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CONTENTS

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THE EVOLUTION OF BOTANICAL RESEARCH[1]

A meeting of the American Association in St. Louis is of special interest to botanists. When this city was little more than a frontier town, Dr. George Englemann became one of its citizens. In spite of his duties as a successful physician, he became one of our greatest botanists. In fact, in the days when taxonomy was practically the whole of botany, and our virgin flora was being explored, the great American trio of botanists was Asa Gray, of Cambridge, John Torrey, of New York, and George Englemann, of St. Louis. Englemann's distinction was that he published no general botanical works, but selected a series of the most difficult problems in taxonomy, and in a masterly way organized for us many perplexing groups. With these groups his name will always be associated. To a botanist, therefore, St. Louis means the home of George Englemann.

There is another association also for the botanist. St Louis is the home of one of our great botanical gardens, identified for those of us who are older with the name of Henry Shaw; but we are becoming accustomed to its later name, the Missouri Botanical Garden. Its plans and activities represent a fitting continuation of the spirit of Englemann and Shaw, adapted to the progress of botanical science.

In consequence of these associations, St. Louis may be said to have a botanical atmosphere, of which botanists are very conscious. We have the feeling, therefore, not of a visit, but of a home-coming.

A presidential address, delivered to a group composed of investigators representing all the sciences, and including also those interested

[1] Address of the president of the American Association for the Advancement of Science, St. Louis, December, 1919.

in science should deal with some interest common to all. In my judgment our common bond is interest in research; in fact, the major purpose of this association is to stimulate research by the personal contact of investigators. In selecting as my subject, therefore, the evolution of botanical research, I am assuming that the situation developed may apply in a general way to all scientific research.

My purpose is not to outline the history of botanical research, but rather to call attention to certain evolutionary tendencies and to project them into the future. We are all familiar with the gradual historical development of different phases of botany, until botanists became segregated into many distinct groups, the only common bond being the use of plants for investigation. This segregation was for a time very complete, so that the interests of one group would not have been affected if none of the other groups had existed. This monastic phase of botany has subsided somewhat, not for all individuals, but for the subject in general. The different groups are coming into contact and even interlocking, so that the science of botany bids fair to be recognized as an increasing synthesis, rather than an increasing disintegration. In connection with these gradual evolutionary changes, I wish to emphasize three tendencies which seem to me to be significant. As in all evolutionary progress, the tendencies may seem numerous, but the three I have selected seem to me to be especially prophetic of a new era of botanical research.

1. One of the growing tendencies of botanical research is to attack problems that are fundamental in connection with some important practise. The outstanding illustration, of course, is the increasing attention given to the problems that underlie agriculture; but there are many other practises also which are bedded in botanical investigation. We all realize that this tendency was stimulated by the war; in fact, this has been the experience of all the sciences, more notable perhaps in the case of physics and chemistry than in the other sciences, but a very obvious general result. This tendency is so strong at present, that I do not believe it will ever subside, but it should be understood. There is no evidence that it is tending to diminish research whose sole purpose is to extend the boundaries of knowledge, which all of us must agree is the great objective of research. It merely means that experience developed in connection with an important practise has suggested fundamental problems, whose solution is just as important in extending the boundaries of knowledge as in illuminating some practise. In fact, among our most fundamental problems are those that have been suggested by experience. The injection of such problems among those not related to general experience is not to the detriment of the latter, but simply extends the range of research.

I have no sympathy with the artificial segregation of science into pure and applied science. All science is one. Pure science is often immensely practical; applied science is often very pure science; and between the two there is no dividing line. They are like the end members of a long and intergrading series; very distinct in their isolated and extreme expression, but completely connected. If distinction must be expressed in terms where no sharp distinction exists, it may be expressed by the terms fundamental and superficial. They are terms of comparison and admit of every intergrade. The series may move in either direction, but its end members must always hold the same relative positions. The first stimulus may be our need, and a superficial science meets it, but in so doing it may put us on the trail that leads to the fundamental things of science. On the other hand, the fundamentals may be gripped first, and only later find some superficial expression. The series is often attacked first in some intermediate region, and probably most of the research in pure science may be so placed; that is, it is relatively fundamental, but it is also relatively superficial. The real progress of science is away from the superficial, toward the fundamental, and the more fundamental are the results, the more extensive may be their superficial expression.

