; and M. Barrande thus sums up the result of his examination:—

1. The last phase of the "faune troisième" contained in the *étages*

G and H is more or less closely connected in all classes of fossils with the former phases of this fauna contained in the underlying *étages* E and F.

2. Notwithstanding certain general connexions between these same upper *étages*, G and H, of the basin of Bohemia and the three great Devonian subdivisions, there is no such affinity between the faunas of the two formations as would justify our considering them as representing, under different appearances, contemporaneous deposits. And with regard to the apparent paradox that the "faune troisième" during its later phase, nearest in point of time to the Devonian fauna, is less closely connected with it than with the lower *étages* E and F, he observes that his investigations prove that each class of fossils shows a greater or less number of specific connexions, without counting the constant generic connexions between the *étages* E and F and the overlying G and H; and consequently that, in a palæontological point of view, the *étages* G and H completely maintain their Silurian character, and are only associated with the Devonian beds by those ordinary points of resemblance which occur during any given geological epoch to announce the following period. I have already pointed out the object of the second portion of this work; but I cannot take leave of M. Barrande, to whom I fear I have hardly done full justice, without making one observation.

Whether the colonial theory of M. Barrande be right or wrong, it is impossible not to see in all his observations a confirmation of that argument which has often been supported in this room, and to which I have myself more than once ventured to allude, viz., that in formations of the same age, although separated geographically by greater or less distances from each other, we must not expect to find the same species or even genera always appearing at any given geological horizon simultaneously. The various conditions of life, the depth of the sea, the different proportions of calcareous or siliceous or argillaceous elements in the deposit, must have produced a difference in the organic contents of the formation—a difference which may often have shown a greater intensity in neighbouring regions than in such as are separated by greater distances in space. The difference caused by distance in time has always been appreciated by geologists; but that caused by distance in space has sometimes been overlooked, not so much perhaps of late years as formerly, when the identity or non-identity of fossil contents was looked upon as the all-sufficient reason for synchronizing or separating formations occurring at a considerable distance from each other.

Amongst the more important discoveries of last year I must notice that of Professor Huxley, who, in examining some reptilian remains found in the Kilkenny Coal-field, ascertained the existence of not less than six genera, five of which are certainly new, while the sixth, according to Profesor Huxley, may or may not be identical with the *Anthracosaurus* of the Scotch Carboniferous rocks.

The five new genera have been defined in a notice communicated to the Royal Irish Academy by Dr. Wright, on behalf of Professor Huxley and himself, under the names of *Urocondylus*, *Ophiderpeton*, *Ichthyerpeton*, *Keraterpeton*, and *Lepterpeton*. *Ophiderpeton* is remarkable for its extremely elongated and snake-like form; *Ichthyerpeton* for its fish-like body and short limbs; while *Urocondylus*, *Keraterpeton*, and *Lepterpeton* have Salamander-like forms and well-developed limbs. In all, the vertebræ are abundantly ossified, and there are no traces of persistent branchial arches, so that they present very important differences from *Archægosaurus*. The authors then show that four of these five genera present unmistakeable remains of the ventral dermal armour characteristic of the Labyrinthodonts, and that from this and other circumstances there can be little doubt that they all belong to that group of extinct Amphibia.

Professor Huxley informs me that, up to the time when these discoveries were made, eight genera, in all, of higher organization than fishes were known to occur in rocks of Carboniferous age in Europe, and five in America. Of the eight European genera, only *Archægosaurus*, *Pholidogaster*, and *Anthracosaurus* were known by more than mere fragments; nor do we possess at this moment a knowledge of the nature of the limbs in any one of these genera, except *Archægosaurus*. The five American genera *Baphetes*, *Raniceps*, *Dendrerpeton*, *Hylerpeton*, and *Hylonomus* were much more fully known; and it was a curious problem whether further research in Europe would tend to reveal the existence during the Coal-period of small Amphibia with well-ossified vertebræ and well-developed limbs, like the American forms, or whether it would show that the Labyrinthodonts of the European area rather adhered to the Archægosaurian type already known to occur in Europe, but not hitherto found in America.

So far as the Irish discoveries have yet gone they prove the existence, during the Carboniferous epoch of Europe, of Amphibia which, are analogous to, though altogether distinct from, the "homotaxic" American Labyrinthodonts,—analogous to them in the degree of ossification of the skeleton and development of the limbs,—different from them not only in detail, but in the existence of such types as *Ophiderpeton* and *Ichthyerpeton*, which have at present no parallel either in America or elsewhere.

The discoveries of the last five years show that the Labyrinthodont Amphibia were as largely represented and as well developed in the Carboniferous as in the Triassic formation. Three genera are known from the Permian formation of Europe, and five from Asiatic, African, and Australian rocks of an age which, if not certain, may safely be assumed to be between the Carboniferous and Lower Mesozoic periods.

Professor Huxley concludes these observations by the following remark:—"putting all these facts together, it would appear that the Labyrinthodonts represent the first rope of the bridge which will one day be suspended across the gulf which at present separates the Palæozoic from the Mesozoic fauna."

This interesting discovery in Ireland affords additional confirmation of the correctness of the theory which assumes that new forms of animal life, either as species, as genera, or as classes, were created or made their appearance on our earth at the time when the conditions of life were best suited to their existence, and that they were formed with an organization adapted to the external conditions under which they were to live. When we analyze the great Carboniferous deposits, and recognize in them the vast tracts of ancient swamps and marshes covered with the rich and luxuriant vegetation which they formerly presented, subject to the gentle oscillation by which they were alternately submerged beneath the ocean and slightly raised above the level of its waters, we find, as in the great dismal swamps in some of the Southern States of North America, the very conditions of life most suitable for reptilian existence; and precisely on this horizon they appear to have come into existence not in one or two vague forms developed out of previously existing ones, but, as it is now shown, in a great variety of new forms, all belonging to the same reptilian class, varying in different hemispheres, but presenting those peculiar characteristics which constituted them the fit inhabitants of low swampy regions, clothed with an abundant yet varied vegetation. Future discoveries will, no doubt, in time add to the list of genera and to our more perfect knowledge of the reptilian fauna of the Carboniferous age. In the mean time we may congratulate ourselves on this great addition to our knowledge of this fauna, for which we are indebted to the zeal and acumen of Professor Huxley and Dr. Wright.

In the 'Bulletin de la Société Géologique de France'* will be found an interesting account of the history of the discussion respecting the Carboniferous formation of the Alps, by Prof. Alphonse Favre, of Geneva, in which he describes the progress of the discussion which so long prevailed respecting the age of the anthraxiferous formation of the Alps, in consequence of the apparent intermixture or alternation of beds containing vegetable impressions, supposed to indicate a Carboniferous period, with beds containing Belemnites, supposed to be of Jurassic age. You all, no doubt, remember the numerous memoirs published on this subject, and of which a very full account was given by M. Scipion Gras in a former volume of the 'Bulletin.'

M. Favre has taken up the subject, and has carried on the history to the latest times. He divides it into four periods. I need not trouble you here with any notice of the first two; and, with regard to his third period, I will only observe, that it extends from 1858 to 1860, and contains an account of all the observations which tended to prove the existence of the Triassic formation and of the Infralias, as well as the consequences which resulted from this discovery. He shows that the existence of these two formations created such a break between the Lias and the Coal-formation, that it was no longer possible to admit that the beds in question could belong to the same age. The Trias was even discovered at Petit Cœur, so that this locality could no longer be claimed as a proof of the union of the

* 2me sér. vol. xxii. p. 59.

Lias and the Coal-formation, and the battle-field of the discussion was removed to St. Jean de Maurienne. The fourth period extends from 1860 to 1863. It began with the discovery of Nummulites at Maurienne, and continued to the close of the discussion. Then it was that the recognized presence of the Trias and the Infralias, as well as the position of the Nummulites found in a formation hitherto considered by M. Scipion Gras as anthraxiferous, combined with the mineralogical character of the rocks, their stratigraphical position, so long misunderstood owing to the numerous contortions of the beds, and the fossils which they contained, proved the presence of the real Carboniferous formation in the Alps.

The fact was generally admitted at the meeting of the French Geological Society at St. Jean de Maurienne in 1861. The same results were applied to Dauphiné and Provence; and finally M. Heer, who had so completely mastered the mystery of the fossil flora of Switzerland, published in 1863 a memoir respecting the flora of the Carboniferous formation in Switzerland and Savoy, in which he showed that not one single plant of the Carboniferous formation of the Alps was found either in the Lias or in the Trias.

Is it not a curious fact, observes M. Favre, that it required thirty-five years of discussion and of argument to clear up a point of Alpine geology? It has led, however, to a much better knowledge of details; and now questions relating to the age of a formation can be solved as well in the Alps as in the neighbouring countries, and the charge of backwardness can no longer be maintained against the geology of the Alps.

In concluding this *précis*, M. Favre gives a list of the various geologists who had adopted the different views respecting the age of the anthraxiferous beds of Switzerland. In this list he places my name amongst those who referred this formation to the Lias. Now, although there can be no discredit in being placed in the same category with such names as Elie de Beaumont, Sismonda, Collegno, Roget, &c., I think it right to say that the only part I took in the discussion was this, that in the anniversary address which I delivered from this chair in 1856, after giving a sketch of M. Scipion Gras's memoir on the subject, I stated, on the strength of the alleged superiority of evidence derived from the fauna of a formation as to its age, over that derived from its flora, that "the weight of evidence appears to be in favour of referring the whole formation to the Jurassic rather than to the Carboniferous period."

M. Favre also adds that, if the discussion had terminated in the contrary sense, the whole question of palæontology would have had to be seriously modified. If it had been proved that the coal plants were still living during the Liassic period, the value of fossil botany would have been destroyed, as it would no longer have served to characterize a formation. The labours of Prof. Heer have saved us from this catastrophe.

With reference to this question I may also direct your attention to another memoir in the same number of the 'Bulletin' by M. Lory, in which he endeavours to explain the stratigraphical anomaly

of Petit Cœur in the Tarantaise. The locality is a very limited one, and the phenomena cannot be explained by inversion of the strata, or by a turning over of the different beds. After describing the principal facts, he shows that the anomalous position of these beds, which had caused so much difference of opinion amongst geologists, was owing to two faults, one general and the other local, and to the slipping or sliding-in of overlying beds into the cavities thus caused, and so bringing the Upper Lias beds in immediate contact with the Coal-measures, and even the underlying crystalline rocks.

Neither time nor space would allow me to go through the numerous works which the industry of the German geologists have produced on those portions of the secondary series, the Triassic and Liassic formations, which are so extensively developed in the Alps and in Germany itself. It would require volumes to do justice to them all. I must therefore confine myself to a slight allusion to some of the more interesting memoirs which have come under my notice; and in doing this I feel it is impossible to withhold an expression of admiration at the zeal and energy with which these investigations have been pursued in so many different parts of Germany. It is not that one eminent palæontologist has directed his attention to this subject, but a whole army of eager and enthusiastic explorers, animated by the recent rapid accumulation of facts, by the discovery of new fossils, and by the greater accuracy with which the different fossil-bearing strata have been distinguished, seem to have come forth from every corner of Germany, each taking up some special branch, and in the end almost overwhelming us with the mass of accumulated results.

Professor Gümbel has published a very important memoir on the geological conditions of the Triassic district of Franconia. After describing the topographical features of the district under consideration, he gives a general account of all its geological features, showing that the crystalline rocks (Urgebirgs-felsarten) of the Odenwald form the basis of the whole system. The Silurian, Devonian, and Carboniferous systems are wanting in this district. The conglomerates of the Dyas (Rothtodtliegendes) rest immediately on the Urgebirge and form the basis of the Triassic formation (Bunter Sandstein, Muschelkalk, and Keuper), which fills up the whole region between the crystalline rocks of the Odenwald and the Hercynian mountain-system. It is well known that all the rocks of the Franconian Alps rest upon this Triassic surface, and form a kind of insular continent in the Keuper district.

The different beds and rocks throughout this region, with their characteristic fossils, are then carefully described; after which the author makes the following general remarks:—"The long period of time during which the massive rocks of the Jurassic formation were gradually deposited in eastern Franconia, passed away without leaving any additions to the rock-formations in the greater part of the western district. Western Franconia was a continent of dry land during this period of the formation of the earth's crust. Not until the Tertiary period did this district again share in those changes and

convulsions which were constantly going on—sometimes here and sometimes there—over the whole surface of the earth. It is, however, comparatively only a small portion of the Franconian region which took part in these changes during the Tertiary period; but the new formations are of so gigantic a character that they make up in intensity for what may be wanting in extent. To these phenomena belong the volcanic formations, which were developed within the district of the Rhön mountains; they form a link in that great chain of volcanic operations which connects the central mountains of Bohemia through the Fichtelgebirge on the one hand, and through the Vogelsgebirge and the Westerwald on the other, with the Siebengebirge.

Dr. Waagen has endeavoured in a short memoir to give us a general classification of the beds of the Upper Jurassic formation, taking as his basis the classification of English geologists, as the first which was founded on a more accurate knowledge of the different beds, although he doubts whether the names which were sufficiently appropriate in the localities to which they were originally applied, are equally so when applied to large areas where the same beds either assume a different petrographical *facies* or are characterized by a distinct or abnormal fauna. After describing the various local horizons from the Portland Stone to the Oxford Clay, he endeavours to establish a comparison between the English beds and those on the continent, which are assumed to be their representative zones. The following table shows how he groups these formations:—

	Local Horizons.	English Divisions.
Kimmeridge Group.	Zone of *Trigonia gibbosa* ..	1. Portland Stone. 2. Portland Sand.
	Region of *Orbicula latissima* and *Acanthoteuthis speciosa* ..	3. Kimmeridge Clay.
	Region of *Ammonites mutabilis* and *Exogyra virgula*	
	Region of *Ammonites alternans* and *Rhynchonella inconstans*	
Oxford Group.	Region of *Cidaris florigemma*	4. Upper Calcareous Grit. 5. Oxford Oolite.
	Region of *Ammonites Martelli*	6. Lower Calcareous Grit.
	Region of *Ammonites biarmatus*	7. Oxford Clay.

I must also notice the work of Dr. Ferdinand Stoliczka, entitled 'A Revision of the Gasteropoda of the Gosau beds in the Eastern Alps.' This memoir was written in Calcutta, where the author is one of that band of geologists who, under the superintendence of Prof. Oldham, are working out the geology of India. Having collected in the Gosau district a vast amount of material before his departure for the East Indies, he has been induced to publish his observations in consequence of what he considers the great errors in Herr Zekeli's account of the Gosau Gasteropoda; and it was with a view of rescuing geological science from these errors, some of which are pointed out, that he undertook the critical examination of these species, which have been too hastily increased in number by Zekeli from 124 to 193 species.

