

LEAGUE OF NATIONS

COMMITTEE ON INTELLECTUAL CO-OPERATION

ENQUIRY

INTO

THE CONDITIONS OF INTELLECTUAL WORK

Second Series

INTELLECTUAL LIFE

IN THE

VARIOUS COUNTRIES

**The United States of America**

**SCIENCE IN THE UNITED STATES**

Mathematics, Physics, Chemistry, Psychology, Botany, Zoology,  
Medicine, Engineering, Geology, Geography, Archæology,

with an Introduction

by **Henri REVERDIN,**

Professor at the University of Geneva,  
Expert of the Committee on Intellectual Co-operation.

IN COURSE OF PUBLICATION

in the collection "ENQUIRY INTO THE SITUATION OF INTELLECTUAL LIFE"

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## NOTE

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*The object of the Committee on Intellectual Co-operation in publishing this series of pamphlets is to call attention to the problems of organisation and intellectual assistance to which each subject gives rise. The Committee does not propose to treat these subjects exhaustively, but desires rather to bring them to the notice of the public and to provide an opportunity for further suggestions.*

*The author alone is responsible for the opinions expressed.*

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## SCIENCE IN THE UNITED STATES

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### INTRODUCTION.

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For the purposes of my enquiry into the situation of science in the United States, I have divided science into two groups. The first group comprises mathematics, physics and the natural sciences ; the second consists of what are often described as the moral sciences.

Dr. Millikan, the American member of the Committee on Intellectual Co-operation, kindly provided me with the information I needed in order to conduct the enquiry concerning the first group of sciences. In May 1923, he wrote to me : "I am sending you the names of a dozen or so of the most representative of our scientific men, all members of the National Academy of Sciences, and chosen so as to represent all of the divisions of this organisation."

I have sent the questionnaire to all these scientific men whose names Dr. Millikan had given me<sup>1</sup>, and, as a result of my correspondence with them and the interest which they have shown in the enquiry, I am able to produce original documents, thus fulfilling the hope which the Chairman of the Committee on Intellectual Co-operation, M. Bergson, expressed to the experts before they began their work.

Dr. Vernon Kellogg, Secretary of the National Research Council, kindly furnished me with a list of the scientific societies which are affiliated to the National Research Council, of which he is the Permanent Secretary.

In addition, therefore, to writing to distinguished representatives of special branches of science, I sent questionnaires to the most important scientific societies in the United States. Thus I was able to collect valuable information for the Committee on Intellectual Co-operation.

In this report, I publish the replies of the representatives of special branches of science whose names were given in Dr. Millikan's list. If we take into consideration the many calls which are made upon the time of these eminent men of science, we must, I think, feel bound to express our deepest gratitude to them.

I attach, as an annex, a letter on the National Research Council from Dr. Vernon Kellogg, giving information concerning this great organisation supplementary to that which has appeared in my printed report entitled *The Principal Scientific Academies and Societies*.

HENRI REVERDIN.

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<sup>1</sup> I have mentioned in the title of this report the sciences of which Dr. Millikan gave a list, with the exception of astronomy and anthropology, no replies having been received concerning these sciences.

LETTER DATED JANUARY 15TH, 1923, ADDRESSED BY THE CHAIRMAN OF THE  
COMMITTEE ON INTELLECTUAL CO-OPERATION TO SPECIALISTS  
(SCIENTISTS, ARTISTS, ETC.)

The Committee on Intellectual Co-operation has, with the approval of the Assembly and of the Council of the League of Nations, undertaken to enquire into the present conditions of intellectual work. The Committee considers that, before proceeding to carry out the enquiry, it should ask the opinion of a number of well-known personalities in the world of science, literature and art in every country.

I have therefore the honour to submit to you a few questions, to which I should be very glad if you would reply in so far as you think advisable. Your replies would be of the greatest service to us and would assist us in determining the lines upon which our work must proceed.

It is scarcely necessary for me to add that any suggestions you may make, even though they lie outside the field covered by these questions, will be gratefully received. I may remind you that the Committee is endeavouring, above all, to obtain information on essential matters regarding intellectual work in every country and its most urgent needs.

(Signed) Henri BERGSON,  
*of the French Academy.*

QUESTIONNAIRE.

In every country, for every branch of intellectual work, certain well-known specialists will be requested to reply to the following questions, in as detailed a manner as possible, forwarding any statistical information in their possession, giving references of publications and stating the results of their own experiences and their personal opinion. It is naturally expected that the replies will apply more particularly to the specialist's own country, but any information relating to other countries and any general observations will be gladly received.

1. Have any important changes taken place during the last ten years in the branch of intellectual work in which you are interested? Are the changes, if any, due to the application of new methods, to the influence of public opinion, or to any other causes? Has there been progress or the reverse? Please state the period and the particular points to which your remarks refer. What is required to ensure progress? What is the relationship between this branch of work and the general intellectual work of the country? How much of the work is original and how much is simply making knowledge accessible to the public?

2. To what extent does the public take an interest? How is such interest expressed (attitude of the Press; assistance by the State, by public bodies and private individuals; scholarships, prizes and various endowments)? What, if it can be so expressed, is the commercial success attending this intellectual work? What special facilities or difficulties exist in production and sale?

3. How are specialists recruited for your branch? Is this becoming easier or more difficult? What should be done to improve the situation? What is the economic condition of workers in this branch? How is their technical education assured? Do they experience any difficulty in obtaining instruments and material for their work?

4. In the branch in which you are concerned, which are the most important and active organisations (associations, research institutes, educational establishments, reviews, periodicals, etc.)? How do these organisations carry on their work? Do they possess sufficient resources? Which of them are in a precarious condition? Do you consider that any are required which do not already exist?

5. What is the influence and what is the part played by foreign countries in your branch of the work? Has your work any influence abroad?

6. What are the sources of your information concerning the work in your branch: (1) in your country; (2) throughout the rest of the world? What should be done to keep you better and more fully informed?

7. What are the relations between workers in your special branch in your country and similar workers abroad or with special organisations? Might such relations be extended or improved? In your opinion, is an international organisation possible and, if so, of what kind?

8. What developments or what new lines of work do you foresee in the branch in which you are interested?

9. Kindly mention to what extent, if any, the state of public morality exercises an influence on the kind of intellectual work in which you are interested or is influenced by it.

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## MATHEMATICS.

1. During the last fifteen years mathematics has made very satisfactory progress in the United States. There was, of course, a natural dislocation due to the war: the oncoming students were drawn off into war activities of various kinds and the energies of many of the mathematicians were turned to war problems. But the war undoubtedly made much clearer to the public, or at least to the thoughtful public, the fundamental importance to the nation of all the sciences; and in this gain in public appreciation mathematics perhaps shared most largely, since from its abstractness it had before often been thought of, even by other scientists, as largely of the nature of a luxury.

This progress is evidenced by the increasing body of graduate (*i.e.*, of university) students of mathematics, by the high success of the meetings and the publications of the mathematical societies, etc., and also in another way which should be mentioned since it is of happy augury for the future.

The Rockefeller Foundation, of New York City, which is devoting its resources almost exclusively to the improvement of existing and the founding of new institutions for medical education and medical research the world over, in the recognition that medical research rests upon research in the physical and biological sciences, has, since 1919, enlarged its programme by the establishment, through the mediation of the National Research Council of Washington, of National Research Council fellowships tenable by the most promising men who have taken doctorates of philosophy in those sciences and wish to devote themselves to the continuation of their researches. The plan was for a five-year period, with \$100,000 annually allotted to the physical sciences and a larger sum to the biological sciences.

Now the plan has been renewed for a second five-year period, and the allotment to the physical sciences (heretofore specifically physics and chemistry) has been enlarged to \$125,000, with the inclusion of mathematics, in recognition of the fact that research in physics and chemistry rests upon research in mathematics. It is not required or expected that the researches shall be immediately applicable to medicine ; the bridge from mathematics to medicine is long but existent ; I suppose that perhaps the career of Pasteur has led the authorities of the Rockefeller Foundation to this appreciation of the solidarity of the natural sciences.

It is to be hoped that results will justify the continuation on the part of the Foundation of the research fellowship plan. Certainly the research neophytes chosen as fellows will find their research purposes strengthened and their research ideals broadened and elevated, and there will be a resultant keener appreciation of the value of research among the general body of graduate students and men of science. For mathematics in this country this fellowship plan will undoubtedly mean a very great step forward, since our mathematical research has been largely in the more purely mathematical theories and should in the next generation include much more work than heretofore in mathematical physics. Perhaps I should add that there are signs that this inflexion in the stream of mathematical research in this country is taking place in a natural way in connection with the important rôle in present-day physics of the theory of relativity, for that theory by its very abstract character strongly appeals to and requires and is receiving the co-operation of pure mathematicians.

You will understand that I have been referring to the progress of mathematics as a growing science in this country. The various branches of research are well represented — of course, not all in the same university. I am not able to give statistics, but in the *Proceedings of the Fifth International Congress of Mathematicians* held in 1912 in Cambridge, England, published by the Cambridge University Press in 1913, you will find historical-critical data from the various countries up to 1912 ; and as to America, the progress since that time has been much accelerated and the range of activity much extended. I have above indicated that, and why the prospects for the future are most auspicious, especially by the closer integration of mathematical research with research in the adjacent sciences. So far as I am able to judge, at present we are most backward in mathematical physics, while, on the whole, in the various branches of pure mathematics and in the other branches of applied mathematics (*e.g.*, theory of statistics, actuarial science, etc., and especially mathematical astronomy), our status is fairly comparable with the status in any other country.

With respect to the teaching of mathematics, attention should be called to a 682-page book : *The Reorganisation of Mathematics in Secondary Education : A Report by the National Committee on Mathematical Requirements, under the auspices of the Mathematical Association of America*, published in 1923 by the Association, and obtainable from its secretary, Professor W. D. Cairns, Oberlin College, Oberlin, Ohio. This report reflects the increasing interest in the problems of the teaching of secondary mathematics during the last twenty years, with the purpose of shifting the emphasis away from the more formal treatment of algebra, geometry, etc., towards a treatment requiring a deeper appreciation of the subject-matter and of its availability for various types of more significant application. This movement in this country, like the so-called Perry Movement in Great Britain, promises to bring our treatment of secondary mathematics into closer harmony with the current treatment in Europe, and of its ultimate importance for the development of mathematics in this country I have no doubt.

2. There is little direct interest in mathematics on the part of the public as expressed in the Press. Of course, every State, by the system of public education (which is specifically of State and not national jurisdiction), fosters mathematics like other subjects ; and at present most of the States maintain State universities of high grade in the collegiate domain, while there is a general tendency in these universities to develop strong graduate departments leading to the degree of doctor of philosophy for those students who have research ability. In only a

few of the State universities (notably in California, Michigan, Illinois, Wisconsin) has this tendency been realised in the domain of mathematics ; the tendency is, however, well defined and strong, and the change in this direction is likely to be rapid.

There has been for some decades a movement in favour of the establishment by the national Government of a national university ; this would require action by Congress, and, owing to our educational traditions, as well as our political doctrine of maximum independence of the States as amongst themselves and as to the nation, it may be doubted whether this movement is destined to succeed. In the specifically university domain, the major part of the educational work is done by the privately endowed universities, like Harvard, Yale, Johns Hopkins, Columbia, Cornell, and Princeton in the East and Chicago in the Middle West ; in mathematics, Harvard and Chicago are generally recognised as standing in the lead for the period under consideration.