Not only are practical problems not a detriment to botanical science, but inciden-

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tally they strengthen its claim on public interest as a science that must be promoted. As an incidental result, I look with confidence to a future of far greater opportunity for research than has been possible heretofore, research which must be increasingly fundamental and varied. Even if this were not true, my creed for science is that while its first great mission is to extend the boundaries of knowledge, that man may live in an ever-widening horizon, its second mission is to apply this knowledge to the service of man, that his life may be fuller of opportunity. From the standpoint of science, the second may be regarded as incidental to the first, but it is a very important incident, and really stimulates research. In short, I regard this so-called practical tendency in research as being entirely in the interest of research in general, in increasing the range of fundamental problems, in contributing a powerful stimulus, and in securing general recognition of the importance of research.

2. A second tendency, which I regard as more important, is an increasing realization of the fact that botanical problems are synthetic. Until recently a problem would be attacked from a single point of view, with a single technique, and conclusions reached that seemed as rigid as laws from which there is no escape. In plant morphology, for example, and I speak from personal experience, we described structures, with no adequate conception of their functions. Plant physiologists, on the other hand, would describe functions, with no adequate knowledge of the structures involved; while ecologists often described responses, with no adequate knowledge of either structure or function. The same condition obtained in the other segregates of botany. We all recall the time when plant pathologists described and named pathogenic organisms and paid no attention to the disease, which of course is the physiological condition of the plant. In short, not only taxonomists, but all of us, were simply cataloguing facts in a kind of card index, unconsciously waiting for their coordination. This coordination has now begun, and is one of the strong tendencies which is certain to continue. The morphologist is beginning to think of the significance of the structure he is describing; the physiologist is beginning to examine the structures involved in the functions he is considering; and the ecologist realizes now that responses to environment which he has been cataloguing are to be interpreted only in terms of structure and function. In other words, around each bit of investigation, with its single point of view and single method of attack, there is developing a perspective of other points of view and other methods of attack.

This does not mean a multiple attack on each problem by each investigator. We must remain morphologists, physiologists, and ecologists, each group with its special technique and special kind of data. But it *does* mean a better estimation of the results, a watchful interest in the possibilities of other methods of attack, a general toning down of positiveness in conclusions. We all realize now that plants are synthetic, and that is quite a notable advance from that distant time when we thought of them only as objects subservient to laws of nomenclature. This increasing synthetic view is resulting in a proper estimate of problems. The data secured by each investigation constitute an invitation to further investigation. We have in mind the whole problem and not scraps of information. In short, the synthetic view has developed about our problems the atmosphere in which they actually exist.

3. A third tendency, which seems to me to be the most significant one, is the growing recognition of the fact that structures are not static, that is, inevitable to their last detail. As a morphologist, I may recall to your memory the old method of recording the facts in reference to the development of such a structure as the embryo of seed plants. Not only every cell division in the ontogeny was recorded, but also the planes of every cell division. The conception back of such records was that the program of ontogeny was fixed to its minutest detail. It is probably true that such a structure is about as uniform in its development as any structure can be; but it has become evident now that many of the details recorded were not significant. In-

stead of cataloguing them as of equal value, we must learn to distinguish those that are relatively fixed from those that are variables.

In the same way, much of the older work in anatomy must be regarded as records of details whose relative values were unknown. Even the structures involved in vascular anatomy are not static, but many a phylogenetic connection has been formulated on the conception of the absolute rigidity of such structures in their minutest detail. This conception has made it possible, of course, to develop as many static opinions as there are variables in structure.

Perhaps the greatest mass of details has been accumulated by the cytologists, in connection with their examination of the machinery of nuclear division and nuclear fusion. In no other field has the conception of the rigidity of the structures involved become more fixed, even to the minutest variation in form and position. Of course we all realize that any field of investigation must be opened up by recording all the facts obtained; but we must realize that this is only the preliminary stage. The time has come when even the recorded facts of cytology are being estimated on the basis of relative values; that is, the inevitable things are being differentiated from the variables.

The same situation is developing in the field of genetics. We all recall the original rigidity of the so-called laws of inheritance. It was natural to begin the cultivation of this field with the conception that the program of heredity is immutable, and that definite structures are inevitable, no matter what the conditions may be. There was probably more justification for this conception in this field, on the basis of the early investigations, than in any other, but experience has begun to enlarge the perspective wonderfully. The rapidly accumulating facts are becoming so various that consistent explanations require a high degree of mental agility. More fundamental, however, is the recognition of the fact that the problem of heredity involves not only germinal constitution, which gives such rigidity as there is, but also the numerous factors of environment. In other words, such problems have become synthetic in the highest degree, making possible results that are anything but static.