With regard to this formation, I will only quote one sentence from Dr. Stoliczka's work, to show one *facies* of the Gosau deposit. "It is well known that during some one of the elevations of the calcareous rocks of the Alps, after the deposition of the Lower Chalk, the calcareous crust was cracked and opened out in numerous directions. These fractures extended downwards to the 'bunter Sandstein.' The sea of the Upper Chalk period penetrated these openings, took up its material chiefly from the 'bunter Sandstein,' and deposited it again under a somewhat altered form. This is the reason why our Gosau beds generally rest immediately on the 'bunter Sandstein,' and why it is often no easy task to decide what is Gosau deposit and what belongs to the 'bunter Sandstein.' The occurrence of fossils affords the easiest and safest solution of the question. The Gosau beds were thus deposited in bays and inlets of the sea, which, however, had a far greater extension than now appears; not only the abundance and variety of the fauna, but positive proof derived from the conditions of the deposit leave no doubt on this point. Mighty rivers soon emptied themselves into these bays, and drove away the true marine fauna. A peculiar molluscous fauna developed itself at the mouth of these rivers with species of *Cerithium*, *Potamides*, *Nerita*, and *Omphalia*, accompanied no doubt by numerous fish and gigantic Saurians." He further shows that, under the influence of this great addition of fresh water, the water itself became brackish, or alternately marine and lacustrine. By degrees, the marine fauna was checked and driven more towards the middle of the sea, where it was powerfully developed in the neighbourhood of islands or in other favourable localities.

I would also have given some account of the following papers, had time permitted:—

"On the Cephalopod family *Acanthoteuthis*," by Prof. Ed. Suess, read at the meeting of the Imperial Academy of Sciences on March 16, 1865.

"On the Formation of the Bunter Sandstein and Muschelkalk in upper Silesia and its Fossils," by Dr. Henry Eck.

"On the Tithonic Etage," by Prof. Oppel of Munich, published in the journal of the German Geological Society, 1865. This formation is intermediate between the Upper Jurassic and Lower Cre-

taceous beds, and the author defines it more strictly as occurring between the Kimmeridge and lower Neocomian beds. It refers to certain Alpine deposits containing Cephalopoda, probably corresponding with Portland, Purbeck, and Wealden beds, but of which the exact parallelism has not yet been sufficiently made out.

"On the Fauna of the St. Cassian beds, being a Supplement to the Palæontology of the Trias of the Alps," by Gustav Laube, in two parts, the first of which contains a description of the *Spongitaria*, *Corals*, *Echinidæ*, and *Crinoidæ*, with 10 plates; the second part contains the *Brachiopoda* and *Bivalves*, also with 10 plates.

"The position of the Raibl beds in the Franconian and Suabian Keuper," by Prof. F. Sandberger.

With reference to the much discussed question of the true position of the *Avicula-contorta* beds, to which I alluded on a former occasion, I find in the 'Bulletin de la Société Géologique de France,' 2nd ser. vol. xxii. p. 369, an interesting communication by M. Jules Martin, entitled "The Rhætic formation or *Avicula-contorta* zone; its petrographical, stratigraphical, and palæontological constitution in the different parts of Europe where it has been studied." Dissatisfied with many of the results of previous investigations, M. Martin determined to go fully into the whole question, the result of which has since been published. In the meantime he here gave a general *résumé* of what appeared to him the real state of the case, after examining the data observed in different countries in a mineralogical, stratigraphical, and palæontological point of view.

After describing the mineralogical character of the beds in question in different parts of Europe, he comes to the conclusion that the petrographical constitution of the zone is always dependent on the nature of the underlying beds, or of the coasts which were washed by the seas of this distant period. A coarse sandy conglomerate when in contact with the crystalline rocks, becomes a fine sand when it succeeds the grit of the Keuper, and marly limestone when it rests upon the variegated marls and other argillaceous beds. Thus it often happens that the lower beds resemble, and even alternate with, the Keuper for a certain time, and then in the upper portion pass by a regular transition into the overlying Lias. Mineralogically, therefore, there is no evidence to show that it belongs to the Lias or to the Keuper absolutely.

The same may be said respecting the stratigraphical evidence. With the exception of a few local cases of a very limited character, there does not appear to have been any violent or cataclysmal disturbance, either at the beginning or at the end of the *Avicula-contorta* period. In general, these beds are found to be in a position of conformable stratification, both with the Keuper and with the Lias.

The palæontological evidence is more important. M. Martin has carefully examined all the lists given by the different authors who have written on the subject, and endeavours to show how many species and genera are common to the Keuper and the *Avicula-contorta* zone, how many are peculiar to this zone, and how many it contains in common with the overlying Lias. After eliminating

useless synonyms, he proceeds to examine the geological limits now known of the 149 genera, to which belong the 535 species which form the fauna of this formation. He thus finds that only 12 of these genera, containing 37 species, belong to the Palæozoic and Triassic formations, and appear for the last time in this zone; that 47 other genera, comprising 71 species, appear here for the first time, and extend in great numbers into the Jurassic series; that some are peculiar to this horizon, and that the remainder are common both to the overlying and underlying beds. From these lists alone, we find that the greater preponderance of forms connects this zone with the Lias rather than with the Keuper. He then analyzes the different classes with the same general result, except in the case of the Brachiopods, which show a greater affinity to the Keuper than to the Lias.

Again, looking at the question with regard to species, he finds a far greater number identical with the Lias than with the Keuper, and this with reference to the *flora* as well as to the *fauna*. The next question is whether this zone is to be considered as a distinct formation or merely as the lowest member of the Liassic series. There can be no doubt, according to M. Martin, that the number of organic forms which appear for the first time at this horizon is too great and too important not to be considered as characteristic of a distinct epoch; at the same time it is essentially Jurassic in its character, and should therefore be considered as the lowest member of the Jurassic series. The author concludes his paper with a series of propositions involving in a concise manner the arguments above recorded, but which it is hardly necessary to repeat on this occasion. I will merely add that he gives a list of sixteen species common to the *Avicula-contorta* zone and to the Trias, as well as another list of fifty-seven species common to this zone and the Liassic formation.

Dr. Benecke, of Heidelberg, in his work on the "Trias and Jura in the Southern Alps," published during the present year at Munich in the 'Geognostisch-palæontologische Beiträge,' has taken another view of this question, and endeavours to show, in opposition to the views of Renevier, Stoppani, and others, that the Rhætic beds including the *Avicula-contorta* zone, should be referred to the Trias rather than to the Lias. He denies that the Infralias possesses that peculiar character which justifies its being considered as a distinct formation intermediate between the Trias and Lias. But, independently of this question, the work of Dr. Benecke contains much valuable information respecting the stratigraphical details of these formations, and the comparison of those of Lombardy with those of Southern Germany. Nor is the palæontological element overlooked. The forms of animal life of the different strata are carefully compared, and the whole argument is mainly based on sections which he has himself observed in the different districts he describes.

On a former occasion I gave you some account of the observations of M. Renevier on the Infralias or Rhætic beds in the neighbourhood of the Lake of Geneva. He has since published an account of the geological formation of the Oldenhorn, a peak which rises to the

height of 3124 metres a little to the eastward of the Diablerets. A short notice of this will not, I think, be uninteresting, as giving a clear explanation of some of the complicated structures of the secondary beds in this portion of the Alpine chain. After describing the orographical limits of what he calls the *massif* of the Oldenhorn, which is separated by a fault from the Col de Pillon on the north or north-west, he describes the different formations of which the northern slope of the mountain consists. These are broken into several alternating anticlinal and synclinal masses, or, as he calls them, *combes* and *vallons*, or saddles and troughs as they are sometimes called. It forms a portion of the Cretaceous and Nummulitic zone of the Alps. The principal nucleus of the formation is Neocomian, partially covered over by the Urgonian limestone, resting on which are occasionally found fragments of the Nummulitic beds, these generally occur in the troughs formed by the synclinal arrangement of the Urgonian limestone. Without going into all the details given by the author, it may suffice to say that these beds, which are sometimes seen in an almost horizontal position, become, higher up the mountain, completely vertical or even sometimes slightly inverted towards the north. This alternation is repeated several times.

This remarkable arrangement, he observes, is precisely similar to the saddles and troughs of the Jurassic chain, with this difference, that the system of contortion which in the Jura has a horizontal base, must be referred in the Alps to a highly inclined base line, so that the two sides of a trough which in the Jura "are symmetrically inclined, become in the Alps the one horizontal, and the other vertical." This is well shown in his section of the Sanetsch, where he has drawn an inclined ideal base line, which, when placed in a horizontal position, reduces the Alpine contortions and inversions to simple Jurassic undulations; by this means the structure of the Alpine beds is wonderfully simplified, and throws an interesting light on the mode of elevation of the chain of the Alps. Here, at least, it appears that the elevation of the Alps presents two principal elements. The first action formed the undulations of the beds, producing a structure analogous to that of the Jura; by the second, the whole mountain-mass underwent an unequal amount of elevation starting from the centre of the chain, producing an inverse effect on the undulating beds, raising up and overturning some, while others were brought into a horizontal position. This semi-jurassic orography has given him the key to other stratigraphical arrangements in the Alps, even more complicated and unusual.

The author then proceeds to describe the various formations, the most recent of which is the Nummulitic, which consists of four distinct beds, and, as I have observed, always occurs in the troughs formed by the synclinal Urgonian limestone. He mentions various points where it is seen, and the different fossils by which it is characterized. Several species of *Cerithium* are abundant in the lowest bed.

The next formation is the Urgonian. No traces of the Cenomanian, Gault, Aptian, or Rhodanian have been here found. The Ur-

gonian formation consists chiefly of a white compact limestone. In its fracture it is slightly crystalline, sometimes white, but more frequently of a greyish hue, and except by its fossils is often hardly to be distinguished from the Nummulitic limestone. Wherever the Urgonian beds are broken through in the anticlinal saddles, a mass of brown schists rises up below them. The author attributes them to the Neocomian formation on account of the fossils they contain, as *Belemnites pistiliformis*, Blainv., *B. dilatatus*, Blainv., *Ostrea rectangularis*, Röm., a *Hamite*, and a *Terebratula* resembling *T. pseudojurensis*, Leym; at the same time he is not prepared to say that other older beds may not also be associated with the Neocomian.

To the N. or N.W. of the Oldenhorn rises the Col de Pillon, separated by a fault which follows the line of the river Dard to a well known spot called Sur Pillon. The beds to the north of this fault consist of alternating bands of gypsum and *Corgneule* or Rauchwacke, which, in accordance with the views of Prof. A. Favre, the author considers as belonging to the Triassic group. He has traced them to a considerable distance from the Plan des Isles to the eastward. It is difficult to make out their stratification; M. Renevier suspects that they represent repeated undulations of the same beds. They are in part concealed under erratic deposits, and appear to be overlain by the sandstones, schists, and conglomerates of Palette du Mont, the highest point of the mountain-mass to the north, and which is laid down as Flysch. No fossils have been found in these beds, nor in the gypsum or *Corgneule* of the Col de Pillon. The latter is generally more or less cellular, and the gypsum varies from white to grey.

Amongst the valuable works which have been published in Switzerland, I may also mention that of W. A. Ooster on the "Pétrifications remarquables des Alpes Suisses," in which he gives a full synopsis of all the fossil Echinoderms which have hitherto been discovered in the Alps of Switzerland. The work is illustrated by twenty-nine plates of fossils, and professes to give a description of all the species hitherto known, from the Infraliassic beds upwards to the Tertiary formations, amounting in the whole to 193 species, which are thus distributed:—Trias 3, Infralias 4, Lias 4, Jurassic 27, Cretaceous 93, and Tertiary 62 species.

In the last year's volume of the 'Zeitschrift der Deutschen Geologischen Gesellshaft' will be found an interesting account of a visit to the copper-mines of Monte Catini in Tuscany, and to some other places in their neighbourhood, by Herr von Rath, of Bonn. The mineralogical and physical features of the country are well pourtrayed, as well as the different geological formations. The sterile aspect of the Pliocene clay-hills, on which every attempt at cultivation has failed, is graphically described, and we have also a full account of the Borax Lagoons (Lagoni) of Monte Cerboli.

There is, however, one passage in this memoir which has surprised me. In describing the well-known statuary marble of Carrara, which belongs to the Lias formation, the author says that in the Apuan Alps the finest statuary marble occurs in large lenticular masses, which

are surrounded by a husk or crust containing much mica or talc and other substances, and are imbedded in the common crystalline limestone. This husk is called "Madre-macchia;" and the more it is developed, the purer is the marble within.

This is precisely the manner in which the pure white alabaster of Florence is found in the gypsum-quarries of Castellina, as I have already described it*. I have also visited the marble-quarries of Carrara but never observed this peculiar structure there. No doubt the marble varies much in quality in different localities and on different hills, but it always occurs in large amorphous fissured masses, all trace of stratification being removed by the metamorphism it has undergone. If the author has not, as I suspect, confounded the structure of the alabaster with that of the statuary-marble, it will be a curious coincidence to find that both occur under such similar circumstances. The explanation of this structure given by the author is no doubt correct, viz., that during the metamorphosis of the limestone or gypsum, the foreign particles mixed up with it were driven out by chemical action and formed the Madre-macchia; and the more this was done, the more perfect was the marble or alabaster.

Prof. Reuss has published in the 'Transactions of the Imperial Academy of Sciences at Vienna,' a paper on a portion of the fauna of the Upper Oligocene formation of Germany, viz. the Foraminifera, Anthozoa, and Bryozoa. The author's former works on these minute forms are well known; and, after alluding to the previous partial publications of other authors, he observes that, owing to the large mass of materials placed in his hands by numerous palæontologists as the results of recent investigations, including all the known German localities of Upper Oligocene beds, he has been enabled to compile a complete view of the whole Foraminiferous, Anthozoan, and Bryozoan fauna of the Upper Oligocene. Should future researches lead to the discovery of a few more species, they would only fill up gaps, but in no way effect any important change in the general view of the question. Before describing the individual species he makes the following remarks:—

1. *Foraminifera*.—Hitherto 142 species have been observed, with two remarkable varieties. Of these only 5, which, moreover, are very scarce, belong to the division with siliceous shells; 16 species have a thick calcareous shell without pores; the great majority, viz., 121 species, have a calcareous poriferous shell.