Most productive mathematicians are connected with the universities. With the great increase in the cost of living, due in large measure to the war, there has been a considerable but far from adequate increase of salaries. There is activity in the textbook field ; in the secondary and collegiate domains, where there is no difficulty in securing publication, this activity is distinctly lively, and, as time progresses, really valuable books are appearing more frequently.

In the strictly university domain, on the other hand, the activity is very limited, not so much on account of the lack of good manuscripts as on account of the reluctance of textbook publishers to publish treatises on such special branches of mathematics, the circulation of which will necessarily be limited and slow. However, the publishers are gradually becoming more liberal in their commitments and, moreover, our various university presses are beginning to work out into this very important field of publication in such wise that the prospects for the future are distinctly encouraging, although I fear that it will be only after several decades that our status will be really satisfactory.

3. The preceding remarks have fairly covered this item.

4. The American Mathematical Society (1894) contains in its membership almost all the research mathematicians of the country, together with many from other countries, and also a large fraction of the teachers of mathematics in colleges and universities who are interested, although not personally active, in the scientific and historical-critical development of mathematics. The office is at 501 West 116th Street, New York City. The *Transactions* of the society is a quarterly journal of research in pure and applied mathematics (1900), the principal research journal in this country. The *Bulletin* (1894) of the society (nine or ten numbers per year) contains (besides current news of the society and of mathematical events of the world, including lists of current publications) brief research articles and studies in the history of mathematics and longer or shorter reviews of the more or less important books of recent publication.

The Mathematical Association of America (established about 1912) has much the same membership, but devotes itself primarily to the interests of mathematics in the collegiate field. The association has taken over as its official journal the *American Mathematical Monthly*, which has appeared since about 1890. In it appear shorter research articles of more general interest, besides news notes, etc. Office : Oberlin College, Oberlin, Ohio.

For the field of secondary mathematics, there are various societies with their journals.

There are two other periodicals of mathematical research : (1) Founded about 1880, and since that time published by the Johns Hopkins University, Baltimore, Maryland, the *American Journal of Mathematics*, devoted to more technical articles of research ; and (2) the *Annals of Mathematics*, under the auspices of Princeton University, Princeton, New Jersey, devoted to somewhat less technical articles of research.

The progress of mathematics in this country has been in large measure associated with the American Mathematical Society and, latterly, with the Mathematical Association of America.

Both associations hold numerous meetings in various parts of the country. About once in four years, the society conducts, in connection with its summer meeting, a Colloquium, that is, usually two series of lectures on two fields of mathematics in which at the time there is special interest. These Colloquium lectures are published by the society. Several years ago, the association, by the generosity of a friend of mathematics, was enabled to undertake the publication of a number of introductory texts on certain important branches of advanced mathematics. Manuscripts of the first two books are approaching completion. There is reason to hope that this series of texts will prove to be of such high value that its permanence and gradual extension may be possible.

The various journals are not in receipt of subventions from the national Government or from State governments, as is so often, if not usually, the case in Europe. Accordingly, with the present high cost of printing and of print-paper, the publication of the journals is disturbed by financial difficulties. To permit the enlargement of its journals, a result much to be desired for the welfare of the science, the society within the last year has entered upon a campaign to secure \$100,000 endowment. Pledges for upwards of \$30,000 have been obtained, chiefly from members of the society. It is hoped that the residue will be obtainable from the large textbook-publishing companies, from the large corporations utilising more or less directly mathematics and the physical sciences, and from the large foundations whose endowments are for public service and in some cases more specifically for the advancement of science.

No one of the journals is, to my knowledge, in an absolutely precarious condition. There is, however, acute need of increased facilities for publication of textbooks, treatises, and memoirs in the more advanced and technical fields of mathematics; and, as to periodicals, this means that there is need of either the enlargement of existing or the founding of one or more new periodicals. ✓

5. Our principal university libraries contain the principal books and periodicals published in other countries, and our researches are accordingly closely integrated with the researches in other countries. And it seems to me that our work has, in general, received due recognition in other countries; however, it is true that the war and post-war conditions have latterly caused a change for the worse in this respect, since, especially in Central and Eastern Europe, our books and periodicals are not circulating so freely as formerly.

6. This item is covered by preceding remarks.

7. There is an American section of the International Union under the International Research Council. There is a very general desire on the part of the mathematicians of America that as early as possible the present restriction in membership in the International Council and the International Union be removed in such wise that the Council and the Union may become truly international.

8. I suppose that, as heretofore, mathematics will progress in three principal ways:

(a) By the intensive development of fields already under cultivation, in connection with the study of problems of new types and of increasingly difficult problems of old types.

(b) By the critical study of the foundations of the fields already under cultivation, and especially by the increasingly piercing comparative-critical study of the foundations of allied fields, from which will, from time to time, emerge the determination of more general fields worthy of independent investigation, since in every case the allied fields giving rise to a general field are various instances of that general field, and accordingly the theory of the general field is immediately

applicable not only to the theories of the various allied fields but usually also to various new special fields likewise instances of the general field.

(c) By the development of mathematical methods capable of application in the theories of the new fields of research in the physical and even the biological sciences which are being constantly opened to investigation.

9. In my opinion there is, without doubt, a connection between the status of public morality and the status of scientific achievement in a country, in the sense that, at least in a measure, low morality and high scientific achievement are incompatible. Certainly the scientific communications from a country of notably low public morality would be received in other countries only after especially critical scrutiny.

Eliakim H. MOORE,  
*Professor of Mathematics.*

Department of Mathematics, University of Chicago.

June 30th, 1924.

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### PHYSICS.

1. On the whole, during the last ten years, there has been steady progress in the field in which I am interested, more rapid perhaps in the last five years, because in this country the effect of the war was undoubtedly to increase public interest in the development of science and to increase the efforts to apply science in the industries. The efforts of physicists in this country are largely directed towards research either in pure or applied science, there being relatively little serious attempt to make this knowledge acceptable to the public. There has been during the past few years, however, a decided increase in the interest of scientists in the popularisation of their subjects, the best evidence of which is in the successful operation of a "Science Service" in connection with the National Research Council in Washington.

2. Public interest, especially in the applications of science, is still far from general. Our scientific meetings are, as a rule, not well reported in the newspapers and there are not many of the general public who are interested in such reports. The attitude of the Press is cordial enough, but reflects a rather general unintelligent public opinion. In this respect, however, there are signs of improvement. Assistance by the State, both the Federal Government and the individual States, has, on the whole, been generous, and this also may be said of the attitude of certain public foundations, such as the Carnegie Foundation and the Rockefeller Foundation. A very significant and important event was the founding of the Rockefeller Research Fellowships in Physics and Chemistry.

The fellowships and scholarships which are commonly provided at the larger educational institutions have become, in recent years, of much less significance, because the compensation attached to them has not been increased to keep pace with the increasing cost of living, so that many of the best candidates cannot afford to apply for such fellowships or scholarships. There have, in recent years, been no particularly important new prizes offered in this country, and only one significant large endowment in physics — namely, the very unique and important endowment of the Norman Bridge Laboratory of Physics at Pasadena. The outlet for intellectual effort in physics may be divided into four principal classes :

- (a) In educational institutions ;
- (b) In industrial research laboratories ;
- (c) In governmental laboratories ;
- (d) In endowed research institutions.

In all of these divisions I feel that there has been a very satisfactory increase in the commercial value of work in physics during the past ten years.

3. Specialists are recruited largely through the educational institutions. A rather surprisingly large proportion of the young men who go on to specialise in this field begin their training in physics at smaller institutions. A large institution may have in its elementary classes ten times as many men as a small one, but it never happens that, out of this larger number, ten times as many men go on for advanced and special training. For this reason, as well as for others, the type of men in charge of the instructional work in the smaller institutions is a matter of great importance. One of the greatest needs is an improvement of the situation and condition in many of the smaller institutions in the way of reducing the amount of routine instruction required of their professors, so that they may maintain a more active contact with the intellectual growth of their subject. Personally, I believe that ultimately a satisfactory condition will only be reached when all of these men maintain a certain amount of productivity in conjunction with their teaching, the type of work and the amount being suited to the man and to the institution. In smaller institutions it is usually difficult to obtain instruments and material for work. This is seldom true with the larger institutions.

4. The most important and active organisations are :

(a) General associations : National Academy of Science, American Association for the Advancement of Science, American Academy of Arts and Sciences, Washington Academy of Sciences.

(b) Special associations : American Physical Society, American Optical Society.

(c) Research institutions : The Carnegie Institution, National Research Council.

(d) Educational establishments : A dozen or more of the leading universities, having large and finely equipped laboratories, many of them built within a few years.

(e) Periodicals : *Physical Review*, *Journal of the Optical Society*, *Proceedings of the National Academy*, *Proceedings of the American Academy*, *Journal of the Franklin Institute*, and Government publications.

None of these organisations is in a precarious condition, but several of them could make efficient use of considerably increased resources, notably the National Research Council and the *Physical Review*. There is room for improvement in the matter of abstracting of literature on physics.

5. Physicists in general keep in such close touch all over the world that one hardly thinks of international boundaries in this connection.

6. My sources of information are personal contact with men in this country, connection with several of the institutions and periodicals mentioned above, and some little personal contact with men abroad.

7. Increase in the amount of personal contact between workers in this field in different parts of this country is much to be desired, but improvement in this respect has been brought about in the last few years by the National Research Council. Distances are so great in this country that it is almost as difficult to maintain contact between the extreme west and the extreme east as it is to maintain contact with workers abroad. The latter will be stimulated by the recently organised Union of Pure and Applied Physics.

8. An answer to this would quickly lead one into rather too detailed a discussion.



The general public attitude toward morality, using this term in a very general sense, exercises an influence in this field as it does in others, particularly in reference to the degree of idealism with which the individuals work.

C. E. MENDENHALL,  
*Professor of Physics.*

Department of Physics, University of Wisconsin, Madison.

April 3rd, 1924.

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### CHEMISTRY.

1. During the last ten years the development of the science of chemistry in America has been very great. Undoubtedly, the greatest stimulus to this development was the European War, which threw America on its own resources in all matters relating to chemical products. These had been, to a very great extent, imported from European countries, and when the supply was cut off the attention of the public and of the industrial and financial leaders of the country was directed to the necessity of building up a self-supporting chemical industry. Naturally, this created a tremendous influx of students into the departments of chemistry of the universities. The demand for chemists increased enormously all of a sudden, and chemistry became an extremely popular subject with students. The number of research workers in the universities and industrial laboratories has enormously increased, and as long as the industries continue to demand the help of chemists, this increase will continue. At the present time, the departments of chemistry of all universities are filled to overcrowding, and new laboratories are being erected and will necessitate being erected for years to come to handle adequately the steadily increasing number of students.

2. Much has been accomplished by the chemical societies and the Government to popularise the work of chemistry. Books on popular chemistry have been written and distributed free of charge to schools and colleges by associations such as the Chemical Foundation, and the interest of the public has been so aroused that very extensive attention has been given to meetings of chemical societies, chemical expositions and announcements of chemical discoveries by the Press of the country.