In considering these illustrations of the tendency to recognize that facts are not all pigeon-holed and of equal value, it is becoming more and more obvious that our botanical problems are in general the application of physics and chemistry to plants; that *laws*, when we really discover them, are by definition static, but that their operation results in anything but static structures. In other words, structure must respond to law, but the particular law that is gripping the situation may be one of many.

With such evolutionary tendencies in mind, what is the forecast for botanical research? I wish to call attention to three important features that seem certain to characterize it.

1. It will be necessary for the investigator who wishes to have a share in the progress of the science, rather than merely to continue the card catalogue assembling of random data, to have a broader botanical training than has seemed necessary heretofore. Our danger has been that the cultivation of a special technique, which of course is necessary, is apt to limit the horizon to the boundary of that technique. In some cases the result to the investigator has been more serious than limiting his horizon; it has led him to discredit other methods of attack as of little importance. In case this attitude is associated with the training of students, it is continued and multiplied by pedigree culture. The product of certain laboratories is recognized as of this type, and it is out of line with the evident direction of progress.

This demand of the future does not mean that one must specialize less than formerly. It is obvious that with the increasing intricacy of problems, and the inevitable development of technique, we must specialize more than ever. What the new demand means is not to specialize less, but to see to it that every specialty has developed about it a botanical perspective. In other words, instead of an investigator digging himself into a pit, he must do his work on a mountain top. This secures some understanding and appreciation of other special fields under cultivation, some of which will certainly interlock with his own field. To meet this situation will demand more careful attention to the training of investigators than it has received. Interested and even submerged in our own work, as we must be, still we must realize that the would-be investigator must develop his atmosphere as well as his technique, or he will remain medieval.

To be more concrete, the morphologist in the coming days must appreciate the relation that physiology and ecology hold to his own field. This is far from meaning that he must be trained in physiological and ecological investigation; but he must know its possibilities. The same statement applies in turn to the physiologist and ecologist, and so on through the whole list of specialties.

This first forecast of the future applies to the necessary training of investigators rather than to investigation itself.

2. A second important feature that is sure to be included in the botanical investigation of the future is cooperation in research. During the last few years the desirability of cooperation has been somewhat stressed, and perhaps the claims for it have been urged somewhat unduly. This was natural when we were desiring to secure important practical results as rapidly as possible. It opened up, however, the possibilities of the future. No one questions but that individual research, to contrast it with cooperative research, must continue to break the paths of our progress. Men of ideas and of initiative must continue to express themselves in their own way, or the science would come to resemble field cultivation rather than exploration. It is in this way that all our previous progress has been made. The new feature is that individual research will be increasingly supplemented by cooperative research. There are two situations in which cooperative research will play an important rôle.

The more important situation is the case of a problem whose solution obviously requires two or more kinds of special technique. There are many problems, for example, which a morphologist and a physiologist should attack in cooperation, because neither one of them alone could solve it. Two detached and unrelated papers would not meet the situation. Our literature is burdened with too many such contributions now. The one technique must be a continual check on the other during the progress of the investigation. This is a very simple illustration of what may be called team work. It is simply a practical application of our increasing realization of the fact that problems are often synthetic, and therefore involve a synthetic attack.

Another simple illustration may be suggested. If taxonomists and geneticists should work now and then in cooperation, the result might be either fewer species or more species; but in any event they would be better species. The experience of botanists can suggest many other useful couplings in the interest of better results. In the old days some of you will recall that we had investigations of soil bacteria unchecked by any work in chemistry; and side by side with this were investigations in soil chemistry unchecked by any work with soil bacteria.

Perhaps the most conspicuous illustration of discordant conclusions through lack of cooperation, so extreme that it may be called lack of coordination, may be found in the fascinating and baffling field of phylogeny. To assemble the whole plant kingdom, or at least a part of it, in evolutionary sequence has been the attempt of a considerable number of botanists, and no one of them, as yet, has taken into consideration even all the known facts. There is the paleobotanist who rightly stresses historical succession, with which of course any evolutionary sequence must be consistent, but who can not be sure of his identifications, and still less sure of the essential structures involved. History is desirable, but some real knowledge of the actors who make history is even more desirable.

Then there is the morphologist, who stresses similarity of structures, especially reproductive structures, and leaves out of sight not only accompanying structures but also historical succession.