From the table of genera it appears that the Rhabdoideæ (with 21 species), the Cristellarideæ (with 25 species), the Polymorphinideæ (with 40 species), and the Rotalideæ (with 19 species) are the most abundant. The genera containing the greatest number of species are, *Cristellaria*, *Robulina*, *Globulina*, *Polymorphina*, and *Rotalia*. He then adds a list of those species which are the most abundant and characteristic of the whole fauna, the more so as they are almost all peculiar to the Upper Oligocene.

* Quart. Journ. Geol. Soc. vol. i. p. 282.

He then arranges all the species in a tabular form, showing not only their vertical range in the different Tertiary stages in which they occur, but also their horizontal development, viz. the different Upper Oligocene deposits in which they have hitherto been found. This list shows that the Ahnegraben near Cassel has alone afforded 88 species, the greater part of which are only found in few localities. Very few species have a wide distribution. With regard to the vertical distribution, 67 species have been found only in the Upper Oligocene, to which they seem peculiarly to belong; 47 species descend into the Middle Oligocene or Septaria Clay, and of these 5 reach the Miocene, 3 the Pliocene, and 1 species is still living. Altogether the Upper Oligocene has 42 species in common with the Miocene, 5 of which extend into the Pliocene and 10 are still living.

"Taking all these facts into consideration," observes Prof. Reuss, "we come to this conclusion, that the Foraminiferous fauna of the Upper Oligocene beds is very peculiar, and easily recognized under all circumstances. The marks of distinction are partly common, partly special: the former rest on the remarkable preponderance of various *Polymorphinideæ* and *Cristellarideæ*, and on the abundance of the otherwise scarce *Flabellinæ*; the latter on the numerous species peculiar to the Cassel beds, amongst which the above-mentioned 17 species are remarkable, partly for the great abundance of individuals, and partly for their distribution over almost all the Upper Oligocene localities."

The author then gives a description of all the observed species, with their situation, history, and localities, and adds five well-executed plates of figured illustrations.

2. *Anthozoa*.—Only seven species have hitherto been found which can safely be referred to the Cassel beds; others may perhaps be found by other authors, but the characteristic evidence is still incomplete. Of these 7 species, 3 belong to the *Caryophyllideæ*, 3 to the *Turbinoliæ*, and 1, viz. *Cryptaxis alloporoides*, to the *Madriporideæ*. Fragments of other species have, however, been found too imperfect to describe, and authors have also quoted some which Prof. Reuss has not had an opportunity of examining; the whole number is therefore probably greater. The author then gives a detailed account of the different species at present known to him.

3. *Bryozoa*.—These are much more numerous in the Cassel beds alone. The author is already acquainted with 73 species, and there are probably others. A tabular statement of their different localities then follows, from which it appears that they are very unequally distributed. Thirty-seven species have been found at Astrupp and 28 at Luithorst. It is, however, worthy of notice, that many of these Bryozoa extend through several stages of the Tertiary formation, and they must therefore have continued to exist through a long period of time. This is in direct opposition to the opinion of F. A. Römer, who has stated that each species of Bryozoa is peculiar to one Tertiary formation, and that any one Bryozoon is sufficient to fix the age of the formation in which it is found. This Prof. Reuss considers to be an error. Then follows the detailed

account of the individual species. It must also be stated that the work is accompanied by 15 plates of illustrations.

Although perhaps more interesting in an ethnological than in a geological point of view, we cannot altogether exclude from our notice the phenomena attending the first appearance of Man on our planet. The discoveries of the last few years have satisfactorily shown that the opinions formerly entertained of a great break existing between the period when the now extinct races of Mammalia dwelt in our land, and the first creation of Man, are no longer tenable. Here also we have been obliged to give up the theory of great breaks between successive formations. As we find a gradual passage from one geological formation to another evidenced by the *gradual* dying out of the pre-existing forms of animal life, and the *gradual* introduction of newer, and generally higher, forms (although we do not yet understand the law of such progressive changes), so, when we come to the most recent, or Quaternary, periods in geological chronology, we find evidence of Man's existence on the earth before the final disappearance of those varied forms of mammalian life which have hitherto been generally looked upon as belonging to the final period of the geological cycle. Thus Man of the present day is connected by an almost unbroken series of links with the recently discovered Foraminifera of the Laurentian gneiss. Let me not, however, be supposed to be thereby giving in my adhesion to the doctrines of development, either to that of Lamarck or to the more recent and captivating views of Mr. Darwin.

Since, then, we must now admit human remains, and the evidences of human existence, as belonging to the last period of geological history, I cannot refrain from alluding to some of the publications which have recently appeared on this subject.

Dr. Felix Garrigou, of Tarascon, has published an interesting work on the old Quaternary alluviums and the bone-caves of the Pyrenees and of the West of Europe. After pointing out that different caves contain different animal remains generally, in accordance with the various positions of the caves, he shows that some caves contain as many as three distinct beds characterized by their different contents, as, *e. g.*, the cave of Mas-d'Azil.

The first period is characterized by *Ursus spelæus*, *U. priscus*, *Felis spelæa*, *Hyæna spelæa*, *Elephas primigenius*, *Rhinoceros tichorhinus*, *Megaceros hibernicus*, *Cervus elaphus*, *Bos primigenius*, *Bison europæus*, and sometimes *Cervus tarandus*, &c. The second period is that in which the Reindeer is most prominent; with it are found the Horse, *Megaceros hibernicus*, *Cervus elaphus*, *Bos primigenius*, Aurochs, Sheep, Chamois, Bouquetin, Wolf, and Fox, and a third species of *Canis*, perhaps intermediate between these two last, but no domesticated animals. The fauna of the third or prehistoric period, found at the entrance of caverns and in beds overlying those which contain the Reindeer, consists of *Ursus arctos* (still living in the Pyrenees), three species of *Bos* (domesticated), the Goat, Sheep, *Sus scrofa palustris*, *Sus scrofa ferus*, *Cervus elaphus*, Roebuck, Bouquetin, Chamois, Wolf, Fox, domestic Dog, Hare, Blackcock, &c.

The author then observes that, "as the stratigraphical and palæontological researches point to three distinct periods from the commencement of the Quaternary epoch down to the historic times, so the study of the remains of human industry, so constantly recurring with the different faunas described above, also prove that these divisions are correct;" and he assumes that from the commencement of the Quaternary epoch there are in the south of France three great distinct phases in the palæontological history of this period, as well as in the history of the civilization of the peoples which have lived since the commencement of that epoch.

1. In the first great phase, Man was the cotemporary of the great Cave Bear, and of all those animals which have been shown as accompanying this great mammifer. The bones of these animals lie together, broken by man, either in the old Quaternary alluviums of the sub-Pyrenean valleys, in caves, situated from 150 to 250 metres above the level of the present valleys. The remains of human industry found with the remains of these extinct mammifers indicate an early art somewhat resembling that of the stone implements of Abbeville.

2. During this first phase the great Carnivora and Pachydermata became extinct. The Reindeer, owing to favourable conditions, increased and multiplied, and became characteristic of a second phase, during which Man had not yet learnt to domesticate animals. But human industry had made considerable progress: the flints are prepared with art and neatness, and bones are worked with more intelligence, as they show traces of sculpture and drawing. The Reindeer and its accompanying fauna are found in grottos situated near the foot of the mountain, and at a lower level than those which contain the *Ursus spelæus*; they are also found in some caves in beds overlying those which contain the mammifers of the older period.

3. The third phase is characterized by a fauna consisting chiefly of domesticated animals, the remains of which are found at the mouths of caves in the bottoms of the valleys, and sometimes in a soil which forms beds overlying those containing either the great Cave Bear or the Reindeer. Man has learnt to polish stones, they are only occasionally cut; he is acquainted with agriculture, but has not yet learnt the use of metals.

The author then applies these principles, with the same results, to the other parts of France, as well as to Belgium and the west of Germany, and concludes with a chronological review of the various Mammalia composing the old Quaternary fauna, to serve as a basis for the geological history of Man, which the author subdivides into various epochs, from the doubtful Pliocene of Chartres to the earliest historic period, and concludes with a sketch of some of the geological causes which have led to the cave-phenomena of the Pyrenees, and a statement of the different heights at which these caves occur, for which I must refer you to the work itself.

In continuation of his great work on 'Paléontologie Stratigraphique,' M. d'Archiac has published another volume, entitled 'Leçons sur la faune Quaternaire,' which the editor considers as a con-

tinuation of the 'Introduction à l'étude de la Paléontologie Stratigraphique,' already published. It may also be considered as the first application of the method recommended by him, and, strictly speaking, as the commencement of his course of lectures, the object of which is the exposition of the characters and of the distribution of the fossil floras and faunas which have been successively developed on the surface of the earth. In attempting to give a slight sketch of this interesting work, I pass over the first lecture, which gives a *résumé* of the first portion of his course. The second lecture describes the Quaternary fauna of the eastern and central parts of France. After alluding to the evidence of glacial action in the mountains of the Vosges, the author states that the Quaternary deposits which fill up the depression between these mountains and the parallel chain of the Black Forest on the eastern border of the Rhine, consist of three principal members.

1. The ancient alluvium, or loess, forms the uppermost or most recent member.

2. Beneath this are beds of transported pebbles and blocks, which, derived from the Vosges and the Black Forest, are connected with the glacial phenomena of those chains.

3. These again rest on a deposit of rolled pebbles, designated as the *Alpine erratic deposit*, or Alpine diluvium, occupying the bottom of the great valley of the Rhine.

These three deposits represent three successive epochs. The loess is found on the flanks of the hills rising to a greater elevation in proportion as we ascend the Rhine valley. At Bonn it is found at an elevation of only 65 metres, between Heidelberg and Heilbron at 260 metres, and on the flanks of the volcanic mountain of the Kaiserstuhl it rises to the height of 400 to 450 metres. It contains about 20 species of land and freshwater mollusca, most, if not all, of which belong to living species. In its lower beds have been found the bones of extinct Mammalia, *Elephas primigenius*, *Rhinoceros tichorhinus*, Ox, Horse, and Deer. In the second deposit have only been found a few species of freshwater shells, but in great abundance. The third member or *Alpine deposit* is remarkable for the great number of bones of extinct Mammalia found in it, including, besides those just mentioned, *Ursus spelæus*, *Hyæna spelæa*, *Cervus megaceros*, *Equus adamiticus*, *Bos priscus*, and *Cervus priscus*.

He then compares the loess of the Rhine with the old alluvium of the north of France; the second deposit is compared to certain portions of the basin of the Seine, where beds of transported pebbles and red sand without fossils are found; and, lastly, the sands with rolled pebbles forming the bottom of the plain of the Rhine are the same as those which occupy the lower portions of the valleys of the north of France and of Belgium, containing the same fossils and offering the same physical characters, being exclusively composed of the detritus of rocks which form the respective basins of each depression.

Following this arrangement, the author describes the Quaternary deposits of the different geological regions of France, giving full

historical details of their progressive discoveries and of their respective authors. He then proceeds to discuss in the same way the organic remains found in the caverns and osseous breccias in different parts of France.

In describing the caverns of Arcy near Vermenton in Burgundy, he states that in 1858 M. de Vibraye undertook the careful exploration and examination of one of these caverns. He made out the existence of three distinct layers or formations, and in the lowest, containing the remains of *Ursus spelæus*, *Hyæna spelæa*, *Rhinoceros tichorhinus*, &c., he found a human jaw, still retaining two teeth *in situ*, in immediate contact with the bones of the extinct Mammalia. All the characters of the substance of this jaw were identical with those of the bones with which it was associated and very different from those found in either of the overlying beds. With such evidence he observes that it is almost impossible to resist the conclusion that Man was the cotemporary of these extinct animals.

The author also shows, with reference to the caverns of other parts of France, and especially in Languedoc and in the Pyrenees, that incontestable evidence has been found, not only of the existence of Man during the later periods when the Reindeer abounded all over France and the great Mammalia appear to have become extinct, but even during the period of their existence; and in concluding his chapter on the caves and osseous breccias of the Pyrenees, he observes that, in the valleys of the basin of the Ariége alone, the elements of human chronology from the earliest Quaternary epoch, viz., that of the *Ursus spelæus* down to the time of the lacustrine habitations of Switzerland, are such as have nowhere else been found within so small a space; and he adds that, notwithstanding these accumulated proofs, there are persons who still refuse to believe in the contemporaneity of Man with the great extinct species of Mammalia. "But," he adds, "the history of science shows us at every step instances of this opposition to the introduction of new ideas contrary to old theories, and which wound the opinions and *amour propre* of individuals; let us not therefore be astonished at what we see around us on this question, but let us hope everything from time and perseverance in inquiries, which will ultimately get the better of these oppositions as they have already done of so many others."

The author then proceeds to examine these Quaternary deposits on the northern and southern flanks of the Alps with the same general results, those of the Mediterranean, Asia, North and South America, Australia, and New Zealand, giving in every case an account of the most recent discoveries bearing on this important and complicated question; and he shows, in conclusion, that the phenomena observed in America and Australia confirm the observations made in Europe and Asia, viz., that the fauna of the great extinct Mammalia characterized by the *Elephas primigenius*, *Rhinoceros tichorhinus*, *Ursus spelæus*, &c. must be separated from the fauna of the present day. At the same time the difference between the characters of the Quaternary fauna, when compared with those of the existing fauna, are by no means the same in different classes: in the lower marine ani-

mals, as well as in the land and freshwater mollusca, the differences are very slight; amongst the mammifers it is generally the contrary. The analogy of the Quaternary and modern faunas is subject to its own particular law in each natural division; it is the more striking in proportion as the animals under consideration are of smaller size. If we examine the fossil Mammalia of the southern hemisphere, either by orders, by families, or by genera, we first find that the animals are larger than their congeners of the present day; and secondly, that the species which are identical with those of the present day, or nearly so, are the smallest.

After alluding to the theory of Prof. Owen in his Memoir on the Megatherium, in which he endeavours to explain why the races of smaller forms of animals have had a more prolonged existence than those of greater size, viz., because they could more easily accommodate themselves to those changes in the conditions of life under which the larger forms could no longer exist, he observes that, as a general rule, we find in the different classes of fossil animals the duration of species, and even of genera, is in an inverse ratio to their size and mass, whereas the normal life of individuals is generally in a direct ratio to their size.

"It is," he observes, in conclusion, "a mere question of time, for which man, still new on the surface of the earth, has no chronometer to enable him to measure the periods of existence of the beings which surround him. Palæontology, it is true, reveals to us the existence of gigantic reptiles in past ages, which have successively appeared and disappeared; and the small animals, their cotemporaries, have equally undergone the inevitable law of the renewal of types, both large and small, and of their continual replacement. It is true, we do not observe this movement about us; we are disposed to believe that organic nature, which, since the beginning of creation, has never ceased to modify itself, has become immoveable since Man's appearance, that the laws of succession have been replaced by mere laws of preservation; in a word, that creation is complete and finished.