The commercial success is undoubted, and America possesses at the present time a chemical industry capable of supplying the very large majority of its needs.

3. Specialists in chemistry are recruited from the student body and there is no difficulty at the present time in obtaining a sufficient number to handle the principal needs of the country.

While the profession may not be considered a very remunerative one, according to American standards, the economic condition of workers in this branch is generally very satisfactory and salaries received are adequate to maintain a decent style of living.

There is little difficulty at the present time in obtaining instruments or materials either for pure or industrial research and most of this material is at present of national manufacture.

The technical education of workers in chemistry is assured by flourishing technical schools and departments of chemistry in the universities all over the country, and there is no difficulty in obtaining a high type of chemical education in almost any section of this country.

4. Among the most important active organisations in chemistry are the American Chemical Society (15,000 members), the American Electro-chemical Society (2,500 members), the American Ceramic Society, the American Association for the Advancement of Science (Section in Chemistry), and the American Institute of Chemical Engineers (600 members).

The research institutes and educational establishments are far too numerous to be given in this letter. They amount to approximately 300.

Among publications may be cited the *Journal of the American Chemical Society*, *Chemical Abstracts*, *Chemical and Metallurgical Engineering*, *Industrial and Engineering Chemistry*, *Chemical Age*, *Science*, *Journal of Physical Chemistry*, *Chemical Bulletin*, *Oil Paint and Drug Reporter*, publications of the Bureau of Mines and publications of the Bureau of Standards.

Among the associations furthering research may be mentioned the National Research Council (Division of Chemistry and Chemical Technology), the Chemical Foundation and, indirectly, the Carnegie Foundation and the Rockefeller Foundation. At the present time sufficient resources are available for all purposes and there are no associations which may be said to be in a precarious condition.

5. Chemical work is of such an international character that it would be very difficult to assign any particular value to the influence played by foreign countries as well as the influence of the American work on foreign work.

6. My sources of information concerning work in my branch in chemistry are, in my country, my personal experience as member of a number of chemical societies here and abroad and of the Division of Chemistry and Chemical Technology of the National Research Council, of which I am chairman. At the present time I am fully informed on foreign conditions through the International Union of Pure and Applied Chemistry, of which I have the honour to consider myself a founder.

7. The relations between workers in chemistry in America are fully taken care of by frequent meetings of the chemical societies mentioned above and the work of such co-ordinating organisations as the National Research Council. The increasing influence of the International Union of Pure and Applied Chemistry in establishing close personal relations between chemists of different countries is a potent factor in establishing close co-operation between nations.

8. It will require a very large volume of printed matter to enumerate the developments and the new lines of work which may be foreseen in the field of chemistry.

9. I regret to be unable to see any connection between the state of public morality and the development of science and chemistry.

J. E. ZANETTI,

*Chairman, Division of Chemistry and Chemical Technology.*

National Research Council, Washington.

September 24th, 1923.

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## PSYCHOLOGY.

The following statements refer, unless otherwise specified, to the last decade, 1914 to 1923, inclusive.

1. Extraordinarily important developments have occurred in psychology, psycho-biology and psycho-technology during the decade. They are due primarily to unusually spectacular and at the same time convincing applications of the methods and results of psychological enquiry to various practical domains. Early in the decade rapid development of practical

relations of psychology to education, medicine and law gave impetus to psychological work and increased the number of students. Beginning in 1918, the results of psychological examining in the United States army focused public attention on psychology, increased interest, and led to the wide-spread conviction that psychology may be very useful in a variety of directions.

Since 1917, what is technically known as the psychology of personal procedure has received increasing attention, and personnel problems have been studied in industry as well as in academic institutions. This undoubtedly was a direct result of the work of the Committee on Personnel of the United States Army.

The demonstration of varied uses of methods of mental measurement in the army and in such special institutions as prisons, reformatories, hospitals for the insane, feeble-minded, special training classes, etc., led to effort to prepare methods of mental measurement which should either supplement or replace prevalent forms of academic examination, and become increasingly useful as methods of selecting applicants for educational opportunity, for classifying them in accordance with their abilities and achievements, and for vocational suggestion or advice.

These several practical developments naturally enough reacted on the science of psychology and greatly augmented its personnel throughout the country, and its material support in educational as well as other institutions. They likewise brought it into better repute with the other natural sciences and tended to link it more closely with the biological sciences, including government, economics and sociology. Research has been correspondingly stimulated and augmented. There has undoubtedly been a far larger increase in psycho-technology than in so-called "pure science" research.

2. The public, especially since the military demonstration of usefulness of psychology, has taken keen, intelligent, and increasingly critical interest in psychology as science and as technology. The Press gives a large amount of space to popular and technical psychological materials. Lay and professional interest of exceptional nature and extent is shown also in employment of psychologists by Federal, State, municipal and private bureaux, institutions or business corporations. It has become increasingly difficult to secure well-trained psychologists. Both institutional and private support of teaching and research in psychology have increased steadily.

The National Research Council has recently compiled a list of graduate scholarships and fellowships. It has not yet been published, but as soon as available a copy will be supplied as an exhibit supplementary to this statement. It will indicate the number of appointments available in psychology. There are very few prizes for students of psychology in this country; the amount of money available for the support of psychological research has very greatly increased in the decade. At present several psychological investigations are subsidised by individuals or foundations. The writer knows personally of appropriations approximating \$100,000 per year for psychological investigations apart from regular institutional budgets. This is new, encouraging, and clearly indicative of the popular interest and belief in psychology as science.

The commercial success of psychology is not inconsiderable. In general, psycho-technologists are well paid, and this country has already provided one instance of a psychologist to a large commercial concern becoming a highly important member of the staff of the organisation. There are many successful clinical psychologists as well as personnel specialists in active practice. The Psychological Corporation of America, although not yet financially prosperous, expresses the interest and faith of the psychologists of the country and their conviction that reliable service should be generally useful. Dr. J. McKeen Cattell, formerly head of the Department of Psychology, Columbia University, and one of the most eminent of American psychologists, is President of the Corporation, which has its headquarters in New York City.

Psychology is rather too well provided with organs of publication, as is indicated by the accompanying directory. American publishers are eager for psychological manuscripts, and the monograph series provide at reasonable cost to authors for the issuance of special reports which commercial publishers cannot afford to accept. In general, the sale of psychological products, including apparatus, test materials and publications, is good. It has very greatly increased in volume during the decade.

3. Psychologists in this country are provided primarily by colleges and universities whose departments or divisions more or less adequately train them for professional activities. There are probably at least a hundred institutions of higher learning in which fairly satisfactory elementary instruction in psychology may be obtained. There are possibly as many as fifty institutions in which advanced instruction and opportunities for research are offered. But really first-rate departments of psychology, well manned and well equipped for professional training of students, probably do not exceed twenty-five.

In my opinion, the situation demands specialisation in a few well-located centres, and the development of strong departments or special schools of psychology. At present almost all of our institutions undertake to do work which may be done adequately *on the professional level* by only a few. Several of the leading psychologists of this country are urging the establishment of pre-eminently strong schools of psychology in connection with three or four of our best universities.

The economic condition of American psychologists is comparable with that of other scientific groups, with the possible exception of chemists, whose technological opportunities are of course superior to those of other scientists. Psychologists are increasingly in demand and therefore increasingly well paid, because of the rapid and extensive growth of psycho-technology. Since the war, positions have been increasingly difficult to fill satisfactorily.

There is no special difficulty, so far as I am aware, in obtaining technical equipment for psychological work. Instruments, test materials, publications, etc., are available through several reliable firms.

4. The American Psychological Association is the national organisation of which almost all active and reputable psychologists with what is considered adequate professional training are members. The Psychological Corporation, mentioned above in paragraph 2, represents provision for the solution of practical problems on basis of fee, and the promotion of research through the utilisation of a portion of such fees. There are numerous minor and local societies or sections of organisations devoted to the advancement of psychology.

Of research institutions there is none in America devoted exclusively to psychological work. In such institutions as the Wistar Institute of Philadelphia, the Laboratory for the Study of Experimental Evolution of the Carnegie Institution, Cold Spring Harbor, and in a few similar organisations, psycho-biological problems are from time to time investigated. The major part of psychological research is conducted in the laboratories of colleges, universities, technical schools, hospitals, penal institutions, and State and Federal bureaux. The work in these institutions is carried on in a variety of ways, and financed more or less adequately in accordance with available resources and degree of interest in psychology.

It would be a large order to list all of the organisations in this country which are conducting or furthering psychological research. In educational institutions alone there would be a list of three-score psychological laboratories, in the majority of which important investigations are continuously in progress. There are probably as many laboratories in special institutions which from time to time house important psychological research.

In general, the condition of psychological laboratories, departments or divisions is fair to excellent. The situation is distinctly encouraging, and in every way indicative of growing

popular and technical support. As indicated above in paragraph 3, the professional status might, in the opinion of the writer, be improved by the development of a few highly adequate centres, as, for example, schools of education for professional training in psychology. This would, of course, comprehend varied provisions for instruction and for research, and would tend to place psychology on a plane similar to that of the medical sciences in adequacy of provision for professional training.

5. Psychological work in other countries certainly has had less influence on development in this country during the past decade than previously. By reason of circumstances conditioned by the World War, America naturally became the leader in psychological research and in the development of psycho-technology during the decade of which we write. Previously English, French, German, Italian, Scandinavian and Russian psychologists and psycho-biologists and the trends of psychology in the several countries greatly influenced American work. The majority of the leading American psychologists up to the present decade received at least a part of their professional training in some foreign country, usually France or Germany. In the last ten years, the situation has changed radically, and very few of the present generation of American psychologists received any considerable portion of their psychological training elsewhere than in home institutions.

There are clear evidences of the increased influence of American psychological work in other countries. This is particularly noticeable in the case of American studies in animal behaviour, comparative and genetic psychology, and applied psychology or psycho-technology.

6. My sources of information are too numerous and varied to list completely. I shall mention only the principal ones. For some twenty-five years I have been in intimate touch with American psychologists and psychological progress. My personal contacts and first-hand acquaintance with the situation are largely responsible for the statements of this report, but, in addition, I am depending upon American and foreign psychological journals and other publications; on the reports of the American Psychological Association; the report on the psychological personnel of America by Professor Harold G. Bingham, copy of which is being sent under separate cover as supplementary exhibit; various informational lists and files in the Research Informational Service of the National Research Council, etc.

The most obvious informational need of America and other countries, so far as research is concerned, is an international abstract journal which shall list and objectively abstract all scientific contributions to psychology. Psychological publications in America are much too numerous and should be reduced by wise consolidation. If an international abstract journal were established, it might well be published either in some auxiliary language to be used in all countries, or in English, German and French editions simultaneously. The materials should be prepared by international co-operation, thus avoiding the waste of independent abstracting in several different countries.

7. The relations of American psychologists with those of other countries are primarily personal. There is no active international organisation. From time to time an international psychological congress is held, but this has only temporary value as means of bringing the psychologists of the world together. The Seventh International Psychological Congress is to meet in Oxford, England, this summer.