Latest in the field is the anatomist, especially the vascular anatomist, who compares the vascular structures in their minutest detail, and loses sight of other important factors in any evolutionary succession.

Apparently no one, as yet, has taken all the results from all fields of investigation, and given us the result of the combination. In other words, in phylogeny, we have had single track minds. This has been necessary for the accumulation of facts, but unfortunate in reaching conclusions.

This is but a picture of botanical investigations in general as formerly conducted; and it seems obvious that cooperative research will become increasingly common as cooperation is found to be of advantage.

The second situation in which cooperative research will play an important rôle is less important than the first, but none the less real.

It must be obvious to most of us that our literature is crowded with the records of incompetent investigations. Not all who develop a technique are able to be independent investigators. They belong to the card catalogue class. They are not even able to select a suitable problem. We are too familiar with the dreary rehearsal of facts that have been told many times, the only new thing, perhaps, being the material used; and even then the result might have been foretold. It is unfortunate to waste technique and energy in this way; and the only way to utilize them is through cooperative research, for which there has been a competent initiative, and in the prosecution of which there has been a suitable assignment of parts. In my judgment this is the only way in which we can conserve the technique we are developing, and make it count for something. I grant that the product of such research is much like the product of a factory, but we may need the product.

In one way or another, cooperative research will supplement individual research. Individuals, as a rule, will be the pioneers; but all can not be pioneers. After exploration there comes cultivation, and much cultivation will be accomplished by cooperation.

3. The most important feature that will be developed in the botanical investigation of the future is experimental control. Having recognized that structures are not static, that programs of development are not fixed, that responses are innumerable, we are no longer satisfied with the statement that all sorts of variations in results occur. We must know just what condition produces a given result. This question as to causes of variable results first took the form of deduction. We tried to reason the thing out.

A conspicuous illustration of this situation may be obtained from the history of ecology. Concerned with the relation of plants to their environment, deductions became almost as numerous as investigators. Even when experimental work was begun, the results were still vague because of environment. Finally, it became evident that all the factors of environment must be subjected to rigid experimental control before definite conclusions could be reached.

What is true of ecology is true also of every phase of botanical research. For example, I happen to be concerned with materials that showed an occasional monocotyledonous embryo with two cotyledons, while most of the embryos were normal. The fact of course was important, for it connected up Monocotyledons and Dicotyledons in a very suggestive way, and also opened up the whole question of cotyledony. Important as the fact was, much more important was the cause of the fact. We could only infer that certain conditions might have resulted in a dicotyledonous embryo in a monocotyledon; but it was a very unsubstantial inference. That problem will never be solved until we learn to control the conditions and produce dicotyledonous embryos from Monocotyledons at will, or the reverse. Comparison and inference must be replaced by experimental control; just as in the history of organic evolution, the method shifted from comparison and inference to experimental control. It will be a slow evolution, and most of our conclusions will continue to be inferences, but these inferences will eventually be the basis of experiment. In fact, most of our conclusions are as yet marking time until a new technique enables us to move forward.

These illustrations from ecology and morphology represent simple situations as compared with the demands of cytology or genetics, but the same need of experimental control is a pressing one in those fields. The behavior of the complex mechanism of the cell is a matter of sight, followed by inference, when we know that invisible factors enter into the performance. How the cell program can ever be brought under experimental control remains to be seen, but we must realize that in the meantime we are seeing actors without understanding their action. In fact, we are not sure that we see the actors; the visible things may be simply a result of their action. The important thing is to keep in mind the necessary limitations of our knowledge, and not mistake inference for demonstration.

Even more baffling is the problem of adequate experimental control in genetics. We define genetics as breeding under rigid control, the inference being that by our methods we know just what is happening. The control is rigid enough in mating individuals, but the numerous events between the mating and the appearance of the progeny are as yet beyond the reach of control. We start a machine and leave it to its own guidance. The results of this performance, spoken of as under control, are so various, that many kinds of hypothetical factors are introduced as tentative explanations. There is no question but that this is the best that can be done at present; but it ought to be realized that as yet no real experimental control of the performance has been devised. The initial control, followed by inferences, has developed a wonderful perspective, but a method of continuous control is yet to come.