"This, undoubtedly, is an illusion, caused by this fact, that the few dozen centuries which constitute our history are not sufficient to bear witness to any important changes; but if study and observation have taught us anything, it is this, that the history of the whole human race is of no more account in the history of nature than the life of those ephemeral insects of which a single day beholds the birth, the reproduction, and the death."

An interesting Monograph has been lately published by Dr. G. A. Maack, entitled 'Palæontological Inquiries respecting hitherto unknown *Lophiodon* Fossils from Heidenheim on the Hahnenkamme in Central Franconia, together with a Critical Review of all the hitherto known species of the genus *Lophiodon*.' In describing the historical development of this genus, the author remarks that the great gap which exists between the Ruminants and Multungula (Vielhufer) of the existing fauna has been in a great measure filled up by the discovery of fossil remains. The contrast hitherto

supposed to exist between these different types has been removed by means of the fossil remains of the now extinct Elasmotheria, Palæotheria, Lophiodonta, Anthracotheria, &c. The object of this memoir is to describe more fully than has yet been done the peculiar zoological position of the genus *Lophiodon*, and its connexion with, and difference from, allied genera, so far as it can be done with the help of the hitherto discovered fossil remains.

He then proceeds to describe all the known species of *Lophiodon*, and begins by subdividing the genus into the five following subgenera, according to the different structure of the teeth in each separate species:—1. *Coryphodon*, Owen; 2. *Tapirotherium*, Blainv., this is the typical form to which Cuvier gave the name of *Lophiodon* in 1822, although Blainville had already named it in 1817; 3. *Pachynolophus*, Pomel.; 4. *Lophiotherium*, Gervais; and 5. *Tapirulus*, Gervais.

The next subject to which the author directs his attention is the examination of the *Lophiodon* remains of Heidenheim. This important discovery was made by Rütimeyer not long ago, and Dr. Maack has been enabled to examine and compare about forty well-preserved teeth, besides fragments of teeth, jaws, and bones. These are all carefully described, and some curious anomalies in the structure of the different teeth are pointed out. Thus he observes that neither the molar nor premolar teeth of his new species, *L. rhinocerodes*, would, either in form or structure, give any clue as to what the canine or incisor teeth were; on the contrary, we should be greatly misled if we attempted, from the remarkable resemblance between the molar teeth of *Tapir* and *Lophiodon*, to infer a similar resemblance between the canine and incisor teeth of both animals.

He then discusses the zoological position of the genus *Lophiodon*, and shows, as a necessary consequence of recent discoveries, and of which he gives Rütimeyer the chief credit, that it belongs to the great family of *Pachydermata omnivora*, and concludes that *Lophiodon* is not connected with *Tapir* and *Palæotherium*, although in the structure of its teeth it combines many characters of these two genera, but that it is more closely allied to the genera *Chœropotamus*, *Hyopotamus*, and *Anthracotherium*.

With regard to the geological age of the beds in which *Lophiodon* has been found, he comes to the conclusion, that this genus, with its cotemporaries, formed a peculiar fauna, the remains of which are buried in the clays, lignites, marls, freshwater conglomerates, and marine limestones of the age of the *calcaire grossier* of Paris. The work is illustrated by fourteen plates, chiefly representing the different teeth in various positions.

I think it may be interesting to allude here to a new theory respecting the transport of erratic blocks recently published by Count Keyserling*.

Finding great difficulty in accounting for many of the phenomena which accompany the erratic blocks which cover the level lands of

* Mélanges physiques et chimiques tirés du Bulletin de l'Acad. Imp. des Sciences de S. Pétersburg, tome v.

Livonia by the usually adopted theory of glaciers or of floating icebergs, Count Keyserling calls attention to phenomena recently observed on the shores of the gulf of Pernau as affording a more satisfactory explanation, showing a movement of ice from the sea-level inland and uphill.

During the first frosts of 1863, a vast field of ice, from 2 to $2\frac{1}{2}$ feet thick, had formed itself on the shore, extending far out to sea. The water then rose about 4 feet, owing to the milder weather, covering the field of ice. This was subsequently raised by the water, and formed a free-floating field of ice of enormous extent. A violent storm on the 15th and 16th of January drove this field of ice against the shore, and forced it with great power over the land. Similar occurrences, but on a much smaller scale, had previously taken place; but now, owing to the much greater thickness of the ice, the event assumed an intensity which had not been observed for several generations; three peasants' dwellings on the promontory of the Tackerort were so suddenly invaded by the ice and destroyed, that the inhabitants lost all their property, and had only time to escape with their lives. The ice here rose 60 feet above the level of the sea; in other places, where the shore was less steep and only 12 feet above the sea, the ice came upon a fir-wood, broke the stems (some of which were 13 inches in diameter), threw them down, and covered them with an unbroken coat of ice. Wherever the floating field of ice encountered a steep precipice, it rose up like a sheet of paper, its free edge rose over the land, and then, turning over, fell partly into the sea and partly in fragments over the land and was pushed further in. On the flat shore of Heuschläger the ice was driven 1023 feet inland, carrying with it a vast quantity of stones; at the same time, stones were everywhere raised out of the sea by the ice and driven on shore.

When Count Keyserling himself visited the spot, he found a block of granite, weighing about 60 poods (2160 pounds), lying amongst the blocks of ice, 30 feet above the level of the sea, and which had evidently been raised by the ice from the bottom of the sea, thus confirming the generally received opinions respecting the transport of stones by means of ice. In another spot, where there is a land-cliff 30 feet high, he found a heap of ice-blocks 10 feet thick, which had been generally tilted into an almost vertical position. Their upper surfaces were covered with gravel and stones; the lower surface was pure ice, and had originally formed the upper surface of the field, thus showing that the broken masses of ice had been completely overturned by the violent pressure.

"If now," adds Count Keyserling, "we could suppose that during the period of the great erratic phenomena the same circumstance took place, but on a larger scale, so that fields of ice of many hundred square miles and 4 feet thick were periodically driven over the land, we should have a natural explanation of the scratched surfaces in parallel lines, and also of the non-marine character of the erratic deposits." He considers that these phenomena show how blocks of stone out of the sea can be pushed by ice into places far beyond the reach of the water, and how deposits may be formed

along the coasts high above the level of the sea resembling true inundations on the shore.

As an appendix to these observations of Count Keyserling, Prof. Baer, of the Academy of Sciences, has added some interesting remarks of his own respecting huge boulders which he had himself seen in various spots along the coast of Finland and the adjacent islands, some of which are of great size, and all of which, he was told by the inhabitants, had been driven into their present position by the pressure of the great fields of ice. He then proceeds to give an account of the island Laven Lari, on the coast of Esthonia, where he considers that erratic phenomena are still going on, although the chief events took place at a far distant period. He compares the present form and outline, and its accumulation of gravels and boulders, with those given in older maps, and believes that the map of Spafariew, published in 1822, on data obtained in 1813, although not absolutely correct, is yet sufficiently so as to justify the assumption that the differences in the two maps represent the changes which have taken place in the last quarter of a century. The reports of the inhabitants respecting the movements of the ice would appear to account for these changes, which are closely connected with the facts communicated by Count Keyserling.

At the same time Prof. Baer admits that other causes of this change of form may possibly have come into play; as the inhabitants alluded to the conviction of the gradual rising of their island above the level of the sea, without, however, giving any satisfactory reasons. In conclusion, Prof. Baer states, as the result of his observations, that very large boulders are only seldom moved by ice; moderate sized ones more frequently; but that small blocks, particularly near the level of the sea, are so frequently moved and heaped together by ice, that they escape the notice of the inhabitants, and yet produce important changes in the outlines of the flatter island in the course of a century. Thus erratic phenomena are continued even to the present day, although the distribution of the superficial boulders appears to point to an enormous lapse of time.

But there are other erratic blocks found buried in the soil far inland, which can hardly be referred to the action of the present sea and its floating ice, and these extend as far as Moskow. In the Gulf of Finland also are great masses of blocks which reach so near the surface of the water as to cause serious impediments to navigation. The Professor concludes by distinguishing still existing or recent erratic phenomena from others which may be called diluvial, and considers the floating ice and the present level of the sea, or perhaps one slightly elevated, as a sufficient explanation of the former. With regard to the older erratic or diluvial phenomena he has no suggestion to make, but advocates the necessity of further local observations.

Don Casiano di Prado has published during the past year 'A Physical and Geological Description of the Province of Madrid.' On this occasion I need only refer to the second or geological portion of the work. He says that in this province are found remains of the organic life of the Silurian period in beds which rise to a height of

2000 mètres, and this formation was not again submerged until about the commencement of the Cretaceous period; but before the close of this period both these formations were again raised above the surface of the sea, and there is not the slightest evidence that they were ever again submerged, as the Tertiary deposits which rest upon the Cretaceous have been entirely, or at least for the most part, formed at the bottom of a great freshwater lake. The Quaternary or diluvial beds were also formed in fresh water, and at a period when this lake had been partially filled up and drained.

The series of formations is therefore far from complete in the province. Of the Palæozoic period, the Devonian, Carboniferous, and Permian are wanting; of the Mesozoic or Secondary period there are no traces of the Triassic, Jurassic, and a portion of the Cretaceous beds; and of the Tertiary period only the Miocene occurs, there being no certain evidence either of Eocene or Pliocene. The result is, that the formations which are found in the province of Madrid are Plutonic, consisting exclusively of granitic and gneissic rocks, Silurian, a portion of the Cretaceous, part of the Tertiary, the Quaternary, and recent formations.

The author then describes these different rocks, commencing with the granite, which occurs principally in three distinct masses, lying in a N.E. and S.W. direction. But there are also numerous granitic islets in the gneissic rocks, many of which are so small that it has been impossible to lay them down on a geological map; they extend into the provinces of Toledo, Segovia, and Avila, and even into those of Salamanca and Cáceres, forming one of the most extensive granitic regions of the peninsula. He then describes in great detail all the different varieties of granite, passing into kaoline, syenite, pegmatite, micaceous porphyry, and many others; also the external forms and structure of these masses, many of which are very remarkable, caused chiefly by the unequal decomposition of the rock. Isolated peaks and pillars, from 12 to 26 mètres in height, have been thus produced, and the "mountain of the seven peaks" has been crowned with its seven isolated craggy rocks. These granite masses are often traversed by fissures of various width, but sometimes large enough to be used as threshing-floors by the peasants.

The author then enters into long details respecting the origin and decomposition of the granite. He adopts the modern views that water was no less necessary to its formation than fire, and thinks that it must have formed the first crust of the earth, though he is hardly prepared to say whether the granite of Madrid belongs to this primordial granite, or to those masses which have been subsequently erupted; but there is no doubt that much of it belongs to the erupted class. Some of the phenomena accompanying this process show that not only have great disturbances and dislocations taken place, but that the more recent and easily decomposed granites contain blocks of an older period, and of a harder and more compact nature.

The gneiss is less extensively developed than the granite, but occurs under a great variety of forms, as micaceous, felspathic, quartzose, amphibolic, &c., all of which are described by the author; it

sometimes contains masses and veins of granite, in other places it is interstratified with calcareous bands or nodules, metamorphic, and so charged with magnesia as to be useless for burning. It is generally stratified, and rises into more rugged crests and crags than the granite, though this is not so much the case in the province of Madrid itself as in the neighbouring districts.

With regard to the origin of the gneissic rocks which were formed by sedimentary action, the author observes that they are not all of the same age. In the province of Madrid the gneiss is decidedly metamorphic and contains beds of limestone which do not occur in the Silurian formation. The gneiss has undergone much less decomposition than the granite, although it appears to have been eroded on a very large scale. This strikes Don Casiano as worthy of notice, inasmuch as the granite contains 30 per cent. of quartz, whereas in the gneiss this latter substance is almost entirely wanting, and of the three component elements of both these rocks the quartz is the least subject to decomposition. Other remarkable instances of the decomposition of the gneiss are then described and commented on; but my space and your time will not allow me to enter further into their consideration.

The author then describes the Silurian formation, which, however, is not of any great extent in this province; it consists chiefly of slates, sandstone, and quartzite, the former being most preponderating. Roofing-slate does not occur here, though it is found in the neighbouring provinces of Segovia and Guadalajara. The amount of denudation in former periods has been very great, and the quartzites which alternate with the slates having offered greater resistance to this action are now seen standing out and forming rough and rugged crests. After describing the principal strikes of these beds, which oscillate from N. 20° E. to N. 22° W., and the metamorphic action to which they have been exposed, the author proceeds to describe the fossils which have been found in them.

These are very scarce in the province of Madrid, though many casts of *Graptolites* have been found in that of Segovia. Those described here are:—*Cruziana* six species; *Scolithus*, *Orthoceras*, *Lingula*, one each. Several forms of *Acephala* have also been met with, but in too imperfect a condition to allow of their being satisfactorily determined. These are followed by an account of the veins and minerals which occur in the granite, gneiss, and Silurian beds; these are both metalliferous and non-metalliferous. The latter consist chiefly of pegmatite, quartz, and diorite: the metalliferous veins contain a little silver, galena, sulphate of barytes, fluorspar, and iron pyrites. These metals occur sometimes in detached masses or nodules, and sometimes disseminated throughout the whole substance of the rock. Between the years 1841 and 1860 there was a great development of mining enterprise, but the results were anything but satisfactory.

The author then describes in detail the various minerals found in the granitic, gneissic, and Silurian rocks, and concludes this portion of his work with an account of the different systems of elevation

which prevail throughout these formations. The direction of the principal mountain-chain which traverses the peninsula from Lisbon to the Pico de Grado, passing through the provinces of Segovia, Soria, and Guadalajara, is from E. 27° N. to W. 27° S.; four other important mountain-chains run nearly parallel to it, although slightly obliquely. The author then, taking up the views of M. Elie de Beaumont, endeavours, I think somewhat hastily, to refer these different lines of elevations to the different systems laid down by the great French geologist in the European region: thus he refers the chains of the Guadarama, La Gata, and La Estrella, the mean direction of which is E. 39° N., to the System of Westmoreland, which throughout Europe oscillates between N.E. and E.N.E. But it is unnecessary to pursue this question any further.