It is highly desirable, in my opinion, that an international union or association of psychologists should be organised and from time to time provide for general meetings or congresses. Such international organisation might well concern itself with the furtherance of co-operation in publication, provision of standards, manufacture of apparatus, the cultivation of profitable contacts through establishment of an informational bureau, and provision for exchange or

migration of teachers, investigators and students. Each national psychological organization should, I believe, be member of and contribute to the support of an international psychological union.

8. There are several conspicuous trends or lines of interest in American psychological work. Among them are relations of psychology to education, to medicine, to industry, relations to physiology and general biology, as indicated in psycho-biological research, renewed interest in studies in animal behaviour and comparative and genetic psychology, development of mental measurement for purposes of research and practical examining. Although psychotechnological activities seem at the moment to monopolise attention, careful enquiry indicates that a large amount of work on fundamental problems is in progress. America has hundreds of persons who class themselves as professional psychologists, and scores of well-equipped, successful investigators. There is every reason to anticipate steady development of the science as such, increasingly adequate provision for it in educational institutions, and more intimate and profitable relations with such kindred sciences as the biological and social.

Of minor interest in connection with this statement is a list of important investigations, several of them primarily psychological, which are being furthered by one of the research committees of the National Research Council, the Committee on Scientific Problems of Human Migration.

9. I can discover no adequate reason to attempt to reply to this question. It suggests, however, the observation that the anti-vivisection and the anti-evolution movements in America are inimical to the progress of psychology as well as all other biological sciences.

Robert M. YERKES,  
*Division of Psychology.*

National Research Council, Washington. — Franklin N. H.  
July 14th, 1923.

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## BOTANY.

### *Plant Morphology.*

1. During the last ten years, plant structures are coming to be regarded more and more as responses, rather than rigid inheritances. As a consequence, research in morphology is coming to include experimental work, to distinguish between inheritance and response. This means great progress, and much of the work is original.

2. The public is taking an increasing interest in the whole subject of botany, because of the very important practical applications that have come from research. Industrial firms are providing funds and scholarships for research. An outstanding illustration is the recent establishment of the Boyce Thompson Institute for Plant Research near New York City, for which several million dollars of endowment were contributed. This institute proposes to do for botany what the Rockefeller Institute is doing for medicine.

3. Specialists are recruited by our graduate schools, and the numbers are increasing rapidly. In general, the "economic condition" of our workers is fair, but there is a movement now to better these conditions.

4. Our most important and active organisation is the Botanical Society of America, with several minor organisations representing the different fields of Botany, all organisations co-operating. In my judgment we are organised sufficiently.

5. The influence of foreign countries is naturally not so great as formerly, in the way of training our investigators, but all foreign work is followed for information and suggestion. I have reason to know that our own work has a similar influence in foreign countries.

6. Our sources of information are well-established journals in this country and throughout the rest of the world, all of which are available in every research centre.

7. Our relations with foreign workers in similar lines are intimate, both through correspondence, and often through exchange of visits.

In my judgment an international organisation is not only possible, but also very desirable. It would stimulate research and develop increasingly the spirit of co-operation, which in my judgment is the hope of the future.

### *Plant Physiology.*

1. During the last decade there has been considerable progress in plant physiology, particularly with reference to the applications of physics and chemistry to the problems of plant life. The internal nutritional conditions of growth have received much attention, and the knowledge obtained has brought substantially nearer the time when we can control plant production by control of the internal conditions through manipulation of external conditions.

There is a very considerable volume of new work which is increasing in value, and the main efforts of physiologists have been directed to acquisition of new knowledge, and but slightly to the problem of making our knowledge accessible in popular form. The latter field is too much neglected.

2. The interest of the public in general is not as great as it should be. There is evidence of interest, however, on the part of seedsmen, florists, horticulturists, and fruit producers, transportation companies, warehousemen, and all who handle the more perishable plant products.

The matter of endowments and scholarships has not been properly worked, but such companies as the sulphur companies, lime associations, gypsum industries, etc., have established fellowships at various times and places for research in plant physiology. I believe that transportation companies would be willing to support research on the handling and storage conditions, the physiological processes of fruits, etc., in transit and storage.

3. The specialists in plant physiology are recruited mostly from the agricultural colleges, experiment stations, and from related sciences, like agronomy, horticulture, etc. Workers in these fields find that they cannot solve their problems without the fundamental physiological training which this division of Botany provides.

The economic condition of the workers in plant physiology in America are as good as in the other divisions of botany. They may even be at an economic advantage because of the practical bearing of the fundamental research in this field. In common, however, with all other professional educational pursuits, the plant physiologist is underpaid. The same training in business would enable any of them to secure several times the average salaries now paid.

4. At the present time plant physiologists are unorganised, but a new society is being established to provide means of mutual encouragement and inspiration. The physiologists have maintained a section of the Botanical Society of America, but it has had no objectives

aside from the annual meeting for the reading of papers. I believe that a strong organization with regional committees to centre attention on the most pressing problems in agriculture, horticulture, soil management, etc., where the training of the physiologist is needed, would do an immense amount of good.

5. There is a certain amount of foreign influence in our work. We try to keep in touch with the results of European and other foreign research, particularly with reference to the adoption of new and improved methods of research. Reciprocally, work in America has a certain amount of foreign influence. These reciprocal influences, however, are not as pronounced as they should be. The new Benecke-Jost textbook of plant physiology gives a very good summary of European literature, but has made use of only a small part of the American literature. Similarly, any book written in America would probably draw most largely from American sources, giving to the foreign literature less attention than it deserves.

6. The sources of information in plant physiology are our current periodicals, the *Experiment Station Record*, and *Botanical Abstracts*. The last attempts to cover all important journals of botany, both domestic and foreign. In addition, we use the foreign abstract journals, such as the *Biologisches Centralblatt*, *Botanisches Centralblatt*, etc., and a rather incomplete set of foreign current periodicals.

7. The relations with foreign workers are cordial, so far as they go, but we do not have sufficient opportunities to travel abroad among scientists in general, nor do foreign scientists visit us with sufficient frequency to make personal relations as close and as friendly as they should be.

8. In my judgment, I believe that in plant physiology there will be an increasingly intensive study of the problems of metabolism, and of the influences which environmental changes exert upon the course of events in the actual process of living. The ultimate goal of the work is ability on the part of man to understand and control the life processes of plants in such a way as to secure the greatest good to man himself, and to his plant companions.

### *Plant Ecology.*

1. The advance in plant ecology may be most clearly indicated by the organization of the Ecological Society of America, which recently held its ninth annual meeting, at which twenty-five papers were presented, representing results of research in plant ecology. This society has established, and has, on a self-supporting basis, a quarterly journal, which is now in its fifth annual volume. In addition, numerous papers embodying the results of ecological research have appeared in such journals as the *Botanical Gazette*, and in the publication of the United States Department of Agriculture and of various agricultural stations.

A very large proportion of the work of ecologists has been original, and the greatest advance has been along the lines of introducing quantitative methods in studying the factors which control vegetation. The composition of vegetation has also been made the subject of statistical studies. In these fields notable advances have been made.

Decided progress has also been made in showing that the investigations of ecologists are of great importance in solving many of the problems of forestry, grazing and crop production.

2. Public interest has been shown in the support of the journal *Ecology* by subscriptions outside the rank of professional ecologists, and by the popularity of books and articles on natural history having the ecological viewpoint.



The science of plant ecology has had official recognition by the appointment of scientists to the United States Department of Agriculture under the title of Plant Ecologist. Specialists in plant ecology have been employed by the Federal and by the State governments in the settlement of legal disputes involving land ownership and boundary lines. Here a study of existing vegetation was able to throw light upon the migration of streams and upon the nature of the land surface when certain surveys were made.

3. Specialists in ecology have come from the ranks of graduates from universities and agricultural colleges. A few amateurs of the best type have made useful contributions.

The economic conditions of the workers in this branch of science do not differ materially from those of other scientific workers. As a rule they are underpaid and hampered by lack of funds.

4. Decidedly the most active and important organisation is the Ecological Society of America. Some local botanical societies and academies of science have encouraged ecological research and have published the results of such investigations. The ecological investigations of the Carnegie Institution of Washington have been numerous and valuable.

5. The influence of foreign countries upon ecology has probably been less during the past decade than previously. The British School has exerted some influence through its publication of the *Journal of Ecology*, and the publications of the Danish school have perhaps led to more interest in the structure of vegetation and the sociological problems of plant communities.

American ecology has exerted a decided influence upon members of the British school.

6. The sources of information in our own country are the quarterly journal *Ecology*, and the *Bulletin of the Ecological Society of America*, both published by the Ecological Society of America, also the publications of the Carnegie Institution of Washington, the *Botanical Abstracts*, and to a less extent other botanical journals and *Science*.

The sources of information from other countries are the *Journal of Ecology*, published by the British Ecological Society, the publication of the Pflanzengeographische Kommission der Schweizerischen Naturforschenden Gesellschaft of Zurich ; and various monographs, books and articles in scientific journals.

7. There exists a very informal international organisation known as the International Phytogeographical Excursion Committee. Under its management three international meetings have been held : Great Britain in 1911, United States in 1913, and Switzerland in 1923. Another meeting is planned for Scandinavia in 1925. These meetings have taken the form of field trips and informal conferences, and have had a membership of some twenty-five ecologists in attendance at each, with a further attendance at certain of the meetings of some hundred others interested in the science. At present no other international organisation seems to be necessary.

8. The advances in plant ecology in the future seem likely to be along the following lines : (1) The refinement and further application of methods for the quantitative study of the factors which control the development of plants and plant communities ; (2) the quantitative and statistical study of the phytosociological problems ; (3) the wider recognition of the dependence of agriculture and forestry upon the work of plant ecologists, and the greater use of the results of ecological investigations by foresters, agriculturists, horticulturists, and others engaged in various phases of plant production.



*Plant Pathology.*



1. During the last ten years there have been no epoch-making discoveries. There has been an enormous amount of work done in establishing and elaborating the broad principles of disease laid down by Pasteur, De Bary, Kühn, Sorauer, and others. The trend is physiological rather than mycological, with an increasing demand for monographic study of groups which contain important pathogenes.

Although reconnaissance work is still going on, the tendency is toward experimental determination of the correlation between environmental studies of the method and nature of infection, susceptibility, resistance and immunity—that is, toward cellular pathology. More stress is being laid upon a fundamental restudy of “old diseases” than upon the mere reporting of “new diseases.”

Advance has been made in the study of the mosaic diseases, and proof has been brought that non-filterable entities are involved as causative agents. This work has practically undermined the old stand on “degeneration diseases.” The extreme importance of insects as disease carriers has been demonstrated in connection with this work.

The work done by plant pathologists on “crown gall” has had a stimulating effect on animal cancer workers. Both groups are coming to find an intermediate ground relative to the causation of plant galls and animal cancers the most tenable one.

Control of plant diseases by selection and development of resistant varieties or strains is getting to be considered a more promising method than control by exclusion, extermination, inhibition and protection. Although the latter still are the standard methods and have achieved notable results, they are becoming increasingly expensive and threaten to become the limiting factors of production.

The activities of the War Board of the Phytopathological Society and the establishment of the Plant Disease Survey in the Bureau of Plant Industry have been important factors in bringing together the workers and in co-ordinating the work done in the United States Department of Agriculture and in the various States.