Having considered the conspicuous evolutionary tendencies of botanical research and their projection into the future, it remains to consider the possible means of stimulating progress. It will not be accomplished by increasing publication. It is probably our unanimous judgment that there is too much publication at the present time. What we need is not an increasing number of papers, but a larger percentage of significant papers. This goes back to the selection of problems, assuming that training is sufficient. A leader is expected to select his own problems, but we are training an increasing army of investigators, and the percentage of leaders is growing noticeably less. There ought to be some method by which botanists shall agree upon the significant problems at any given time, in the various fields of activity, so that such advice might be available. It is certainly needed.

I realize that our impulse has been to treat a desirable problem as private property, upon which no trespassing is allowed. Of course, common courtesy allows an investigator to work without competition; but the desirable problems are still more numerous than the investigators; and we must use all of our investigative training and energy in doing the most desirable things. There need be no fear of exhausting problems, for every good problem solved is usually the progenitor of a brood of problems. We will never multiply investigators as fast as our investigations multiply problems. In the interest of science, therefore, we should pool our judgment, and indicate to those who need it the hopeful directions of progress.

Not only is there dissipation of time and energy in the random selection of problems, but there is also wastage in investigative ability. Every competent investigator should have the opportunity to investigate. The pressure of duties that too often submerge those trained to investigate is a tremendous brake upon our progress. I am not prepared to suggest a method of meeting this situation, but the scientific fraternity, in some way, should press the point that one who is able to investigate should have both time and opportunity. A university regulation, with which we are all too familiar, which requires approximately the same hours of all of its staff, whether they are investigators or not, should be regarded as medieval.

In conclusion, speaking not merely for botanical research, but for all scientific research, it has now advanced to a stage which promises unusually rapid development. The experience of the recent years has brought science into the foreground as a great national asset. It should be one of the functions of this great association to see to it that full advantage is taken of the opportunity offered by the present evolutionary stage of research and public esteem. We must choose between inertia and some display of aggressive energy.

John M. Coulter
University of Chicago

TIME, SPACE, AND GRAVITATION[1]

After the lamentable breach in the former international relations existing among men of science, it is with joy and gratefulness that I accept this opportunity of communication with English astronomers and physicists. It was in accordance with the high and proud tradition of English science that English scientific men should have given their time and labor, and that English institutions should have provided the material means, to test a theory that had been completed and published in the country of their enemies in the midst of war. Although investigation of the influence of the solar gravitational field on rays of light is a purely objective matter, I am none the less very glad to express my personal thanks to my English colleagues in this branch of science; for without their aid I should not have obtained proof of the most vital deduction from my theory.

There are several kinds of theory in physics. Most of them are constructive. These attempt to build a picture of complex phenomena out of some relatively simple proposition. The kinetic theory of gases, for instance, attempts to refer to molecular movement the mechanical thermal, and diffusional properties of gases. When we say that we understand a group of natural phenomena, we mean that we have found a constructive theory which embraces them.

THEORIES OF PRINCIPLE

But in addition to this most weighty group of theories, there is another group consisting of what I call theories of principle. These employ the analytic, not the synthetic method. Their starting-point and foundation are not hypothetical constituents, but empirically observed general properties of phenomena, principles from which mathematical formulæ are deduced of such a kind that they apply to every case which presents itself. Thermodynamics, for instance, starting from the fact that perpetual motion never occurs in ordinary experience, attempts to deduce from this, by analytic processes, a theory which will apply in every case. The merit of constructive theories is their comprehensiveness, adaptability, and clarity, that of the theories of principle, their logical perfection, and the security of their foundation.

The theory of relativity is a theory of principle. To understand it, the principles on which it rests must be grasped. But before stating these it is necessary to point out that the theory of relativity is like a house with two separate stories, the special relativity theory and the general theory of relativity.

Since the time of the ancient Greeks it has been well known that in describing the motion of a body we must refer to another body. The motion of a railway train is described with reference to the ground, of a planet with reference to the total assemblage of visible fixed stars. In physics the bodies to which motions are spatially referred are termed systems of coordinates. The laws of mechanics of Galileo and Newton can be formulated only by using a system of coordinates.

The state of motion of a system of coordinates can not be chosen arbitrarily if the laws of mechanics are to hold good (it must be free from twisting and from acceleration). The system of coordinates employed in mechanics is called an inertia-system. The state of motion of an inertia-system, so far as mechanics are concerned, is not restricted by nature to one condition. The condition in the following proposition suffices: a system of coordinates moving in the same direction and at the same rate as a system of inertia is itself a system of inertia. The special relativity theory is therefore the application of the following proposition to any natural process: "Every law of nature which holds good with respect to a coordinate system K must also hold good for any other system K' provided

[1] From the London *Times*.

that K and K' are in uniform movement of translation."