Cretaceous formation.—In the district under consideration Don Casiano has found only one of the four groups into which M. d'Archiac divides this formation, namely, the Lower Chalk (*craie tuffeau*), the second in descending order. He has found no trace either of the white chalk immediately above, or of the gault immediately below, or of the fourth or lower group. It is found only in narrow and contorted bands in certain spots; this is all that remains of the greater extent of ground it must have originally covered, except such portions as may be concealed by the Tertiary and Quaternary deposits, and which towards the south may extend continuously into the province of Cuenca. There is no appearance that the Cretaceous sea ever extended further west than the Mota del Cuervo in this last-mentioned province, or Quintanar de la Orden in that of Toledo, or Quijorna in that of Madrid, Espinar in that of Segovia, or the river Luna in the province of Leon. In this ancient sea the Sierra, or mountain-chain of Guadarama, formed one peninsula, which terminated towards the east, not far from the Pico de Grado, and another smaller, within the province of Madrid. The author then describes the different bands which he has examined; their dip is generally S.E., and they are of no very great breadth or length, but are naturally broader where the dip is less. One of these bands, in the neighbourhood of Atalaya del Vellon, has been broken through at the spot where its strike is curved round, forming a gorge of a few metres in breadth, at the bottom of which the mica schist (*micacita*) on which the chalk rests is exposed.

The prevailing rock in this formation is limestone, varying much both in colour and in structure, being occasionally quite spathose or crystalline; very little of it can be used either for building-purposes or for lime. It is sometimes argillaceous or marly. Chalk-marl occurs in some of the beds, as well as sandstones, apparently Greensand. In this and in the lower beds a few traces of lignite occur, which in former times, and especially in the reign of Charles III., gave rise to the most extravagant expectations respecting the coal of Manzanares, which was said to be superior to that of England, because it contained more sulphur! The greatest thickness of the Cretaceous formation is about 300 metres, but in many places it has been reduced by denudation to from 20 to 25 and even 17 metres.

A description of one section given by the author as seen between Madrid and Burgos, before entering Molar, will suffice to give an idea of the superposition of the beds. They dip 30° S.E. The base consists of a few metres of arenaceous beds resting on the gneiss, having in the middle a thin band of limestone. These are followed in ascending order by a considerable thickness of limestones of various qualities, succeeded by a thick mass of marls and argillaceous limestone, and thin beds of limestone containing an irregular tabular vein of manganese; the whole being followed by the diluvial gravels. In some places, as at Atalaya del Vellon, marly beds are interstratified with the lower arenaceous beds. After describing the general form and structure of the principal masses of this formation, which has a general inclination of from 20° to 50° to the E., N.E., and S.E., according to the great bend to which these beds have been subjected, circling as it were round a central point, the author notices the principal escarpments and ravines, and some of the numerous and extensive caverns met with in this province.

He then proceeds to describe the fossils of the formation. These are very few, but, as he observes, sufficient to identify this formation as the second group or Lower Chalk. The following are the species found and described by Don Casiano:—*Astarte striata* Sow.; *Arca Cenomanensis*, d'Orb.; *Mytilus Verneuili*, a new species resembling *M. alternatus*; *Lima cretosa*, Duj.; *Lima dichotoma*, Reuss; *Avicula pectinoides*, Reuss; *Avicula Villanovana*, a new species; *Pecten tricostatus*, Bayle; *P. quinquecostatus*, Sow.; *Sphærulites squamosus*, d'Orb.; *Hemiaster Fourneti*, Desh.; *Nucleolites lacunosus* (?), Agas., in bad condition; *Arca*, new species, resembling *A. Tailleburguensis*; *Terebratula*, probably a new species. The author also mentions other genera, of which he discovered fragments too imperfect to enable him to give their specific denomination, as a claw of a Crab, the cast of a *Tilostoma*, three species of *Cardium*, a *Cardita*, *Cyprina*, *Arca*, *Mytilus*, *Modiola*, two species of *Ostrea*, several *Rudistes*, and two small Echinodermata.

It may be here observed that the general *facies* of this list, imperfect as it is, corresponds with the fact mentioned by Sir C. Lyell in the last edition of 'The Elements of Geology'*, that in the rocks of the Cretaceous era in the south of Europe *Ammonites* are scarcely ever found, and the genera *Hamites*, *Turrilites*, *Scaphites*, and perhaps *Belemnites*, are entirely wanting; while, on the other hand, genera belonging to the great family of the *Rudistes* of Lamarck are generally abundant.

Tertiary formation.—This forms one of the three great belts into which the province of Madrid is divided, both geologically and geographically, extending from N.W. to S.E. Its thickness is considerable, but, owing to the effects of denudation, it is very variable; in some places, however, it is known to attain a thickness of about 340 metres without reaching the base. It is not a marine formation. The only fossils hitherto found are of terrestrial or freshwater

* 'Elements of Geology,' by Sir C. Lyell, 6th edit. p. 334.

origin, and they appear to belong to the Miocene period; consequently there was here a vast freshwater lake, extending from the Sierra de Guadarama to the Sierra Morena and Montes de Toledo, and even to the mountains of Valencia and Murcia, although in this direction it is somewhat difficult to fix its limits. The rocks of which it consists are limestones of different varieties, clay, gypsum, marls, sands and gravels, siliceous beds (*pedernal* flint), magnesite, and conglomerate or pudding-stone; the three former are the most abundant, and they are not associated with any plutonic or volcanic rock in the province. A considerable portion of the upper bed has been removed by denudation; by this means, and owing to the violent action of the rivers during the Quaternary period, the physical aspect of the country has been greatly modified. Low plains and narrow valleys have been formed, which have been again partially covered up by diluvium. In other places where the beds, which are generally horizontal, have not been affected by denudation, they form vast upland plains, called wildernesses or deserts (*páramos*); but where the upper bed of limestone has been removed by denudation the surface is much more irregular. Generally speaking, the structure or arrangement of this formation is simple enough where the strata are horizontal; but this is not generally the case, as the author proceeds to show in detail, and particularly in some places where the inclination of the strata is almost vertical.

This formation may be separated into three divisions. Limestone prevails in the upper almost exclusively; the middle division, which has the least thickness, consists chiefly of clay and gypsum, and the lowest consists of sandstones and conglomerates. The author then describes in great detail various localities where these different beds are found alternating with each other, and varying even within short distances, the chief peculiarity being that the gypsum always occurs in the central beds. The best building-stone in the province is quarried in the neighbourhood of Colmenar de Oreja; the quarrymen give a different name to each band. Some are better than others; but all are rather apt to split, and great care is necessary in using them for building-purposes to see that the blocks are placed in their natural position.

The siliceous deposits are the most irregular in the whole formation. Sometimes the silex forms large masses in the clay; sometimes it occurs as small angular blocks. Near Vicálbaro rounded blocks of the same substance are found, and in one spot large irregular nodules or slabs of flint form in the clay an irregular bed, which is extensively quarried and used in Madrid.

In order to account for the great variations which occur in these beds even within short distances, the author refers to a suggestion thrown out by M. d'Archiac, namely, that the material for these rocks was supplied from copious mineral springs, and is not alone the result of matter transported by the streams from the surrounding hills. But this explanation does not appear to him sufficient, even without taking into account those rocks which could not have been formed in this manner; and he observes that this variation is the more re-

markable, inasmuch as it does not occur in the older rocks, which are generally persistent for great distances and throughout their whole thickness, except in the case of the conglomerates.

Amongst the special phenomena which the author describes in this formation, may be mentioned the great inclination of the upper limestone beds in certain localities, also that the disturbances in the stratification of the zone of clays and gypsum are much more distinct than in the upper zone of limestone; they present numerous undulations more or less abrupt in their stratification. On the left bank of the Jarama are the soda-mines of Protectora, 4 or 5 kilometres east of Crempozuelos; the beds are horizontal and consist of clays and gypsum. The sulphates of soda and of soda and lime which are worked, occur chiefly in the clays extending through a thickness of about 15 metres; they occur either in detached masses in cracks and hollows, or disseminated throughout the whole mass. One of these cracks is very remarkable, having an undulating course in a more or less horizontal direction. Other local disturbances and unconformabilities of the different strata are described; they are probably owing to some agitation of the waters of the lake during the process of deposition. The origin of these rocks is attributed to mechanical or chemical causes, and sometimes to a combination of the two. The origin of the gypsum appears to the author more involved in difficulty. Was it derived from springs of water which held it in solution, or was it the result of metamorphic action? The gypsum of Madrid is found in beds and in the crystalline form of selenite. Masses of both kinds occur also in the argillaceous beds; sometimes only loose plates of selenite occur, at others it occurs in veins either single or intersecting each other, and in many other forms. The saccharoid gypsum or alabaster is scarce in this province, but it abounds in the neighbouring province of Guadalajara, where it forms large masses or nodules, which are enveloped in a red argillaceous covering or coat*.

The formation of silex and resinite was also probably owing to springs containing it in solution. The emission of silex during this period must have been enormous, for almost all the Tertiary limestones contain it in large proportions, as much as 20, 30, or 40 per cent. Magnesia and salts of soda are also abundant; but rock-salt does not exist in this province, although it is found in the neighbouring province of Toledo, on the south side of the Tagus, and in the district of the Ebro at Remolinos, province of Zaragoza. Here the beds of rock-salt are of great thickness, it being, as the author observes, a remarkable fact that this substance, originally derived from the sea (?), should occur so abundantly in a freshwater formation.

The author next describes in detail the different minerals found in this formation, many of which are interesting, and might be made of great commercial importance; they are quartz, flint or silex, resinite (both opal and hyalite), nitre, salt, sulphate of soda, thenardite,

* See Description of Nodules of Alabaster in the Mines of Castellana in Tuscany, by W. J. H. Quart. Journ. Geol. Soc. vol. i. p. 282.

glauberite, carbonate of lime, sulphate of lime, magnesite, argile, and traces of lignite. With regard to its palæontology, the author states that, strange as it may appear, not a single fossil shell has been found of which it was possible to determine the species: the fossils belong to the genera *Helix*, *Lymnæa*, *Planorbis*, and *Paludina*. *Melanopsis* has been found in the neighbouring provinces of Guadalajara and Toledo. This is an interesting fact, inasmuch as Spain is the only European region in which a true living *Melanopsis* is found, if we except *M. buccinoides* or *prærosa*, which is found in Greece, but belongs to the Asiatic provinces, being abundant in many parts of Asia Minor.

With regard to the land and freshwater shells of this Tertiary formation, the author observes that he has only found casts of them; and after pointing out the importance of local monographs of different Tertiary districts in Spain, he observes that, "if a geologist would devote himself for several years exclusively to the study of the Tertiary formations of the peninsula, he has no doubt but that he would discover numerous fossils of many classes."

Mammalian remains, however, have been found in a better state of preservation, and these are decidedly characteristic of the Miocene age. No bones have been found in the upper or limestone zone in this province; but they occur in the underlying marls and in the neighbouring province of Toledo, near Barcience. The characteristic species which the author has met with are *Mastodon angustidens*, *M. tapiroides*, *Palæotherium Aurelianense*, and *Hipparion*, and a questionable case of *Anoplotherium murinum*. For better identification the author has added engravings of most of the dental remains which he found; and in addition to those mentioned above is a molar tooth of *Rhinoceros Matritensis*, Lartet, a molar of *Sus*, probably *S. Lockarti*. *Sus palæochœrus* has also been found near Madrid, but the author had not seen it, as well as molars of *Palæomeryx*, probably *P. Bojani*.

The author then describes the different elevatory actions to which the Cretaceous and Tertiary formations have been subjected. These have evidently been both partial and general; but, as the author observes, much remains to be done, in Spain particularly, to enable the geologist to reduce the elevatory phenomena to anything approaching a perfect system. The concluding portion of the work is devoted to a minute examination and description of the deposits of the Quaternary or Diluvial period; the various phenomena attending them and the different rocks of which they are composed are analyzed with great care. Traces of glacial action are uncertain; the author rather inclines to the belief that the Diluvial beds owe their origin to aqueous causes; a certain amount of stratification is generally visible. The Diluvium may be separated into three divisions; the uppermost, which is most seen in this province, consists of sands, the second of marls and clay, and the third or lowest of gravel or stone. These are the terms usually applied by the workmen; but, as the author observes, there are clays and gravel in the uppermost, gravel and sand in the second, and sand in the lowest beds. He

then describes the successive changes and phenomena which took place during this period, tending to the deposition and formation of the different beds; he also alludes to the great changes which the older rocks themselves, which form the Diluvium, have undergone during this period. The quartz and quartzites are generally only changed into rolled pebbles, although some blocks of quartzite are to be seen with traces of a conical structure, as if they had been violently struck with a heavy blow; this is shown on the outside by circular fissures which penetrate into the interior, expanding more and more from the centre; the feldspar and Silurian slates are reduced to an argillaceous state. Even the blocks of granite have so completely lost their coherence that they can be cut through with the spade or mattock. The same thing occurs with the limestone, and even with gneiss, which is generally so little liable to decomposition. One of the most remarkable diluvial phenomena in this district is, that the calcareous rocks, after losing their coherence by the operation of diluvial agents, and being scattered amongst the sands and clays, did not become mixed up with them, but remained quite isolated, although reduced to a soft earthy state. Very few cases of hard rock occur in the Quaternary beds, although the author observed a few small bands or patches of conglomerate or puddingstone cemented together by a calcareous or ferruginous matrix. Calcareous tuff is very scarce. There are very few caverns of any importance in the limestone rocks in this district. There is only one worth noticing, called the Cueva del Reguerillo, in the Ponton de la Oliva; it contains numerous stalactitic and stalagmitic formations. No bones, ancient or modern, have been found in it; but as yet no excavations have been made in the stalagmitic bottom, although in the neighbouring provinces of Segovia and Guadalajara there are several caverns from which objects of great interest have been collected. The author does not say what they were.

The palæontological discoveries in this Quaternary formation are extremely poor in Spain, in the province of Madrid almost *nil*; tusks and bones of an elephant were found by M. Graells near San Isidro. This probably belongs to a new species; for the author states that Dr. Falconer, who saw the remains in Madrid, at once declared that they did not belong to either *Elephas primigenius*, or *E. africanus*, or *E. armenianus*. Another lower jaw with three molar teeth, also found near San Isidro, probably belongs to *Cervus elaphus*. *Cervus tarandus* has not yet been found in Spain, and it is remarkable that these two species are never found inhabiting the same locality.

The author concludes with an account of some flint hatchets found in the diluvium of San Isidro, as far back as 1850, in the gravel and below the beds containing the elephant bones, and with some remarks on the antiquity of man, on the recent and vegetable soils, and on the remains of pre-historic times. He feelingly alludes to the difficulties he has had to contend with in the total absence of all geological observations on this district before he undertook his task; and every geologist will sympathize with his last words—"I always started from Madrid with my knapsack and hammer cheerful and

full of joy, on my return I never entered its gates without a vague feeling of sadness."