One of the great weaknesses in plant pathology until the war had been the fact that the results of fundamental research were not properly reaching the public, because the activities of the research workers and of those making knowledge available were not always properly co-ordinated. The introduction of extension work, and the later recognition of the fact that pathologists should have jurisdiction over and also should be responsible for the pathological subject matter extended, have brought great improvement in making knowledge accessible and in making the extended matter reliable.

The recently growing recognition of the fact that the enormous wastage of food products in transit and in storage due to plant diseases as a factor in the tendency of distribution costs to run higher than production costs, has called attention to the important field of market pathology. The newly established receiving and shipping point inspection service by the Federal and State governments recognise the disease factor as a fundamental one. Because of this the pathological audience has been tremendously and effectively enlarged.

Plant pathologists have played an important rôle in the councils of the Federal Horticultural Board in its administration of the quarantine laws.

2. The public is taking an increasing interest in plant pathology. The public in general has supported pathology work in the various States and in the Department of Agriculture through taxation. Plant pathology from the beginning has had the support through various congressional Acts, such as the Adams and Hatch. During recent years, the Crop Protection Institute has been formed, for which funds are supplied by commercial interests, especially those manufacturing fungicides and insecticides. Commercial groups are becoming interested in endowing research work in plant pathology in the tropics. There has been increasing

support of research work in special problems in the form of scholarships, fellowships and other means by commercial groups interested in the propagation and distribution of seeds, and in the culture, processing and distribution of crop plants. Associations of growers and distributors also have given such work support by employing pathologists.

3. Workers are developed in pathology courses given in the State universities, and to a limited extent in the botanical courses given in endowed universities and colleges. Their practical training is obtained in the State Experiment Stations and in the Department of Agriculture.

The remuneration of pathologists on the average is higher than that of other botanical workers.

4. The Phytopathological Society of America is the only organisation of plant pathologists. It is a section of the A.A.A.S. It co-operates and has joint sessions with the Botanical Society of America, the Entomological Society, and the Horticultural Society. There is a tendency toward the formation of sectional groups within the Society. This is a needed step because of the diversity of the group.

5. Plant pathology was born and reared in Europe. Contact between it and plant pathology in the United States was established in De Bary's laboratory by Farlow. Pathology was definitely established in this country through teaching at Harvard (1895), through formation of the Section of Plant Pathology in the Division of Botany in the United States Department of Agriculture (1887), and through organisation of State Experiment Stations (1888). Europe led for a long time. Leadership has now passed to the United States, both in research work and in practical application. The American work has exerted a great influence in the recent renaissance of plant pathology in England.

Since the war, workers from Europe, Asia, Africa, Australia, Polynesia, and South America have come to the United States for advanced work.

6. The publications available to pathologists are their official organ, *Phytopathology*, together with the *Journal of Agricultural Research*, bulletins of the Department of Agriculture, and State Experiment Station bulletins, also the *Botanical Gazette* and the *American Journal of Botany*. The Carnegie Institute has published work in phytopathology.

The foreign publications in botanical and phytopathological research are available in the larger libraries.

An international journal of phytopathology, or at least an international abstract journal, is greatly needed.

7. The relations between investigators in plant pathology of the United States and of other countries are good. International meetings have been held in the United States, in England and in Holland. There has been active exchange of visits since the war, mostly on the part of Americans.

An international organisation is possible. The matter of quarantines practically makes international co-operation a necessity.

8. The field of plant pathology will become increasingly important as the food problem becomes more pressing. The disease problem becomes more acute as the supply of new land decreases and repeated planting of the same soil must be resorted to.

I believe that there will be a clearer co-ordination of the plant-disease activities now divided between plant pathologists, plant physiologists and entomologists. There will be great development of research of the disease problems of the tropics and subtropics because of the increasing demands for cotton, rubber, etc.

The problems of market pathology will be stressed because of the increasing costs of distribution. Great efforts will be made along the line of developing and finding disease-resistant plants.

Research work will develop along the lines of cellular pathology, of parasite and host interactions, nature of resistance, susceptibility and immunity, and the determination of relations between environmental factors and the occurrence and severity of disease.

### *Genetics.*

1. During the last ten years the following important changes have taken place :

(a) General confirmation of Morgan's hypothesis of the linear arrangement of genes (developed in *Drosophila*), which provides an extremely useful and accurate system of notation, organisation, and interpretation for experimental results. The plant providing the largest amount of this evidence, the bulk of which has been obtained by American investigators, is corn.

(b) Knowledge of relationship of plant varieties, species and genera, in terms of their chromosome equipment.

(c) Very promising results in the scientific creation of desirable commercial varieties, notably disease-resistant varieties in cereals.

(d) Theoretical interpretation and practical application of knowledge of hybrid vigour.

There has been unprecedented progress in genetics, and the work has been mainly original.

2. The general public has a natural interest in the phenomena of genetics. These phenomena, however, are difficult to present clearly to the untrained public. There have been recently some rather successful attempts, however, to popularise the findings of genetics for the benefit of the agricultural public.

There have been practically no endowments by the general public. Certain funds, notably Carnegie funds, have been devoted to the establishment of research institutions, notably at Cold Spring Harbour. In recent years, the United States Department of Agriculture and numerous State Agricultural Colleges have also endowed work of this kind rather liberally.

3. Methods for recruiting specialists in plant genetics are as yet rather imperfect. The subject is so new that very few educational institutions are as yet equipped to give thorough graduate training in this field. Cornell, and perhaps California, are as yet the only institutions that have any adequate department and equipment. The economic conditions of the workers in this branch is probably a little better than that of the average university instructor.

4. The most important and active organisations are Cold Spring Harbour, Cornell University and Columbia University. There is great need for several more institutions of the Cold Spring Harbour type ; and every large Agricultural University should have its department of plant genetics established for research and the training of investigators.

5. Scientific periodicals, notably abstracting journals, are now functioning rather satisfactorily in keeping American workers in touch with what is being done abroad. There should be better endowment.

The American workers keep informed of the work in other countries, but are less influenced by it than by the work of other Americans. This is due to the belief that the work in America in genetics at the present time is in advance of that in other countries.

Recent years have brought a general acceptance of American discoveries and ideas by workers in other countries.

6. Our sources of information in our own country are : (a) journals, which are functioning as well as could be expected ; (b) an increasing number of personal visits ; (c) scientific meetings, whose recent programmes have been remarkably good.

Information from foreign countries comes from : (a) foreign periodicals, which are well circulated in this country ; and (b) abstracting journals (notably *Botanical Abstracts*), which serve in an excellent way in assembling this work throughout the world.

7. Our international relations are friendly, but not intimate. Probably there is less international visiting and correspondence in this field than in the other fields of science.

An international organisation should be possible and profitable. It would be welcomed by most American workers.

8. Another decade will probably bring general endowments for this work, aggregating at least twice the present endowments. There will also be developed a very close co-operation between practical agriculturists ; in fact, it is now developing rather rapidly. There will also be an increasing amount of instruction for the public in general. Investigations will yield practical results more largely than in the past.

John M. COULTER,

*Head of the Department of Botany*

(with the collaboration of members of his staff  
representing the different branches).

Department of Botany, University of Chicago.

June 9th, 1924.

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## ZOOLOGY.

1. (a) Two important changes in the field of zoology have taken place in the last decade. The first of these is the growth of interest in genetics and eugenics arising from the discoveries of Mendel. Allied to this, but not as yet correlated with it, is the increasing precision of analysis of the differences of species and races based upon serology and immunology affiliated with biochemistry. These differences, tested by biological experiment, may ultimately prove to be allied to those differences detected by genetic analysis and the revision of the study of animal behaviour.

(b<sup>1</sup>) New methods have been developed in the genetic analysis of heredity, in the study of immunological and serological reactions, and in the analysis of the biochemical relations of parasite and host.

(b<sup>2</sup>) The influence of public opinion during the war in the matter of the control and prevention of disease and epidemics was powerful in supporting both research and social action in the study and control of disease. It is my observation that public opinion in labour and capitalistic circles is coming to expression as to the attitude of society towards defectives, immigration, race mixture, birth control, educational policy, and to political and economic legislature affecting the amount and distribution of taxes and the allocation of state funds.

An important aspect of the whole matter is the interpretation of the meaning and content to which the laws of heredity have now developed by the study of genetics, and their applicability to the human species as they touch upon the problem of human equalities and upon human opportunity.

(c) There has, in my opinion, been substantial progress in the analysis of heredity and in the scientific analysis of the causes of disease.

(d) The period within which our knowledge of heredity has made rapid advance has been that since 1900, when the rediscovery of Mendel's law stimulated research in these lines. The progress in scientific study of medicine was greatly stimulated during the war by the necessity of efficiency and by the opportunities offered for the study of disease and its causes, notably in the case of typhus, influenza, the dysenteries, and the constructive aspects of surgery.

(e) Progress rests upon freedom of investigation, distribution of the results of research, frequent opportunities for personal conference of advanced researchers, and the recruiting and stimulating of young men to enter the field of research.

(f) Proper interpretation of biological discovery has numerous results and power in providing sound foundation for the physical health, intellectual growth and sound biological development of the human race, because the proper understanding of man's physical nature, his diseases, and his intellectual processes is undeniably wrapped up with that of the rest of the living world.

(g) There has been a great volume of original work done in the biological sciences. The relative extent of this, as compared with other sciences when measured by titles, can be estimated from a study of the *International Catalogue of Scientific Literature*, now unfortunately discontinued. In my opinion, more effort has gone into original work than into making knowledge accessible to the public in the sense of popularising it. The greatest improvement immediately needed in the technique of the biological sciences is a central, co-ordinated, well-organised means of making advances in knowledge due to research quickly, fully, and regularly accessible to the scientific clientele of the world. A movement in this direction is now under way under the supervision of the Union of the Biological Societies of America. The secretary of the committee in charge of the project for the *International Biological Abstracts* is Dr. J. R. Schramm, National Research Council, 1701 Massachusetts Avenue, Washington, D.C.

2. (a) The general interest of the public in the biological sciences and in zoology specifically has declined steadily in the past twenty years. This is partly due to the introduction of vocational courses in the schools and partly to the decline of interest in nature, which seems to be resulting from the development of machinery and electrical power, the development of the movies and other substitutes for the interest aroused by contact with nature. There has been a revival in the last two years of the publication of matters of scientific import due to the subsidised efforts of Science Service of the National Research Council, now controlled by a committee of the National Academy of Sciences.

(b<sup>1</sup>) The Press has consistently continued its distortion of scientific discoveries, due partly to the search for sensations, to propaganda and to the quality of the repertorial personnel of our metropolitan dailies. The work of Science Service is done in a measure to correct this distortion.

(b<sup>2</sup>) Assistance by the State has declined as a result of the pressure for economy due to increase of taxation. Scientific work generally supported by national and State appropriations has suffered, and is suffering severely, because of the restrictions upon funds available for research. The great growth in numbers of the student body due to the redistribution of wealth consequent upon the war has diverted funds from research to instruction and absorbed the time

of the teaching and researching staff in educational institutions, so that we face a reduction in the research product. Some industrial and other public and semi-public organisations, and a number of private individuals, are contributing to counteract loss of support for research, notably the Rockefeller Foundation, the Carnegie Institution, and various private donors.