The second principle on which the special relativity theory rests is that of the constancy of the velocity of light in a vacuum. Light in a vacuum has a definite and constant velocity, independent of the velocity of its source. Physicists owe their confidence in this proposition to the Maxwell-Lorentz theory of electro-dynamics.

The two principles which I have mentioned have received strong experimental confirmation, but do not seem to be logically compatible. The special relativity theory achieved their logical reconciliation by making a change in kinematics, that is to say, in the doctrine of the physical laws of space and time. It became evident that a statement of the coincidence of two events could have a meaning only in connection with a system of coordinates, that the mass of bodies and the rate of movement of clocks must depend on their state of motion with regard to the coordinates.

THE OLDER PHYSICS

But the older physics, including the laws of motion of Galileo and Newton, clashed with the relativistic kinematics that I have indicated. The latter gave origin to certain generalized mathematical conditions with which the laws of nature would have to conform if the two fundamental principles were compatible. Physics had to be modified. The most notable change was a new law of motion for (very rapidly) moving mass-points, and this soon came to be verified in the case of electrically-laden particles. The most important result of the special relativity system concerned the inert mass of a material system. It became evident that the inertia of such a system must depend on its energy-content, so that we were driven to the conception that inert mass was nothing else than latent energy. The doctrine of the conservation of mass lost its independence and became merged in the doctrine of conservation of energy.

The special relativity theory which was simply a systematic extension of the electro-dynamics of Maxwell and Lorentz, had consequences which reached beyond itself. Must the independence of physical laws with regard to a system of coordinates be limited to systems of coordinates in uniform movement of translation with regard to one another? What has nature to do with the coordinate systems that we propose and with their motions? Although it may be necessary for our descriptions of nature to employ systems of coordinates that we have selected arbitrarily, the choice should not be limited in any way so far as their state of motion is concerned. (General theory of relativity.) The application of this general theory of relativity was found to be in conflict with a well-known experiment, according to which it appeared that the weight and the inertia of a body depended on the same constants (identity of inert and heavy masses). Consider the case of a system of coordinates which is conceived as being in stable rotation relative to a system of inertia in the Newtonian sense. The forces which, relatively to this system, are centrifugal must, in the Newtonian sense, be attributed to inertia. But these centrifugal forces are, like gravitation, proportional to the mass of the bodies. It is not, then, possible to regard the system of coordinates as at rest, and the centrifugal forces of gravitational? The interpretation seemed obvious, but classical mechanics forbade it.

This slight sketch indicates how a generalized theory of relativity must include the laws of gravitation, and actual pursuit of the conception has justified the hope. But the way was harder than was expected, because it contradicted Euclidian geometry. In other words, the laws according to which material bodies are arranged in space do not exactly agree with the laws of space prescribed by the Euclidian geometry of solids. This is what is meant by the phrase "a warp in space." The fundamental concepts "straight," "plane," etc., accordingly lose their exact meaning in physics.

In the generalized theory of relativity, the doctrine of space and time, kinematics, is no longer one of the absolute foundations of general physics. The geometrical states of bodies and the rates of clocks depend in the first place on their gravitational fields, which again are produced by the material systems concerned.

Thus the new theory of gravitation diverges widely from that of Newton with respect to its basal principle. But in practical application the two agree so closely that it has been difficult to find cases in which the actual differences could be subjected to observation. As yet only the following have been suggested:

1. The distortion of the oval orbits of planets round the sun (confirmed in the case of the planet Mercury).

2. The deviation of light-rays in a gravitational field (confirmed by the English Solar Eclipse expedition).

3. The shifting of spectral lines towards the red end of the spectrum in the case of light coming to us from stars of appreciable mass (not yet confirmed).

The great attraction of the theory is its logical consistency. If any deduction from it should prove untenable, it must be given up. A modification of it seems impossible without destruction of the whole.

No one must think that Newton's great creation can be overthrown in any real sense by this or by any other theory. His clear and wide ideas will for ever retain their significance as the foundation on which our modern conceptions of physics have been built.

Albert Einstein

SCIENTIFIC EVENTS

THE ANNUAL REPORT OF THE DIRECTOR OF THE BUREAU OF STANDARDS

A review of the work of the National Bureau of Standards for the year ending June 30, 1919, is given in the alumni report of the director of the Bureau of Standards at Washington. The report describes the functions of the bureau in connection with standards and standardization, and contains a chart and description of the several classes of standards dealt with. The director also gives a clear idea of the relation of the bureau's work to the general public, to the industries, and to the government, and includes a special statement of the military work of the year. Brief statements are made upon practically all of the special researches and lines of testing completed or under way at the bureau. The list of these topics occupies 12 pages in the table of contents.