I have much pleasure in stating that four more parts of the work of Major Crescenzo Montagna, entitled 'Generazione della terra,' to which I alluded on a former occasion, have since been published; they are written in the same moderate and careful spirit as the former ones. The author has avoided all extreme and exaggerated views. He adheres to the generally received opinions respecting the fixity of species, and protests strongly against the doctrine of transmutation and the Darwinian theory. In the 16th and 17th chapters of the fourth book will be found some interesting considerations respecting the appearance and disappearance of species on the surface of the earth. He rejects the doctrine of great breaks in the order of succession of animal life, as well as of those cataclysmal paroxysms which are supposed to have caused them; on the contrary, he finds a passage of genera, and even of species, from one formation to another; many species have survived the causes which led to the destruction of others, and have continued to live on together with the newly created forms. And with regard to the introduction of new and the extinction of old species, he points to many causes which may have occasioned the latter phenomena; but he maintains that man in his present state of knowledge is unable to understand how new forms have been brought into existence, except by the will and law of the Creator. With regard to the extinction of species he has, however, committed one serious geographical error when he states (p. 335), "Quite recently, according to Lyell, the extinction of the Dodo has been noticed, a bird which at no very distant period was an inhabitant of the British Isles."

He protests in the strongest language against the doctrine of transformation of species, and considers the idea that a mollusk could become a fish, or a lizard a man, as worthy only of a madman, and as giving but poor evidence of the progress of civilization at the present time.

In a subsequent passage, however, he bears testimony to Mr. Darwin's great merits in showing to what an extent the *variety* of species does sometimes extend, and in endeavouring to get rid of the endless multiplication of species which some naturalists endeavour to set up on the strength of slight variations of form and markings, which are really only the result of local conditions or a change of geographical position.

The work is accompanied by numerous plates, drawn and engraved by the author himself. It is, however, to be regretted that the work has not been more expeditiously completed, as the last numbers have not yet been published.

In the Bulletin of the Geological Society of France for last year*, M. Boué has published a paper giving his reasons for now modifying some of his views respecting his classification of Turkish Geology, published in 1840. Human knowledge, he says, advances by the

* Bull. de la Soc. Géol. de France, deuxième série, vol. xxii. p. 164.

discovery of new facts as well as by the application of new theories. He shows that this has been the case in every branch of science. Zoology, propped up by comparative anatomy, is now a very different science from what it was; it is the same in the case of geology, both theoretical and practical. About 20,000 works or memoirs have as yet appeared on geological geography, the publication of which, during the last fifty years, shows a kind of geometrical progression. The range of geological science increases in proportion as we discover new facts, and these again increase the number of formations and the limits of their successive beds.

M. Boué then points out the difficulties he had to contend with when he made his expeditions into Turkey, partly owing to the social and physical condition of the country itself, and partly to the total absence of all knowledge respecting the physical features of the country and the want of correct maps. Even the geology of the neighbouring countries with which that of Turkey in Europe is connected, namely, the Eastern Alps, the Carpathians, and Transylvania, was but imperfectly known at that time. Thanks to the Geological Institute of Vienna, these points have now been clearly made out, and we have the means of instituting a more satisfactory comparison between the formations of the two districts; but a new expedition into Turkey in Europe is much wanted. In the meantime, M. Boué endeavours in the following propositions to point out some of the errors contained in his former works:—

1. He is convinced of the existence of the *Palæozoic system* in Turkey in Europe, not only along the Bosphorus and in the central portion of the chain which runs along the coast of the Black Sea, the Little Balkan, but also in the centre of Upper Mœsia, and in the middle of Bosnia, about Voinitza, towards Trawnik and Kiseliak.

2. If the old Carboniferous formation appears to be wanting in Turkey, the *Trias* of the Alps and the Carpathians, with its peculiar *facies*, exists in many places, as in the south-east of Servia, in Western Bulgaria and Upper Mœsia (part of Servia), and in parts of Bosnia. He does not believe it exists in Epirus or Albania. It is probably covered up by younger formations in the Herzegovina. M. Hauer has found a trace of it at the southern extremity of Austrian Albania.

3. The Alpine Lias, that compact and partly dolomitized limestone characterized by *Megalodon*, appears to occupy a considerable portion of Turkey, particularly in Bosnia and Servia, and many other localities which are mentioned by the author with more or less certainty.

4. Various *Jurassic beds*, which, for want of evidence, cannot be more specially described, occur in the mountains of the Bannat and Servia, and in the south-west of Servia, in Bosnia, and in Mount Pindus, now Mezzovo, and in the chain of Agropotamos [query Aspropotamos?]. He also is of opinion that the beds of Kössen and of Hierlatz occur in Bosnia.

5. The *Dolomitic* formation forms a serrated and sometimes double ridge between the Prokletia and the Albanian Drino as far as Vronatz

in Central Bosnia, as well as in the south of Montenegro, in Macedonia, and in other places. He thinks it was a mistake to class these rocks with the Cretaceous system, on account of their close resemblance to the dolomites of the Tyrol and of the Eastern Alps. He is inclined to adopt the view of M. Richtofer, that the dolomites are the remains of coral-reefs partly denuded and considerably mineralized.

6. The *Neocomian* system appears to be very abundant in Turkey particularly in the Balkan, Upper Eastern Macedonia, Western Dardania, and in Servia, probably also in Bosnia. It is very fossiliferous.

7. The *Cretaceous* formation with *Orbitolites* traverses the whole of Bulgaria a short distance to the north of the Balkan. It also occurs in the centre of Servia, with many fossils.

8. The *Gosau* formation is found occasionally in Turkey, particularly in Eastern Servia and in Bosnia, characterized by *Tornatella gigantea*. Limestones with *Nerinæa* are also found in Upper Albania.

9. The *Cretaceous* system with *Rudistes* occurs in considerable masses throughout Western Turkey and in Macedonia, as well as in Servia. It is marked by bands of fossils on several plateaux of the limestone-mountains of Bosnia, Upper Albania, and Mount Pindus, as well as in the south-west of Macedonia.

10. The *Chalk-marl* with *Belemnites* has only been observed in Western Bulgaria.

11. The *Eocene arenaceous beds* of the Carpathians and Vienna, or the Tertiary flysch, is well developed in Central Servia, Western Bulgaria, Epirus, and Southern Albania along the coast.

12. The *Nummulitic system* occurs in parts of Albania towards Epirus, in the west of Thessaly, Southern Albania, and in the Herzegovina, as well as in the neighbourhood of Varna, in Bulgaria, and in Eastern Thrace.

13. The *Miocene* formation, or rather the *Neogene* of Vienna, is found with its clays and fossiliferous limestones in the great Servian valleys, in the basins of the Nish and Upper Drin, and in numerous other basins throughout the country.

14. Erratic blocks are doubtful.

15. The author also mentions several places where the Eocene beds have been pierced by serpentines, diorites, and metalliferous porphyries.

In the 'Smithsonian Contributions to Knowledge' for 1865 will be found an interesting work by Dr. Leidy on the Cretaceous Reptiles of North America. The author had originally intended to include an account of the fossil fishes, and thus to form a monograph of the extinct vertebrata of the Cretaceous period; but this he found was impracticable at present. No other vertebrata, birds or mammals, have been found in the Cretaceous deposits of any part of America. Most of the fossil remains described in his memoir were obtained in New Jersey; many were found in the Greensand, which is largely excavated for agricultural purposes, and others were obtained from lime-

stone beds. The Cretaceous formations constitute a large tract of country, extending through the States of New Jersey, Maryland, and Delaware; they appear in isolated patches in North and South Carolina and in Georgia. More extensively developed in the western portion of the latter state, they curve in a wide crescent-shaped tract through Alabama, Mississippi, and Tennessee, to the mouth of the Ohio river. Thence, passing in a narrow band through Arkansas, they afterwards expand to an enormous extent, and occupy a great portion of the region between the Mississippi river and the Rocky Mountains, reaching north into the British possessions and south into Mexico.

Then follows a very detailed account of all the species hitherto found in the United States, the most characteristic of the Crocodilian remains being a nearly entire skull of *Thoracosaurus neocesariensis*. The species described are 28 in number, belonging to 23 genera, viz. 18 Saurians and 5 Chelonians. The work is illustrated by 20 beautifully executed lithographic plates, and the author anticipates that, when the western and southern Cretaceous regions shall have been explored, many additions will be made to these remains, nearly all of which have been obtained from the eastern border.

I stated last year that M. Jules Marcou had discovered and described a remarkable deposit of fossil plants in the Nebraska territory, which, from its position, appeared to be unequivocally Cretaceous, although the forms were considered by Professor Heer to be of decidedly Miocene character. I have now before me an interesting notice on the position of these leaf-beds of the Nebraska by MM. Capellini and Heer, the former of whom visited and examined them in 1863, while the latter gives a detailed account of the species. Notwithstanding his first conviction that the beds containing the vegetable impressions belonged to a Tertiary formation, M. Capellini was convinced by subsequent examinations that they occurred at the base of the Cretaceous beds, well marked by the abundance of *Inoceramus problematicus*. The vast extent of country over which these beds occur in an undisturbed horizontal position precludes the possibility of any inversion of the strata.

The following observations of Professor Heer, before describing the species, will be read with interest. The collection consists of 16 species (all leaves), four of which are badly preserved. They are all dicotyledonous, and we may in all probability refer 1 to the genus *Ficus*, 1 to *Salix*, 1 to *Diospyrus*, 2 to the genus *Populus*, and 2 to *Magnolia*. These are all living genera, and are also found in the Tertiary formation. Comparing these Nebraska plants with the Cretaceous plants of Europe, we find no identical species; even the greater part of the genera are different. The Cretaceous flora of Hainaut in Belgium, and those of Blankenburg and Quedlinburg, are also quite different. The Cretaceous flora of Moletein in Moravia offers a greater resemblance; it contains 2 species of *Ficus* and 2 of *Magnolia*. There exists, therefore, a certain relationship between the Nebraska flora and that of the Upper Chalk of Europe, although there are no identical species. Hitherto, however, the genera which

characterize the Cretaceous flora of Europe have not been found at Nebraska.

If we compare the plants of the Nebraska with the Tertiary plants we find no identical species, but seven genera (*Populus*, *Salix*, *Ficus*, *Platanus*, *Andromeda*, *Diospyrus*, *and Magnolia*), which are both Miocene and still living; thus the flora of the Nebraska is more closely connected with the Tertiary than with the Cretaceous flora of Europe. We must also remember that we are acquainted with only a small number of the American species, and, on the other hand, that the Cretaceous flora of Europe is more allied to the Tertiary flora than was generally supposed. In the Cretaceous flora of Moletein in Moravia are found *Ficus* and *Magnolia*, which resemble Tertiary species; one of the *Myrtaceæ*, resembling the *Eucalyptus rhododendroides*, Mass., of Monte Bolca; a *Juglans*, and a *Laurinea*, analogous to those of the Tertiary flora; a *Pinus*, and two other *Coniferæ* belonging to the genus *Sequoia*, very abundant in Europe and America during the Miocene period, and which is now found only in California.

As the Cretaceous fishes more closely resemble the Tertiary than the Jurassic fishes, the Upper Cretaceous flora is also quite distinct from the Jurassic, and is more allied to the Tertiary flora; and it appears that in America there is a closer connexion between the Tertiary and the Cretaceous floras than in Europe.

It is very remarkable that the plants of the Nebraska bear so much resemblance to the living flora of America, whilst the Cretaceous flora of Europe has rather an Indo-Australian character. Thus it appears that since the Chalk period the flora of America has not undergone so great a change as the flora of Europe; and whilst the Cretaceous flora of Europe is altogether different from the living European flora, that of Nebraska contains eight genera which are still living in America; and it is remarkable that the greater part of them are still found in the same latitude.

I find in one of the last numbers of the 'Proceedings of the American Philosophical Society, held at Philadelphia'*, an interesting account by Mr. Lesley of a recent discovery of Lignite in iron-ore at Pond Bank, in Franklin County, Pennsylvania, and in which he describes the importance of the discovery in a theoretical point of view. Only one similar discovery had before been made, namely, in Vermont, and, as Mr. Lesley observes, they reopen the discussion of the age of the present Silurian, Devonian, and Carboniferous surfaces, and suggest an entire revolution in the generally accepted modes of regarding the production of Appalachian topography. The Lignite was struck in a shaft 40 feet below the surface; it contains large logs of wood, which is partly converted into a brilliant cannel coal, and the rest of it into common brown coal. Its extent is by no means considerable; and Mr. Lesley, dissenting from the views of Professor Hitchcock, describes it as a mere plug of coal thrust vertically downwards into a mass of clay. It is closely associated with

* Vol. ix. p. 463.

the great belt of iron-ore or hæmatite which extends along the great valley for many hundred miles in Pennsylvania and Virginia; but he is anxious to show that the Lignite and the iron-ore are neither of the same age nor possessed of any structural attribute common to both.

Mr. Lesley considers that it is the extreme rarity of these Lignite apparitions in one of the most wonderfully continuous, extensive, and valuable ore-belts of the world that gives them all their importance; and, notwithstanding the contrary assertions of Dr. Hitchcock, he maintains the importance of carefully separating these sporadic occurrences of Lignite from the general occurrence of the iron-ore.

In describing the principal features of the great ore-belt of the Atlantic States along the Great (Lower Silurian) Valley, which begins in Canada and ends in Alabama, he shows that it belongs geologically to the Lower Silurian limestone formation. It consists, however, of two parts—the one stratified as the Silurian limestones themselves, the other as a surface-wash over the basset edge of the first. The date of this latter may be Tertiary, or even later. The stratified portions must be of Lower Silurian age; but the metamorphism which they have undergone *in situ*, productive of stratified clays and ores, may date from any time subsequent to the formation of a surface-topography approximately identical with that which now exists. The actual change of the original Lower Silurian calcoferriferous sandstones and slates *in situ* into limonite-clay beds *in ipso situ*, stratified as before, but charged with an additional percentage of the oxides from a former higher surface now eroded, and with this extra charge of iron and manganese carried by percolation down to, and crystallized against, their foot rock, may have required an immense time for its completion, and was no doubt going on *pari passu* with the degradation of the surface by slow erosion from higher to lower levels. He then shows that this long era of iron-ore concentration in the Lower Silurian slates could not have commenced until after the close of the coal-era, and probably at a much later period.