(c) Commercial outlets and applications of the biological sciences are practically all absorbed in the medical profession and by agriculture and its affiliated industries. There is increasing demand for scientifically trained men and for the utilisation of industrial methods based upon science. Many industrial organisations, utilising products of the soil in the plant and animal world, are adopting the policy of employing specialists. This is true of the great co-operative farmers' associations, and of the canning industry, but is less true in medicine, since the social organisation of medicine is as yet wholly inadequate.

(d) The greatest difficulty at present visible is the uncertainty of employment, due to industrial changes. Men of the highest culture will not enter industrial professions in corporation service when their tenure of employment and continuity of research is uncertain.

3. (a) Specialists are recruited for zoological instruction and research from the graduates of the universities, rarely from any other source.

(b) During and for several years subsequent to the war it was exceedingly difficult to secure competent and qualified candidates owing to the drawing of men into the army and into industry. The rapid development of electrical power and its applications in industry has drawn off from the universities capable men of scientific taste, thus depleting the supply for research and instruction by the removal into industry of many men of great promise. It is therefore becoming more difficult at present to interest men of the highest type in the fields in which industrial outlook and scientific value combined lack the novelty and promise of the marvellous application of electrical power.

(c) The facilities for instruction in research in the biological sciences should be made on a par with those of other fields in our universities. When they lack equality in their personnel and equipment they are in a position of disadvantage.

(d) The economic condition of workers in the biological sciences is influenced by the standards of pay in medicine, in agriculture and in teaching. The higher incomes available in these fields constantly withdraw workers from the field of research in pure biology, because of the fact that salaries available in the fields of research are much less than those in the applied subjects as a general rule.

(e) Technical education of candidates for biological instruction and research is assured at present only by the awards of fellowships and scholarships sufficient to pay living expenses during the three or more years required for the attainment of a doctor's degree.

(f) The great increase in numbers in the universities in which graduate work is given has seriously taxed the available funds for the support of the institutions, with the result that the equipment and personnel for the training of graduates is inadequate, and there is substantial difficulty in obtaining suitable experimental equipment and material for support of this work.

4. (a) To answer this question adequately would require extensive treatment. There is distinct need for the endowment of publication of scientific journals duly vouched for by associations and by expert scientists. There is need of an endowment of the publications now carried on by the Wistar Institute for the biological societies of America. Publication of research work is at present in a very precarious condition in this country and elsewhere.

5. Foreign countries, notably England, France and Germany, have played an important part in the development of biological sciences. The smaller European countries have also assisted in proportion to their educational resources. The subsidising of research in Germany stimulated work elsewhere and exercised prior to the war a profound influence on the development of biological research in the United States. That influence is less to-day because of political conditions and also because of the rapid development of research institutions in the United States. The work of American institutions and of the institution with which I am connected is noted generally abroad. Nationalistic antagonisms and jealousies have in recent years profoundly affected the expressions of opinion in a regrettable way in some instances. There is a distinct tendency in certain German and British quarters to unnecessarily belittle and criticise American work.

6. (a) There is at present in the United States no comprehensive biological, bibliographic or abstracting service to keep biologists informed as to work in other countries. The project brought before the National Research Council by the Union of Biological Societies of America looks towards the establishment of a comprehensive abstracting journal.

(b) The *Zoological Record*, published by the Zoological Society of London since 1878, discontinued after 1922, and the *Zoologischer Anzeiger*, edited at Zurich, Switzerland, and published at Leipzig, are our sole bibliographic aids. Several incomplete abstracting agencies, such as the *Archiv für Naturgeschichte* and the *Zoologischer Bericht*, partially cover the field. We very much need a comprehensive abstracting journal covering all biological literature of the world co-ordinated by cross-referencing and indexing.

7. There are no formal relations between workers in zoology in the United States and those in other countries, or at least outside of the United States and Canada. The last International Zoological Congress was held prior to the war. It would be possible greatly to extend and improve these international relations.

8. In my opinion, the drift of biological investigation of the future must turn from the phenomena of morphology and attempts to interpret processes of heredity and the control of growth and evolution, which at present characterises the work of geneticists, to the field of biochemical analysis. The widespread interest in psychological phenomena will lead to fuller analysis of animal behaviour and the necessity for a sharper and clearer proof as to the relative parts which heredity and environment play in the physical and mental evolution of the race, and the development of the individual will, I believe, tend to extend and diversify research in the field of experimental evolution.

9. The state of public morality in our country acts upon progress and development of science only indirectly by the moral and physical breakdown of a few investigators, and by the social relations and freedom in which research investigation and their consequences are held by the public. The status of public morality determines to some extent the attention paid to, and the influence exerted by, findings of the biological sciences on matters of social import. A striking instance of this interrelation is seen in the distortion of the doctrine of natural selection by proponents of war as a necessary factor in human evolution, as for example, in the German school of military publicists. Labour leaders are at present keenly watchful of the drift of research bearing on factors of human heredity, especially as it affects the ideas of the public as to the status of classes in society and the possibility or not of improvement by environmental forces. There are in some quarters among radical leaders tendencies to decry



and credit the trend of evidence as to the factor of heredity in man as developed by the modern study of genetics.

Charles O. KOFOID,  
*Professor of Zoology.*

Department of Zoology, University of California,  
Berkeley, California.

July 5th, 1923.

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### MEDICINE.

The field in which the writer's interests and activities as Director of the Rockefeller Institute for Medical Research are largely centred may be designated biological research as related to medicine. In this wide field, marked everywhere by an intense intellectual activity, which found its early inspiration in the outlooks opened by Pasteur in showing the significance of lowly forms of life, and to which the remarkable triumphs of research in physics and chemistry have so largely contributed, one may perhaps wisely select as the dominant change during the past decade the growing conviction of the unity of science and the closer approach in aim and co-operation of the various phases of research.

Physics and chemistry are going forward hand in hand. It is now clear to biologists that physical and chemical processes in large measure underlie and sway the manifestations of life. And while this wider conception of the field of biological research is not new, the firmer foothold which it has gained in the purlieus of the laboratory and of practical medicine serves to signalise this period of intellectual activity.

This heartening condition is not due to new methods or to the influence of public opinion, but apparently to the natural development of knowledge and the growth of the scientific spirit which in so many phases of research found new impulses at the close of the last and the beginning of the new century. If this scientific spirit can be fostered and the devotees to science will hold in view as a subsidiary though an important factor in their work the education of the public in their inspirations, aims and achievements, progress along the present fruitful and promising lines may be confidently anticipated.

Research in biology as related to medicine seems to be deserving and receiving more and more attention among the educated classes, and this tendency will be the more likely to continue in proportion as the accomplishments of research are of intrinsic importance and receive popular exposition at the hands of its devotees. At present, popular exposition lags far behind scientific achievement.

The present interest in medical research is indicated by the vast number of articles relating to it in current publications, by the increasing number of legislative appropriations for the purposes of health organisations and special researches, by gifts, prizes and endowments by private individuals for various phases of investigation.

If the saving of human life can be reckoned in dollars, the researches in biology relating to disease prevention and cure are each year of almost incalculable value to the world. If for no other reason, there is need for more and ever more support of such research as relates to medicine and to the fundamental disciplines of physics and chemistry which seem destined to play so dominant a role in the future conceptions of the nature of life and its processes.

The recruits for the devotees to biological research come largely from the Universities, and, in spite of the few exceptions in the case of the larger endowments, the careers which these phases of research offer are sorely handicapped by the prospect of poverty which must be faced

unless support is won by large sacrifice of time and energy in the subsidiary profession of teaching. This difficulty can be in a measure overcome by adequate endowment of research, and its conduct under the supervision of leaders of experience, wide vision and trained sagacity. With few exceptions the career of workers in these branches of research is one of continued self-sacrifice without provision for adequate family support or for old age.

It is becoming more difficult to secure competent devotees to research in these lines in part because of the enticements of business and scientific careers under the auspices of industrial institutions. Thus it is that the economic condition of workers in this branch in the universities where they are most largely engaged, as well as of those engaged in independent investigations, is likely to be unsatisfactory. The technical education required for such pursuits varies so largely with the various disciplines that no definite statement can be made as to necessary requirements. There is less difficulty in obtaining instruments and materials for work than competent men to use them.

The most active organisations in these phases of research in biology as related to medicine are the universities, the medical schools, the federal services, a few large industrial establishments and a few endowed organisations. Under these auspices the work is carried on with varying degrees of efficiency, in some places with abundant resources, in others with very meagre support. There is perhaps a sufficient number of organisations supporting such work, but nearly all need more endowment and more men.

Similar phases of work pursued in other lands are large contributors to the results aimed at in these phases of research, and are stimulating and helpful to us as is our work to them. My sources of information concerning the work both in this country and abroad are publications and personal acquaintance with a large number of the workers.

There are no more relations between workers in this special branch in this country and between them and similar workers abroad than exist in several phases of science, and these are maintained through publications and personal intercourse. Such relations, of course, might be extended, and possibly improved; but it seems doubtful whether an international organisation would at this time be useful.

It is impossible to forecast very definitely what lines of work in these branches are likely to receive special attention in the immediate future, but the outlook would seem to indicate a closer and closer affiliation of the physical and biological sciences with all the varied lines of pursuit which this involves.

Simon FLEXNER,

*Director, Rockefeller Institute for Medical Research.*

Rockefeller Institute for Medical Research, New York.

November 8th, 1923.

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## ENGINEERING.

1. Many important changes and developments have taken place in electrical engineering in the last ten years or so; for instance, in electrical communication, radio and long-distance telephone; in electrical transportation; in illumination; in long high-voltage electric power lines; in the development of electrical theory and in research.

These developments are largely due to the increase in knowledge of, and improved application of, electrical principles rather than in development of new methods. Further progress

can be measured by the continuation of the scientific method and the analysis of needs of industry and for promoting the comfort and well-being of the individual. Most of the work is original rather than popular, and is dependent upon the great intellectual growth in scientific circles. Progress will continue as long as intellectual men emphasise the value of scientific research.

2. The public is taking an increasing interest in these developments, particularly with reference to betterment and increasing use of artificial illumination, the educational and industrial effects of better communication, and the labour-saving aspects of a more widespread use of electric power. This increase in interest is expressed in all the ways named in the questionnaire, *i.e.*, through the Press, financial assistance by public bodies and by private individuals, scholarships, endowments for general engineering education, and the large amounts being appropriated for research. The most noticeable commercial result is the seemingly unbounded expansion of electrical engineering industries of all sound types.

3. Specialists are recruited in general through the engineering schools and the graduate schools of Universities. While attendance is growing as a general average, yet statistics showing estimates of the need for men capable of engineering leadership indicate that the attendance at engineering schools is yet too small.

In order to improve this situation it is necessary to draw the attention of the public and of men prominent in the industries more fully to the situation, and to provide for the education of all those who can derive advantage therefrom. This applies especially to education for those naturally qualified for responsible positions in the industrial world where scientific applications are of notable importance.

The economic conditions are fair, but it appears that the communities must be prepared to offer more adequate rewards to men capable of creative work. The technical education of such men under present conditions is assured by the increasing endowments of the engineering schools and by the greater opportunities in prospect for good technical men. There is still difficulty in financing research and in providing adequate compensation for teachers to meet the present scale of costs.