The bureau is organized in 64 scientific and technical sections and 20 clerical, construction and operative sections. During the year the bureau has issued 51 publications, not including reprintings, 36 of which were new and 15 revisions of previous publications. In the several laboratories of the Bureau more than 131,000 tests were made during the year. The appropriations for the year, including special funds for war investigations, were approximately \$3,000,000. A noteworthy event of the year included the completion of the industrial laboratory in which will be housed the divisions having to do with researches and tests of structural materials. The building also includes a commodious kiln house for use, among other purposes, of the ceramics division in the experimental production of new clay products and for general experimental purposes.

The report comprises 293 pages and may be obtained as long as free copies are available by addressing the Bureau of Standards, Washington, D. C.

NEEDS OF THE COAST AND GEODETIC SURVEY

Declaring that the work of the United States Coast and Geodetic Survey, which provides the navigating charts which are the direct means of protecting from loss the vessels of our navy, Coast Guard, and merchant marine, is seriously hampered by lack of funds, the superintendent of the survey makes an appeal for an adequate appropriation to remedy this situation, in his annual report to the secretary of commerce.

In order to make and put these navigational charts into the hands of all who demand them both the field and office forces must be kept up to the highest standards of efficiency, and this can not be done without sufficient funds to maintain and operate modern surveying vessels and obtain able officers and crews to man them. In addition to the funds needed for the field work of the bureau, larger funds than are now available are required for carrying on the office work, for it is necessary to have highly trained men to prepare and care for the data used in making up these charts.

Lack of money prevents the bureau from obtaining a sufficient number of such men, and many of those at present in the service are leaving for better salaried positions elsewhere. There have been large numbers of resignations from the commissioned personnel and other scientific arms of the bureau, in fact, from all classes of the service, and it is expected that these conditions will continue until something is done to meet the situation.

The superintendent points out that the condition is so serious that it threatens to jeopardize public welfare, for, he says:

The commissioned officers are the lowest paid men of their training in the federal service. Their salaries, compared to those paid in the army and the navy for similar qualifications, are 30 to 50 per cent. less. Much of their work is more hazardous, requires special training, and takes them into all our country's possessions as the pioneer workers or navigators—surveyors who "blaze the trail" on land and sea. And no army or navy officer has greater qualifications, nor do they sacrifice more than the officer of the Coast and Geodetic Survey, yet the latter works for much the lowest salary, gets no longevity pay, no emoluments, and after he has given his best years to the service of his country he must retire without pay.

Too few persons realize the sacrifices a man of ability is making at the present time by remaining in the Coast and Geodetic Survey. Before this country entered the war conditions had grown to a serious stage, but since the signing of the armistice steady disintegration has gone on, and the situation has reached a point where the quality of the Survey's employees is declining principally under the stress of present economic conditions. Unless proper relief is forthcoming at once, and the present salaries are materially advanced, this important branch of the federal government, which has so much to do with the protecting of human lives, will, in a measure at least, be stripped of its best brains.

THE ROYAL MEDALS OF THE ROYAL SOCIETY

As has been noted in SCIENCE these medals were awarded to Professor John Bretland Farmer and Mr. James Haywood Jeans. In conferring them on November 30 Sir Joseph Thomson, the president of the society, said:

Professor Farmer's work is characterized by the fundamental importance of the problems worked upon; thus his memoirs on the meiotic phase (reduction division) in animals and plants are of as great value to zoologists as to botanists, and his conclusions and interpretations of the complex nuclear changes which precede the differentiation of the sexual cells have stood the test of criticism, and remain the clearest and most logical account of these very important phenomena. His papers, in collaboration with his pupil, Miss Digby, on the cytology of those ferns in which the normal alternation of generations is departed from has thrown new light on problems of the greatest biological interest, and especially on the nature of sexuality. In his cytological work on cancerous growths Professor Farmer has established the close similarity between the cells of malignant growths and those of normal reproductive tissue.