The author then describes the exact geological position of the two great belts of iron deposit, the one at the point of contact between the Lower Silurian limestone and the overlying slate-formation, formerly a deposit of ferruginous mud; the second between the underlying slate and the lowest sandy layers of the limestone, lying along the foot and part way up the side of the south mountain. In one of these deposits in Pennsylvania the lignite has been found.

He then alludes to the system of underground caverns, which may, without much exaggeration, be called a single cave, extending for a thousand miles and including chambers, some of which, like Weir's Cave, have acquired a world-wide celebrity. Many of the brooks descending from the mountain-sides sink into these caverns. The river drainage on the surface and the cavern system below tell one story, namely, *the extra dissolubility of this particular horizon of Lower Silurian rocks*. The fissures which are now being enlarged into caves, and the caves which are fast growing into catacombs, their roofs every now and then falling so as to produce funnel-shaped sink-

holes in the fields, and sometimes in the roads, receiving leaves, fruit, branches, shells, and other substances with every great spring-freshet —all these once had their analogues in time past.

The author then submits that, by thus reconstructing the older surfaces, we obtain a reasonable explanation of the sporadic masses of lignite, two of which are now known to exist in, or rather near, the iron-ore. It is only necessary to suppose a sink-hole so formed and so stopped up below as first to receive and then to retain an accumulation of forest-trash, and we have the thing ready made to our hand. The author then proceeds to describe in detail the ore-banks of Mont Alto, and the relationship of the lignite to the ore. The ore is in fact nothing but the residue of the Silurian slates and sandy limestone beds after decomposition and dissolution, after the lime has been washed out and their carbonated and sulphuretted iron has been hydrated and peroxidized, the muddy slates forming the present deposits of small ore with white and red clay, while the sandy limestone formed the present harder siliceous rock ore-belts. He concludes with some statistical details respecting the enormous masses of hæmatite contained in this remarkable formation.

As showing the intensity of geological changes now in operation, M. Jules Marcou gives an account, in the 'Bulletin de la Soc. Géol. de France,' of the result of his observations on the Falls of Niagara after an absence of fifteen years. Some of these changes are very remarkable. Looking at the falls from the Victoria point on the Canada shore, he says that he could not observe any sensible change in the fall on the left of the spectator, which is the American fall; but he was much struck with the changes which had taken place in the great fall to the right, known as the Canadian or horseshoe fall. The horseshoe form, which was tolerably regular in 1850, has been greatly modified, being considerably worn away and deepened in the centre. The table rock nas almost entirely disappeared; also the tower known by the name of Terapine is nearer to the edge of the fall, on which side the mass of water appears to have increased, while it has diminished in volume near the table rock; there also appears to be a slight diminution in the volume of water passing by the American fall, between the American side and Goat Island.

He thus tabulates the results of his observations:—

1. The American fall retreats very slowly, and, compared with the Canadian fall, might be said to be almost stationary.

2. The volume of water in the American fall is constantly decreasing, and will continue to decrease in proportion as the Canadian fall retreats; and when the latter shall have reached the islands of the Three Sisters, viz., in eight or ten centuries, no more water will pass by the American fall. Goat Island will be joined to the mainland.

3. The Canadian fall is rapidly retreating, although it is impossible to give any rule of its annual retrograde progression, which varies from year to year.

4. The mass of water in the Canadian fall increases as it diminishes in the American fall, besides which it is leaving the Canada shore,

and is carried more towards Goat Island and the centre of the *horse-shoe*; from which he concludes that the retrograde movement of the Canadian fall will be more and more accelerated; that the valley of denudation of the river will approach Goat Island, and will then turn to the east with an abrupt angle as at the whirlpool, and that another whirlpool will be formed at the very spot where the Canadian fall is now placed.

He concludes his paper with some remarks respecting the stratigraphical relations of the rocks through which the river flows above and below the falls.

Amongst the more important works which deserve notice on an occasion like the present, I must not omit the 'Geological Description of New Zealand,' by Dr. Hochstetter, who, as geologist, accompanied the expedition of the Austrian frigate 'Novara' round the world. The work consists of a large quarto volume in two parts, the first of which is called 'The Geology of New Zealand,' the second 'The Palæontology of New Zealand.' In the very interesting introduction to this work Dr. Hochstetter shows that the three islands belong to one and the same system, marked by a characteristic line of elevation from S.W. to N.E. interrupted by Cook's Straits between the two principal islands. This mountain-chain of true alpine character forms the backbone of the islands, and is said to consist of zones of stratified and unstratified mountain-masses of different ages, which have been raised by plutonic action. It is accompanied, in the northern island at its western base, and in the southern island at its eastern base, by zones of volcanic rocks, which have been affected down to the latest periods by deep-seated igneous action. The lofty formations of the volcanic zones, and new Tertiary and Quaternary sedimentary deposits, have given to these islands their present form; which is, however, even now undergoing constant changes, both from earthquakes and from still continuing elevations and depressions. The geological maps of these islands, even in their still imperfect state, as compared with the detailed geological maps of western Europe, show a very great variety of formations; and although it may not yet be possible to establish an exact parallelism between them and the order of formations in Europe, there is already sufficient evidence to prove that the stratified rocks of Europe have here their representatives from the oldest metamorphic formations to the newest sedimentary deposits, and that the eruptive formations extend from the oldest plutonic rocks to the most recent volcanic lavas.

He considers that New Zealand, with its peculiar living fauna and flora, differing so completely from the neighbouring regions of Australia, the South-Sea Islands, and South America, is admirably adapted for testing the correctness of the theory of Professor Agassiz, that no specific identity can be shown between animals living at a great distance from each other, even when they existed contemporaneously; but that rather genera of the same family, even when belonging to different geological periods, are more closely allied to each other when they belong to the same latitudes than those of the same geological age, but which are derived from different geographical zones.

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With regard to the marine fauna, it appears from Dr. Zittel's examination of the fossils that the molluscous fauna of the younger Tertiary deposits is closely allied to the living fauna, very much in the same proportion as that of the Subapennine formation of Italy is allied to the existing fauna of the Mediterranean. The same genera occur, both fossil and living, and even the species are not unfrequently identical; at the same time they have a great resemblance to the Tertiary fossils of Chili and Patagonia described by Sowerby and D'Orbigny, *i. e.* to a fossil fauna of the same age and from the same degree of latitude.

But if we consider the remains derived from older formations, we find that the *Ammonites*, *Belemnites*, *Inoceramus*, &c. of the northern island, which belong to the upper beds of the Mesozoic period (Jura and Chalk formation), so closely resemble European forms of the same age, that one is almost tempted to look upon them as European species; more particularly the *Belemnites*, belonging to the group of the *Canaliculati*, D'Orb., so completely agree with the *Belemn. canalicalatus*, Schloth, that it is almost impossible to find sufficient differences to justify the adoption of a new name. Moreover, the oldest fossiliferous beds which are found on the southern island, not far from Nelson, contain the genera *Monotis* and *Halobia*, which cannot be distinguished from the European forms *Monotis salinaria* and *Halobia Lommeli*, Wissm., from the Trias of the Alps.

Dr. Hochstetter observes that these facts, if confirmed, would go to prove that the faunas of former periods show an affinity and a correspondence in the northern and southern hemispheres which do not exist in the now living faunas—a conclusion hardly in accordance with the above-quoted views of Agassiz, but quite in harmony with the more generally prevailing opinion, that the older the formations are, the greater is the resemblance in their fossil remains, even in districts at a great distance from each other.

He then gives a general view of all the different formations, with their respective subdivisions in New Zealand, from which he concludes that "at the period when the neighbouring Australia, which was (at least so far as relates to those portions which consist of Palæozoic formations) one of the oldest continents of the earth, rose above the waters of the ocean, certain portions of New Zealand also appeared as rugged land above the ocean; in a different form, it is true, from what it now presents, and possibly in connexion with vast continental masses which have long ago been again submerged. But while Australia, in its eastern and western portions, has been little, if at all, disturbed since the conclusion of the Palæozoic period, so that animals and plants could live and reproduce themselves in an unbroken sequence down to the present day, New Zealand, on the contrary, was, even to the most recent period, the theatre of gigantic terrestrial disturbances and powerful terrestrial conflicts, which, continually changing the original form of the land, have gradually given it its present configuration.

After these general views, the author proceeds to give a detailed account of all the geological features of the north and south islands,

describing first the physical features of the different regions, and then their respective geological formations in the following order:— 1. Palæozoic; 2. Mesozoic; 3. Cainozoic, divided into brown coal-beds and marine deposits; 4. Post-tertiary formations; 5. Volcanic.

Amongst the volcanic phenomena hot springs and *fumarole* are most remarkable, and developed to an extent which can only be compared with the analogous phenomena in Iceland. Both the chemical and mechanical features in these hot springs are identically the same, notwithstanding the vast distance by which they are separated. Another remarkable fact is, that the crystalline, or metamorphic rocks, as well as the igneous rocks, as granite, syenite, &c., which form so important a feature in the southern island, are altogether wanting in the northern island.

The second part of this work contains, as I have said before, an account of the Palæontology of New Zealand, and consists of the following monographs:—

I. Remains of Fossil Plants, with 5 plates, by Dr. Franz Unger.
II. Fossil Mollusca and Echinodermata, with 10 plates, by Dr. Karl Zittel. The Brachiopods, by Edward Suess.
III. The Foraminifera of the Tertiary Greensand of Orakei Bay, near Auckland, with one plate, by Felix Karrer.
IV. Fossil Bryozoa from the Tertiary Sandstone of Orakei Bay, near Auckland, with 4 plates, by Dr. Ferdinand Stoliczka.
V. The Foraminifera of the Tertiary Marl of Whaingaroa Harbour (Auckland), with 4 plates, by Dr. Guido Stache.
VI. Report on an almost perfect skull of *Palapteryx*, with 2 plates, by Dr. Gustav Jaeger.

Dr. Stache concludes his interesting monograph (No. V.) with some important generalizations, and shows that this foraminiferous fauna belonged to two groups, evidently derived from two different sea-depths; and with regard to their geological age, he shows that they bear the greatest resemblance to the Neogene fauna of the Vienna basin, whilst at the same time there are indications of an older period, approaching the Upper Oligocene beds of the north of Germany.

I must now direct your attention to a work entitled 'Frost and Fire,' by Mr. J. F. Campbell, which will be read with satisfaction by all who are interested in the physical causes which have led to the structure of the earth's surface. Although the style of the work is somewhat quaint, and the arguments occasionally slightly obscure, we cannot but admire the energy and perseverance with which the author pursued his researches after the causes, whether heat or cold, frost or fire, which have been at work as the tools and forces which have shaped the earth's crust, either by denudation, deposition, or upheaval.

Starting from various physical calculations, balloon observations, and the temperature on high mountains, he assumes that a low temperature exists in the space through which the earth travels. Descending from these outer regions, through "air," "water," and "rocks," to mines, he finds that the temperature increases towards the

earth's centre, while hot springs and lava-currents indicate still greater heat below the mines thus reached. Thus between attainable limits we find cold outside and heat inside the earth's crust composed of ponderable materials, all of which, either separately or combined, can, and do, exist in three conditions—namely, gaseous, fluid, and solid. Many of these materials are gaseous when heated, solid when cooled, and fluid at intermediate temperatures. Each melts and freezes, or solidifies at definite degrees of heat, and they vary in dimension and specific gravity according to temperature. Heat is force, according to modern views; and rays from the sun, from luminous substances thrown out from the earth, and from artificial sources of light, include heat-rays, and are consequently mechanical forces. Thus force radiates with light and heat from heated centres, causing expansion, and separating particles from each other.

Many examples of this action are given by the author in illustration of these views, drawn partly from natural phenomena, and partly from experiments ingeniously contrived by himself; a full description of the cooling of silver is given at p. 346, vol. ii., as one of the neatest experiments to illustrate the cooling of a molten mass. The same forms which he has observed growing on cooling slag, iron, silver, &c., he finds repeated on a larger scale in cold lavas, in hot and cold mountains, and in old igneous rocks in Iceland. He also alludes to the experiments recently made respecting the sun's atmosphere and the substances supposed to exist there, and to the gradual cooling of the different bodies which form our planetary system; and assumes that the earth, which is intermediate in size, is also in an intermediate state, partly fluid, partly solid, cooling, but still hot within.

Thus he assumes from the facts brought forward that an igneous foundation is the base on which the sedimentary rocks were deposited and now rest; he also assumes that air and water, steam and ice, moved by the two opposing forces, heat within and cold without, levitation and gravitation, have worn down the outer crust of the globe, and have sorted the *débris*, while movements in the igneous foundation, and heat radiating and transmitted from it have disturbed and altered the sedimentary deposits; he also considers that these causes have greatly diminished in intensity since they first began to act on the crust of the globe. He has illustrated by numerous drawings and descriptions the marks made by rivers, waves, currents, glaciers, &c., as well as those made by other denuding agents still at work.

He also assumes that in late geological periods the earth has cooled so far as to freeze water everywhere at the surface, were it not for heat radiating to it from the sun. We have reached a partial glacial period, and the position and extent of ice on the earth now depend on the amount of heat absorbed from the sun, and on movements in the igneous foundation or centre of the earth.

Some interesting experiments are also shown towards the end of the second volume to illustrate the effects of the earth's rotation on

the currents of the ocean, and thus point out the course which arctic currents would have taken at a period when a larger portion of the northern hemisphere was submerged. The traces of these ancient currents are to be found in the scratchings and striæ which mark the rocks of Scandinavia and Great Britain, and other parts of Europe. There is no ice near the equator; perpetual ice near the poles, and more in winter than in summer, because of the earth's position; but it is owing to subterranean movements that ice formerly extended to lower latitudes in certain portions of the globe. Thus he shows that in consequence of a recent elevation of the fundamental rocks of Europe, and a probable sinking elsewhere, the waters which formerly covered certain parts of the surface have changed their position. The arctic stream, which flowed south and west, was thus diverted from those districts in Western Europe which have been raised above the level of the sea to the western side of the Atlantic; and with it have been carried those vast masses of ice and snow which formerly scratched and striated with their rocky contents the surface of Scandinavia and North-western Europe, depositing great boulders on their way, and which now condense, chiefly on Greenland, Labrador, Newfoundland, and North America.

Having thus endeavoured to explain the general theory of the author, I will merely state that the first volume is chiefly devoted to an account of the denudation of the earth's surface, the engines by which this has been effected, viz., frost and ice, and the tools which have actually done the work, glaciers, icebergs, and Arctic currents, as represented in Scandinavia, Iceland, Switzerland, and elsewhere.