4. The most active organisations are the schools and colleges, the scientific and engineering societies and the technical press. Recently there have been organised very important co-operating committees of educators and industrialists, which are carrying on important studies of technical education for the industries and of the promise of research to the industries.

The resources of the educational institutions are not adequate, largely on account of the recent increase in costs over pre-war costs. This is particularly true in respect to instructing staff. The result may be an ultimate loss of morale. No greater injury on account of the war can be imagined than the levelling down of the intellectual classes. It is difficult to see future progress if educators should suffer from lack of morale and equitable compensation or lack of respect in the communities of which they are a part.

The most important associations related to electrical engineering in the United States are the American Institute of Electrical Engineers, the Institute of Radio Engineers, the Illuminating Engineering Society, and the American Physical Society. Each supports a valuable journal, and all are fairly prosperous. The Engineering Division of the National Research Council is a valuable instrumentality with great potential possibilities, which have not yet been brought out fully, on account of its youth.

5. There is a mutual influence in the part played by the work here and abroad. This is brought about largely through the scientific and technical journals and by an interchange of visits. The latter could be increased to the advantage of all countries.

6. The sources of information are largely the technical press and the reports of engineering and scientific societies and the educational institutions. It would help considerably to have

a wider dissemination of the progress being made in technical education and in the means for selection of those who should receive additional educational advantages.

7. There is very little co-operation with the educators of other countries except by exchange professorships and scholarships and more or less chance contacts of individuals. These relations might well be considerably extended. Arrangements for exchange of students and exchange of professorships can be greatly enlarged with advantage. It would appear advantageous to have an international organisation for engineering education composed of industrialists and educators from the various nations. This perhaps could be accomplished through the Board of Investigation and co-ordination of the Society for the Promotion of Engineering Education, which will soon turn its attention to a comparative study of European and American professional engineering education.

8. Every fundamental discovery relating to electricity and magnetism and many of the new discoveries in other branches of physics and chemistry contribute to develop and widen the scope of electrical engineering. It is difficult to foresee or foretell what developments may occur. Also, new methods will be devised for the selection of men capable of benefit from scientific education, which will in return react favourably on improvement in industrial management and processes. The new developments will also include better methods of teaching engineering, research, economics and management. As our present type of civilisation is supported on a foundation of ready transportation of persons and goods, and rapid interchange of intelligence, broad developments in these fields may be expected.

9. The state of public morality affects engineering education very materially, inasmuch as the higher education is building for the future, whereas a low state of public morality is concerned largely with the present. The engineering profession requires integrity, courage, and a consideration for the comfort and well-being of the community. It therefore exercises a beneficial influence on municipal, state and public affairs, and can be most serviceable only in communities of high type. Engineering promotes the co-operative spirit, which cannot well exist in a low stage of public morality. Engineering education may concern itself more and more in the future with economics, with able and honest management, and with the development and equitable distribution of natural resources of raw materials and power.

Dugald C. JACKSON,

*Head of Department of Electrical Engineering.*

Massachusetts Institute of Technology, Cambridge, Mass.

November 28th, 1923.

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## GEOLOGY.

1. The war induced significant changes of attitude among workers in the scientific branches in which I am specially interested. All endeavours were naturally directed toward the objective of efficiency. Efforts were made by the writer to concentrate upon applications of geological science to immediately effective ends, and to increase the amount of instruction in the science as given in the engineering schools of the country. The stimulus of the war has now been removed, but much of the tendency to devote effort to applicative science remains — much more than is good for the country or for the science. There is, however, a very obvious

effort amongst the more competent intellectual workers in the science to seek out and apply the broadly intellectual and educative aspects of this department of knowledge. Not as much original work is going on at the present time except for applicative ends. Much of the writing now done is based upon unconscious assimilation of knowledge already on record.

2. The public seems to take an increased interest, in so far as this interest is popularly expressed by scientific writers who know how to catch the story in scientific matter which has genuine news interest. The State is less generous than formerly toward official investigations in science. This is doubtless due to the fact that the public is half-blind and legislative bodies are only semi-conscious of their duties to the State. In the judgment of the writer, scholarships, prizes and various foundations for students are not helpful and encourage only a dependence which weakens individual initiative. As before intimated, commercial success from scientific endeavour is at the present time very great, but this success does not magnify the intellectual or moral standing of the people engaged upon it, and consequently does not help the standing of the State itself in these regards. Special facilities for, or difficulties in, production and sale ought to be of indifference to the genuine devotee of science, and are to the writer.

3. There is a notable difficulty in recruiting specialists for our work, and this seems to be due to the fact that the science is not assuring the financial return that can be had from other intellectual occupations. It is obvious, also, that young men entering science think first of bread and meat, and only in a secondary degree of the science itself and its possibilities for intellectual and moral improvement.

4. The most active organisations in the writer's lines of scientific investigation are two, both of them well maintained and in a healthy condition. These are the Geological Society of America and the Palæontological Society.

5. At the present time the Continental academies and societies that are still maintaining their publications are affording an essential assistance to the work done here by the better class of workers. It is believed that this same class of workers, which is a small percentage of the total, have respect and influence amongst their colleagues in other countries.

6. The writer is a member of a large number of scientific societies, both in the United States and the rest of the world, and comes into contact with a large percentage of all that is published on the science. Time would not permit him to be more fully informed than he can be from the literature that comes to his desk. One very needful accessory is a general question box on scientific information, by means of which large expenditure of time might be saved by more direct action. Such a Research Information Service is maintained by the National Research Council, but the writer's present experience with it is that when he asks a question of this Service he is referred back by the Service to himself as the quoted authority upon it.

7. The relations between workers generally in this country to those abroad are, on the whole, remote. So many American workers are engaged upon local problems, especially those which are in the employ of the separate States, that their interest does not extend far beyond the reach of their activities. A considerable number of these men would hardly be competent to comprehend scientific problems as worked out in other countries and expressed in other languages. International relations could only be depended upon as helpful in the science as they are developed out of the universities. Regarding the enquiry as to whether an international organisation is possible, I may say there has been an International Geological Congress in existence for more than 30 years, and that this Congress held its last session in 1922.

8. The developments of geological work and, to some measure also, palæontologic work, will be along applicative lines directed toward the increase of wealth — at least this will be the case for the immediate future. In palæontology, however, there is a very distinct trend toward the interpretation of present human activities — spiritual, intellectual and physical, in terms of the history of life upon the earth; and this is the most important and outstanding promise in this science and perhaps in any science.

9. Salvation is of the few. Scientific investigations having purely intellectual value will proceed regardless of the condition, interests or influence of the masses.

John M. CLARKE,

*State Geologist and Director of Science, State of New York.*

Albany, N.Y.

July 5th, 1923.

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## GEOGRAPHY.

Within the last ten years, there has been a remarkable awakening of interest in this country in all studies which pertain to geography. I think this represents a broadening of the interests of American people. We have come to a time in our history when our interests in the affairs of other countries is becoming more keen. Within the last few years many of the universities and colleges that heretofore had never recognised geography have added this subject to their curricula. I have been asked, since establishing a Graduate School of Geography here at Clark University, by at least fifteen different universities and colleges in this country for specialists in geography to be appointed to their respective faculties. The calls come from States that are scattered from the Atlantic to the Pacific. To-day many of our leading universities, and many of our colleges for men and for women, have Departments of Geography, or are offering courses in geography, in connection with the Departments of Geology or Economics.

The teaching of geography and the study of geography in this country are closely related to the study and teaching of history and economics.

There is a special interest in regional geography, and we are organising our study of this subject around the natural geographic regions of the world. This, we believe, will lead to a scientific understanding of geography. When we take up the study of an individual country, or political unit, we recognise the natural geographic subdivisions of that country—as, in Switzerland or France there are the mountain areas, the plateaus; and in France some distinct lowland areas. In each one of those natural geographic regions we recognise the importance of the climatic factors and the economic factors, as well as the physical features, as environmental factors influencing the life of the people in that section. Our studies, therefore, are tending directly toward the human geography—that is, an understanding of the life and activities of the people in the different parts of the world.

There is much appreciation on the part of the public in this movement. We find the newspapers, the magazines, and prominent public officials putting emphasis upon our knowledge, or the need of knowledge, of the other parts of the world. As yet there are not many special scholarships or prizes to support the study of geography; but at each of the universities graduate students may receive scholarships, and in many cases fellowships, which provide, in addition to free tuition, a few hundred dollars as stipends to assist them in carrying on their studies for higher degrees.

Our students, who become well trained in the subject, usually secure positions which start them in at teaching, or at work in Governmental departments, that yield salaries from two thousand dollars a year upwards. Some of them work in summer schools and add something to their income. The geographers in this country are receiving salaries that range up to five thousand dollars a year ; and the few who have gone into commercial work as advisers are reported to be receiving as high as ten thousand dollars a year in connection with our foreign trade enterprises.

There are published in this country the *National Geographic Magazine*, the *Geographical Review*, and the *Journal of Geography*. Plans are under way for the publication of a special journal on economic and commercial geography. I think each one of the journals is adequately provided for in resources.

Through our library we plan to keep in touch with whatever is going on in geography in the leading countries of Western Europe, and the more distant countries of the world where original work is being done in geography.

It is my hope to have here at Clark a visiting professor from one of the European universities, and I have extended an invitation to Dr. J. F. Niermeyer, of the University of Utrecht, for the year 1924-25. I hope to follow this with invitations to other leading geographers of Europe, who will come to spend a year with us here in this country. Several British geographers and several French geographers have been in this country as exchange professors.

Our ambition as geographers may, I think, be justly characterised as an ambition to establish good will between the various peoples of the world. We believe that a better understanding of the actual conditions under which the different peoples are living will lead to more intelligent sympathy between the peoples of the world. Our educational ideals are therefore towards co-operation between the nations of the world, and the breaking down of the spirit of isolation and complete independence.

Wallace A. Atwood,  
*President of Clark University.*

Clark University, Worcester, Mass.  
August 17th, 1923.

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## ARCHÆOLOGY.

1 and 2. The field of research in which I am engaged comprises the entire Near East, including Persia. The war has naturally attracted a great deal of attention to this region, and, although the cost of research has increased enormously along with the increase in general expenses involved, such work is now receiving greatly increased support, both financially and morally. This increased support constitutes a real change in the whole situation, and involved at once contact with the changed situation in the Near East.

The relationship between Oriental archæology and general intellectual work in the United States is regrettably slight. Our American historians pay but very scanty attention to the results of archæology. The fact that archæological research enables us to trace the evolutionary development of the human career for several hundred thousand years from the earliest discernible beginnings of man's existence down to the modern history of Europe — this fact is very largely ignored, and we have had in the United States a revival of the most ignorant prejudices against this fundamental fact that the human career has been a vast evolutionary process reaching back to the lower animals. The legislatures of several States have very nearly passed

laws prohibiting the teaching of evolution in all schools supported by public funds. In the southern States many educational institutions supported by private funds maintain the most rigid exclusion of all such teaching, and dismiss without mercy young and progressive teachers who even use the word evolution. This is a state of affairs which is doubtless little known in Europe, and is, of course, due to the unripe and undeveloped stage of civilisation in the United States; but it is a very serious situation and one which ought to receive the attention of the best minds among us.

I am glad to state that a very creditable amount of work in the fields of Oriental research in the United States is original work, and is not merely the repetition of facts long since established. We have a considerable group of investigators, especially in Babylonian, Assyrian and Egyptian civilisation, and their number is growing.

Since the discovery of the tomb of Tutankhamen, the public interest in such work has been phenomenal; there has never been anything like it. This interest is expressed in the large amount of space devoted to Oriental research in the newspapers. It cannot be said that State support of any kind has ever been granted to such work, but the support contributed by private individuals is increasing, and our great financial foundations are for the first time appropriating a share of their funds toward such work. I regret to say that incentives such as scholarships and prizes are not available. The commercial success attending such work hardly plays any part in the situation. We who are engaged in it do it for the love of it. Personally, I might mention the fact that I have never been more surprised than by the enormous sale of an ancient history (called *Ancient Times*) which I wrote for the American schools and which, for the first time in such a book, places the Orient in proper perspective behind the classical world. This book, together with two abridgements for shorter courses, is selling at the rate of over one hundred thousand copies a year. This may be termed a commercial success, but it is likewise an indication of public interest in some degree offsetting the ignorant prejudices against any teaching of evolutionary development. For *Ancient Times* distinctly presents the human career as an evolutionary process.

In the production and sale of strictly technical researches our field of work is confronted by serious financial limitations. A great deal of our publication consists of the original documents themselves, especially in Cuneiform and Egyptian. The demand for such documents is necessarily confined to the great libraries and a few well-to-do individuals. Such works are usually printed in an edition of not more than five hundred and often only two hundred and fifty copies, necessarily sold at very high prices. These books cannot be printed at all without a subvention from some individual or institution. It has been, heretofore, very difficult to secure this financial support. The recently founded Oriental Institute of the University of Chicago hopes to be able to command a substantial fund for such publications.

3. We find it very difficult to secure young people of ability for our various branches of research. The difficulty is that, after we have given them sufficient training, the number of posts available is so small that we cannot secure sufficient support for such young recruits. Not infrequently we turn young men and women of promise away from such work as we cannot assure them positions after they have finished university preparation. The Oriental Institute of the University of Chicago has created a few posts which are now all filled with promising young men and women, but the salaries paid are very small and the financial situation of these young scholars is not enviable. It is evident that, in order to improve this situation, our educational institutions should have impressed upon them the importance of the study of the human career and the fundamental place in such study occupied by Oriental research.

4. In Oriental research (and I speak chiefly of the Near Orient) the outstanding organisations are the American Oriental Society, the Archæological Institute of America, the Oriental Institute of the University of Chicago, the Boston Museum of Fine Arts (Egyptian Department),



the University Museum of Philadelphia, the Field Museum of Chicago, the American School of Archæological Research in Jerusalem, and the Oriental Departments in the Universities of Harvard, Yale, Pennsylvania, Johns Hopkins and Chicago. The work of these various agencies is published in a series of reviews, periodicals, and special volumes which annually form a large body of published material, but I have not the data at hand for inserting here a complete list, as I am writing at the moment away from my office and library.

These organisations carry on their work chiefly in two ways, first, by means of field expeditions to the Near East, notably those of the Metropolitan Museum, the Boston Museum of Fine Arts, the University Museum of Philadelphia, and the Oriental Institute of the University of Chicago. Second, by the exhaustive study and investigation of the original documents and monuments secured from their excavations, or already available in the Oriental collections of the Western World. This study takes place both in America and in foreign museums, and results in the publications already mentioned.

It cannot be said that any one of these organisations possesses sufficient resources for doing all that might be accomplished if they were financially better equipped, but it should be stated that they are much better supported than ever before, and that they command funds for their work which a few years ago would have been considered very generous. I do not know of any of them which may be said to be in a precarious condition. There should be three additional organisations not now available — one for the general organisation and conduct of research in Asia Minor ; a second for the same kind of work in Syria ; and a third for such work in Babylonia and Assyria. It may be mentioned at this point that the work in Palestine is conducted by an American School of Archæological Research at Jerusalem, which, however, although about to be housed in its own building, suffers from very insufficient support, and should be much more liberally endowed. Indeed, this school has at present no endowment at all.

5. In Oriental research the devastating effect of the war is obviously very much more seriously felt by countries outside of America than by America itself. Before the war, Germany played a very important rôle in the archæological work in the Near East. It had large expeditions liberally supported in Egypt, in Babylonia, in Assyria, in Asia Minor, in Palestine and in Syria. All these have now, of course, disappeared. With the exception of Egypt and Palestine, no work which would in any degree replace the German expeditions has been launched in the Near East.

We American Orientalists have found the work of our European predecessors and present colleagues most inspiring and helpful. We have had great pleasure in sharing in the centenary celebration of the decipherment of Egyptian by Champollion and of the founding of the Société Asiatique at Paris, also of the centenary of the Royal Asiatic Society at London ; and we believe that participation in such celebrations, if they are not held at too short intervals, are of immense influence upon delegates coming from a young and still undeveloped civilisation like that of the United States.

Without too much self-satisfaction it may, perhaps, be stated that the work of American Orientalists has gained a recognised place abroad, and that their books and journals are found in all the leading centres of such research in Europe.

In the field of Near East research our most expeditious and useful channel of information was, before the war, the monthly journal published in German, known as the *Orientalistische Literatur-Zeitung*. A monthly journal is very much needed in this field, and it remains to be seen whether the German organisation will be sufficient in view of the difficulties under which it is produced. The only other organs in America and the rest of the world are published at long intervals, considerably delaying the transmission of information which should reach all of our Oriental scholars at once.

An international organisation of investigators in the field of Oriental studies already exists. It is commonly called The Entente, and comprises the leading Oriental societies of

the countries participating. These are : The Royal Asiatic Society, for Great Britain ; The Société Asiatique, for France ; The Società Orientale, for Italy, and the American Oriental Society, for the United States. Its relations are maintained by a permanent committee representative of the different organisations, and an international meeting is held at intervals of about three years.

It is difficult to foresee what developments may take place in our field of research. It is quite evident, however, that, unless the Turks and other similar disturbing influences in the Near East should prevent, there will be surprising revelations in Asia Minor, Syria, Assyria and Babylonia. The comparatively new line of work which is likely to result is a correlation of these different areas of research, and a larger synthesis of the lines of human development represented by the different civilisations of the Near East.

I do not think I can discern any influence of the state of public morality on the intellectual work going on in our field. Before the war there were some unwholesome elements in the rivalries between the different nations represented by their various expeditions in the Near East. I think such undesirable influences have now disappeared.

James H. BREASTED,  
*Professor of Archeology.*

The Oriental Institute, University of Chicago.  
August 13th, 1923.

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**Annex.**

EXTRACTS FROM A LETTER FROM DR. VERNON KELLOGG  
ON THE NATIONAL RESEARCH COUNCIL.

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1. . . . .

2. The international relationships of the National Research Council of the United States are represented by its adherence to the International Research Council and to the following Unions :

- International Geodetic and Geophysical Union,
- International Astronomical Union,
- International Mathematical Union,
- International Union of Scientific Radio-Telegraphy,
- International Union of Pure and Applied Chemistry,
- International Union of Pure and Applied Physics.

This Council also has under consideration at the present time adhering to the International Union of the Medical Sciences, but has recently decided not to adhere at present to the International Union for the Biological Sciences.

There being no unions as yet organised for the other fields of science, scientific interests of the United States in such fields as psychology, geology, engineering, anthropology, etc., are represented less formally through organisations of long standing for the holding of periodic international congresses in these fields.

The means provided for international relations in scientific matters ought to be utilised much more extensively than they have been, especially by participation in these international congresses on the part of a much larger number of scientific men from the United States than have thus far been able to attend. This is, however, really an internal problem for this country itself to solve in providing funds for the travel expenses of larger delegations of representatives upon these important international scientific occasions.

3. While it is believed that much more money than is now being expended in scientific work could be spent advantageously in such work, the funds which the National Research Council has at its disposal are sufficient to permit the Council to carry its main purposes forward progressively. As the work of the Council grows, it is believed that additional funds can be obtained with which to support its increased work.

The fundamental condition responsible for the status and support of scientific work is appreciation of its value on the part of the public. It is believed that this appreciation is growing in the United States, it having gained a great stimulus during the war. Large manufacturing concerns, notably in chemical and electrical engineering, are maintaining their own research establishments, some of which have made important fundamental as well as innumerable technical contributions. Outside of manufacturing circles, the direct benefits coming from intelligent agriculture seem, in this country, to be the most forceful means for impressing people at large with the value of scientific work.

The Federal Congress and the State legislatures, as a rule, are ready to appropriate large sums for agricultural advancement. Public money is also appropriated for public health work,

but perhaps somewhat less readily, possibly because a financial return or profit is less apparent than from the investment of money in agricultural research and extensions. The more prosperous commonwealths of this country are ready also to spend vast sums of money on highway construction, but the importance of a certain amount of preliminary investigation in some cases has not been realised until too late. There is a general admiration among academic and technical circles for the recent advances in astronomy, and in knowledge of the constitution of the atom and of electrical radiation on the part of leading chemists and physicists. Altogether, while permitting of much greater development, the general attitude of public opinion in this country is favourable for the extension of appreciation of and support for scientific work.

Scientific men of the United States have numerous organisational facilities for liaison and for stimulus through the large number of existing societies, technical or limited, or of a more general nature. Over seventy of the more strictly research organisations are affiliated with the National Research Council through membership in an appropriate Division of the Council.

The present need in organisation is felt to be not so much for the further co-ordination of activities as for the organisation of existing knowledge and of information which is continuously being added. The establishing of efficient journals for the abstracting and indexing of current scientific literature in several fields which are not now provided with abstracting facilities is generally felt to be one of the most important contributions which this generation can make in the matter of the organisation of science.

4. The National Research Council, which was founded only in 1916, has made little change since that time in its original organisation and purposes. Numerous important undertakings are described in the annual reports of the Council. The largest of these, on the basis of money involved, and perhaps the most important when regarded in the light of a productive scientific investment, is the establishment, made possible by appropriations on the part of the Rockefeller Foundation and the General Education Board, of three series of post-doctorate fellowships in : (a) chemistry, physics and mathematics ; (b) the medical sciences ; and (c) the biological sciences, including zoology, botany, psychology and anthropology. Since the founding of these fellowships, 119 fellows have served on these appointments, of whom 86 are still under appointment. The stipends range from \$1,000 to \$3,000 per year. In addition to these, certain other special fellowships are administered by the Council.

5. No important changes of policy of this Council are expected in the near future.

6. In regard to the economic status of officials of the National Research Council, it has been the policy of the Council to maintain a salary basis about equal to that of the best American universities from which these officials, chairmen of divisions, etc., are usually drawn. According to this policy, the Council this year increased the salary of its several division chairmen who are in residence with the Council on full or part time to correspond to a similar gradual rise in the academic salary scale during recent years.

The chairmen of divisions serve the Council usually for a year at a time, while on leave of absence from their institutions on a sabbatical or special basis. To provide for continuity of administration a permanent secretariat is maintained, and each division of the Council is, moreover, under the directorate of the body of its members, a slowly changing group of from twenty to forty persons, the majority of whom are representatives of related technical societies.

Vernon KELLOGG,

*Permanent Secretary, National Research Council.*

National Research Council, Washington.

December 27th, 1923..

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