The second volume continues the history of the same subject of denudation in the British Islands and America; and the author then proceeds to consider the question of deposition, the result or counterpart of denudation, inasmuch as the material removed by denudation from one place must be deposited somewhere else. Finally, the question of upheaval is also examined, and its causes and results duly considered; this, of course, is considered as the effect of the other great agent in modifying the earth's surface, viz., fire or heat. It is illustrated by many observations and experiments, drawn from the furnace and the smelting-works. These results are shown to be identical with the effects produced by volcanic action, indicating the existence of great central heat, causing disturbance of the earth's surface by earthquakes, and producing upheaval of vast regions by the expansion of subterranean matter.

But without going further into these dynamic questions, or discussing the probable correctness of some of his physical assumptions, I will merely refer to one point, to which Mr. Campbell's attention seems to have been particularly directed, I mean the striation and grooving of rocks by ice-action. Deeply interested in this question by the similarity of evidence found in so many countries, and the apparent parallelism of these striæ over vast regions of the earth, he has collected, partly by his own personal exertions and partly from the writings of others, a mass of evidence by which he has endeavoured to throw light on the causes of these phenomena. Thus,

working his way back by analytical reasoning, calling to his assistance meteorological as well as geological evidence, the laws of physical science, and the counteracting influence of the two opposing forces heat and cold, he comes to the conclusion that these marks are the result of glacial action; and by further reasoning on the various phenomena above alluded to, he concludes that they have been caused by ice borne by an arctic current flowing from north-east to south-west. The denudation of the rocks in many parts of Sweden is enormous, but rivers and weathering will not account for this. The author observes (vol. i. p. 103) that "on the watershed not far from Tann Foss at the roadside (at a height which Robert Chambers estimates at 2000 feet) the clearest marks of glacial action are still perfectly fresh on rocks, in spite of weather and rivers. These marks prove that ice travelled over the hills from north-east to south-west, now 2000 feet above the present sea-level, at the place where streams now part and run to the Baltic and to the Atlantic."

As Scandinavia is now generally admitted to be rising from the sea, there is nothing preposterous in assuming that the greater part, if not the whole, of Sweden may once have been covered up by the waves of an arctic sea, in which currents must have existed, flowing, as now, in different directions, from north and south, according to those physical laws by which the movements of the ocean-currents are still regulated.

But the question of land-glaciers flowing down from high regions, and partly excavating the valleys down which they flow, and leaving their marks also in the shape of scratchings and striæ on the rocky flanks of the valleys, is not overlooked by the author; and on this subject also much valuable information may be gleaned from the pages in question. I will only add, that the many illustrations contained in this volume, and the quaint sources from which the author has sometimes drawn them, render his work one of great interest, and which it is impossible to peruse without deep thoughts and suggestions being forced on the reader's mind.

Before concluding these observations, I wish to bring to your notice one or two points which appear to me to merit the serious attention of geologists in the present day. Prof. Ramsay, in his Anniversary Address from this chair, alluded to the breaks in succession of the British Palæozoic and Mesozoic strata, and suggested the probability that these breaks represented periods of time even longer than those to which the various existing fossiliferous formations of Great Britain bear witness. Dr. Bigsby also not long ago brought under our notice a very interesting paper on missing sedimentary formations from suspension or removal of deposits, in which he has pointed out many of the breaks or gaps which occur between older and younger rocks, caused either by the subsequent removal of the intervening or missing beds, or because the older beds had been raised above the sea during the deposition elsewhere of the intermediate beds. Now it is well known that these breaks or gaps are only local; and the remark has been already made that, if we

Copy.

Hickory Wood Tennessee.
January 11. 1866.

Dear Col Hamilton

If you mention me take the enclosed as your text and so avoid 1000 pages of print. I have turned the book over and over to suit your dignity. I had to creep gradually to my point and to build my castle painfully you ought to stand over the topmost stone in my heart and look down on the work with a masters eye.

Yours very truly
S. H. Campbell.

January 11. 1864.

Sir

As you listened to notes my book I wish to secure your trouble by telling you what you may find in it. —

Starting from calculations between ascents and temperature on high mountains I assume that a very low temperature exists in the space through which the earth travels. Descending from these outer regions through air, water and rocks in mines I find that temperature increases towards the Earth's centre. Hot springs of water & lavas all over the world indicate still greater heat below.

Between attainable limits of cold outside and heat within a shell composed of penetrable materials all of which either separately or combined do exist in three conditions namely gaseous fluid and solid.

Many of these substances are gaseous when heated, solid when cooled and fluid at intermediate temperatures and each melts and freezes at different degrees. Water and Mercury are familiar examples. Heat is force according to modern notions. Rays from the sun: from luminous substances thrown out by the earth,

and from artificial sources of light & visible heat rays and also mechanical forces. (see experiments) Light heat and force radiate from heated centres, cause expansion and separate particles from each other. A familiar experiment is to dip red hot iron in water and watch the luminous red heat creep through the clean cooled shell outside. While radiating force repels the water and expands the iron.

Ray force may be set to work on any of materials within reach. I set it to work mechanical models intended to illustrate the Mechanics of Geology. A manageable heat under and a lower temperature above a small portion of a shell of any easily fused fundamental materials e.g. Wax & over cause circulation in the mass which results in certain forms, which endure after fused materials & heats have cooled and hardened. These forms I take as characters which can be read anywhere, after learning how they are produced.

at P. 346. Vol II is a description of the cooling of Silver which is the

neatest experiment I know to illustrate the cooling of a molten mass. The mass divides closely the fragments are scattered, they cool at different rates according to size, and they have definite shapes.
By making experiments on a small scale, I find that certain volcanic forms and phenomena can be reproduced in miniature. Rising a step I find like movements and forms repeated in larger masses of metal and slag and lava worked by higher temperature. I find the forms which I have watched growing on slag, iron, silver, and many other materials repeated on still increasing scales in cold lavas, in hot and cold mountains, and in old igneous rocks in Iceland. So far I can advance with knowledge of mechanical force which shaped the surface of Iceland. With a telescope I see the same similar forms fixed on the moon, and I have watched them forming and changing on the sun.

The scale differs the forms are alike. I conclude that the forces employed are and were alike.

It is now all but proved that many substances which exist as solids on the earths crust and can be sublimed by heat, also exist in the Sun's atmosphere. The moon appears to be solid at least outside. I suppose that Sun Earth & moon and meteorites are composed of like materials and may once have formed one fluid mass cooling in cold space as the silver globule cooled in cold air. Then the largest fragment of the divided mass ought now to be the hottest and the least of a series the coldest. The Sun appears to be still hot enough at the surface to sublime substances now detected in its atmosphere, & to liquify more which shine & which we see moving as the silver moved. The substances which harden at higher temperatures may have cooled into red hot mountains which are visible during eclipses. All substances have hardened on the moon which is the smallest of a series of three. I suppose that

translation of visible forms to be fair; then I argue from visible form that the earth which is intermediate in size is in an intermediate state.
I suppose it to be partly fluid partly solid, cooling but still hot within.
I suppose that the earth is now in the condition of slag or iron or lava which was fluid, and has cooled so far as to allow water to flow and freeze out about the surface, while the interior is still red or even white hot, and part of it is fused. The case is common at ironworks, and while slag is in that condition, the hot luminous fluid interior often bursts through the cold crust, and the crust is disturbed in various ways like the earth's crust.
To illustrate the structure which results from cooling in space, I give a section of a volcanic bomb which was a fluid mass thrown off by the earth, out of the tube of a volcano; and a rough outline of the Ovifak(?) Meteorite which seems to be a portion of a hollow metal shell which came in from

outer space and broke.
I hold that so far as I can penetrate into volcanic crusts their structure is chambered and tubular like the crusts of meteorites, like the outer shell of the volcanic bomb and like the ~~outer~~ upper crust of slags and materials which I have watched changing from the fluid to the solid condition.
I hold that during that change certain natural phenomena are always reproduced in miniature and I argue that the causes which produce them are alike on all scales.
In this the last part of the book I am driven to speculate, but in every case I have tried to found speculations upon facts, and experiments and to make fair deductions from my facts.
The first part of the book contains facts which make the frame here indicated.
assuming from facts stated that an igneous foundation is the base on which sedimentary rocks now rest, and upon which they were deposited, I also assume that air and water steam and ice moved

by two opposing forces, heat within, cold outside, ~~gravitation~~ levitation and gravitation, have wrought the latter event and have sorted the debris; while movements in the igneous formation, and heat transmitted from it, have distinguished and altered the sediment.

For reasons given I hold that these causes have diminished in intensity.

Leaving the relative age of sedimentary rocks to abler men I have endeavoured to illustrate by drawings and descriptions marks made by rivers waves &c, and marks made by other denuding agents now at work.

In late geological times the earth (as before) has cooled so far as to freeze water everywhere but the surface, were it not for heat radiated to it from the sun. We have reached a Quarternary Glacial period; and the position and extent of ice on the globe depend upon the amount of heat absorbed from the sun, and on movements in the igneous formation upon which sedimentary rocks are piled.

There is no ice in the sea at the equator: perpetual ice near the poles: more ice in winter than in summer, because of the Seven positions: — but it is because of movements undergoing that ice extends to lower latitudes in certain longitudes.

For example. In consequence of a late rise in the fundamental beds of Cumbre, and a sinking elsewhere water which covers part of the surface has changed place. The cold stream which flows South West, was diverted from low lands now above water in western Cumbre, to the western side of the Atlantic, and with it went great heaps of snow and ice which formerly condensed on Scandinavian British and Swiss mountains, and now condense chiefly on Greenland Labrador, Newfoundland, North America and on floating ice in the Arctic current.

In this the first and largest part of the book I have given facts observed by myself, together, with extracts from my journals, and quotations from books of travel.

I have tried to form to test & to express independent opinions

~~and~~ to give them together with my collection of facts how & old & where to tell how & where the facts were collected.

I regret that I have not made myself better acquainted with books. My attention has been directed by Sir Roderick I. Murchison to works in which I found important facts gathered by him in Russia Scandinavia and elsewhere: facts important to all to take interest in glacial subjects, and in movements which are at the base of all Geology.

The book is a traveller's book, not a learned treatise: facts and theories in it must find their own level, & sink or swim.

June 8.
1866.

Dear Mr Hamilton

Many thanks for your kind notice of Frost & Fire. It is a big feather to wear in my cap at the Caledonian ball and elsewhere. Had I known that you were so strongly in favour of water I should have dreaded the extinction of my fire or an ebullition: as it is you have got up steam to give me a friendly lift and I am very much obliged. You must have had hard work to concoct that address: it shews me part of the depths of my own ignorance, and greatly increases my respect for the Geological Society and its late Presidents.

I am
Yours most truly
J. F. Campbell

could only get a sufficient number of sections from all parts of the world, all these local gaps would be filled up, and we should have one unbroken sequence of formations, occurring in some part or other of the earth's surface, from the lowest Silurian or even Laurentian beds to the most recent Tertiary or Quaternary deposits. It would be an interesting task for any geologist to undertake to supply this want, and to point out the gradual succession of beds where they can be found, showing how they pass almost insensibly from one into the other, as the Rhætic beds are now shown to form an intermediate zone or passage from the Keuper to the Lias. We should then see by what almost insensible gradations the crust of the earth has been successively formed, and what were the conditions of life, or some of them at least, which led to the gradual introduction of new forms of life in some places, and their partial extinction in others. And as we have now learnt to recognize the fact that the extinct Mammalia of the Postglacial period had not all ceased to exist before the first appearance of man, we should also probably learn that at no period of the earth's history were all the forms of life destroyed before the introduction of new ones; but that a partial renewal only took place, and that somewhere or other the witnesses of one period lived on with the new creations to keep up an unbroken chain in the history of organic life from its earliest dawn to the present day.

Another point to which I would invite attention is one of greater difficulty; it requires the serious aid of chemistry, mineralogy, and the laws of physical forces. The study of the older crystalline and metamorphic rocks has of late years greatly occupied the attention of many of those geologists who have examined the chemical and mineralogical conditions of formations. We are told that heat alone could not have produced the results we see; that water was an essential element in all these metamorphic operations; and we find, in the works of Sterry Hunt, Daubrée, Evan Hopkins, Delesse, Desor, and others, that even a high degree of temperature was not always necessary to produce these changes. Many of those results which have hitherto been considered as the effect of igneous action, are now believed to be owing to chemical action continued through long periods of time. It therefore appears that the time is come when it is desirable to investigate this question; whether the theory of central incandescent heat is tenable? Whether the plastic condition of the earth, to which its oblate spheroidal form has been attributed, be not owing to an aqueous rather than to an igneous origin? Water is an essential element in every rock, not only mechanically but chemically; and without attempting to revive the doctrine of the Wernerian school, it may be questioned whether we have not sometimes been disposed to overlook the importance of the part it has played in the construction and solidification of our earth.

Another important subject arising out of this question, or rather accompanying it as a corollary, would be, whether the solidification of the earth began at the circumference, after its formation, as is assumed by the advocates of the central-heat theory, or whether the

formation of the earth may not have commenced with a central nucleus consisting of an aqueous paste, gradually increasing in size as matter was deposited around it from the circumambient fluids and gases which filled the solar space before solid matter was aggregated round those spots which now form the planets in our solar system. It is a bold, perhaps even a rash thought, to go back to a period before the earth was formed; and yet such a period must have existed, or the earth would be eternal, which we have no right to assume. I will also venture to suggest one other question.

Assuming the possibility of an aqueous origin, and eliminating the theory of central heat, can we not account for all the volcanic and igneous phenomena which we find on the surface of the earth by chemical action taking place at a comparatively moderate distance below the surface? We know that heat and combustion can be thus produced, and we know that all the elements which are necessary for its production must have been contained within the earth's sphere.

But I will say no more on a question which requires so much close examination and cautious investigation. I recommend it to your consideration, in the hope that at no distant period some one will venture to grapple with it in earnest, and either point out the probability of what I have suggested, or prove its impossibility.

In conclusion, allow me to trespass on your time for a few moments longer, for the purpose of expressing my thanks to every Fellow of the Society, and particularly to the Members of the Council, for the kind support and assistance which, during the time I have occupied the chair, I have invariably met with at their hands. I am well aware of my many shortcomings, but, having ever taken a lively interest in the prosperity of the Society, I trust that this has not suffered during my Presidency. I look with confidence to the rapid increase of our Members, in the hope that that is the best proof that your interests have not suffered at my hands. I congratulate you on the choice of my successor, which you have this day made, feeling confident that, with such a President as you have to-day elected, the Society will continue to flourish as it has hitherto done, to add fresh laurels to its brow, and that it will continue to hold that high estimation in the opinion of men of science in every country which it can confidently boast of having hitherto invariably enjoyed.