Mr. Jeans has successfully attacked some of the most difficult problems in mathematical physics and astronomy. In the kinetic theory of gases he has improved the theory of viscosity, and, using generalized coordinates, has given the best proof yet devised of the equipartition of energy and of Maxwell's law of the distribution of molecular velocities, assuming the validity of the laws of Newtonian dynamics. In dynamical astronomy he took up the difficult problem of the stability of the pear-shaped form of rotating, incompressible, gravitating fluid at a point where Darwin, Poincaré and Liapounoff had left it, and obtained discordant results. By proceeding to a third order of approximation, for which very great mathematical skill was required, he showed that this form was unstable. He followed this up by the discussion of the similar problem when the fluid is compressible, and concluded that for a density greater than a critical value of about one quarter that of water the behavior is generally similar to that of an incompressible fluid. For lower densities the behavior resembles that of a perfectly compressible fluid, and with increasing rotation matter will take a lenticular shape and later be ejected from the edge.

MR. ROCKEFELLER'S GIFTS

THERE were announced on Christmas day two large gifts by Mr. John D. Rockefeller, $50,000,000 to the Rockefeller Foundation and $50,000,000 to the General Education Board, the money to be available for immediate use.

In transmitting the gift to the General Education Board Mr. Rockefeller forwarded this memorandum:

The attention of the American public has recently been drawn to the urgent and immediate necessity of providing more adequate salaries to members of the teaching profession. It is of the highest importance that those intrusted with the education of youth and the increase of knowledge should not be led to abandon their calling by reason of financial pressure or to cling to it amid discouragements due to financial limitations.

It is of equal importance to our future welfare and progress that able and aspiring young men and women should not for similar reasons be deterred from devoting their lives to teaching.

While this gift is made for the general corporate purposes of the board, I should cordially indorse a decision to use the principal, as well as the income, as promptly and largely as may seem wise for the purpose of cooperating with the higher institutions of learning in raising sums specifically devoted to the increase of teachers' salaries.

In reference to this gift, Dr. Wallace Buttrick, president of the General Education Board, makes the following statement:

The general public is well aware that the salaries of instructors in colleges and universities have not thus far, in general, been sufficiently increased to meet the increased cost of living. The General Education Board has since the close of the war received applications for aid from colleges and universities the sum total of which would practically exhaust the working capital of the board.

An emergency exists. It is urgently necessary to take steps to increase salaries in order that men in the teaching profession may be able and happy to remain there, in order that young men and young women who incline to teaching as a career may not be deterred from entering the teaching profession, and, finally, in order that it may not be necessary to raise tuition fees and thereby cut off from academic opportunity those who can not afford to pay increased tuition.

As Mr. Rockefeller's memorandum shows, he recognizes the urgency of the present situation, and has given this large sum to the General Education Board to be used in cooperation with the institutions for the purpose of promptly increasing the funds available for the payment of salaries. It has been the policy of the board to make contributions to endowments, conditioned upon the raising of additional supplementary sums by the institutions aided.

The gifts of Mr. Rockefeller to the General Education Board since its establishment in 1902 have been as follows:

1902	$1,000,000
1905	10,000,000
1907	11,000,000
1909	10,000,000
Total	$32,000,000

The board distributes the interest on the above funds currently and is empowered to distribute the principal in its discretion. Recently Mr. Rockefeller gave the board the sum of $20,000,000 for the improvement of medical education, the interest to be distributed currently and the principal to be distributed within fifty years.

In transmitting the gift to the Rockefeller Foundation Mr. Rockefeller specifically authorizes the trustees to utilize both principal and income for any of the corporate purposes of the foundation which, as stated in the charter, are "to promote the well-being of mankind throughout the world." "While imposing no restriction upon the discretion of the trustees Mr. Rockefeller in his letter of transmittal expresses special interest "in the work being done throughout the world in combating disease through improvement of medical education, public health administration and scientific research." Mr. Rockefeller also alludes to the recent gift of $20,000,000 to the General Education Board to promote general education in the United States, and then adds:

My attention has been called to the needs of some of the medical schools in Canada, but as the activities of the General Education Board are by its charter limited to the United States I understand that gift may not be used for Canadian schools. The Canadian people are our near neighbors. They are closely bound to us by ties of race, language and international friendship; and they have without stint sacrificed themselves, their youth and their resources to the end that democracy might be saved and extended. For these reasons if your board should see fit to use any part of this new gift in promoting medical education in Canada such action would meet with my cordial approval.

This last gift makes the total received by the foundation from Mr. Rockefeller $182,000,000, of which both income and principal were made available for appropriations. In 1917–18 $5,000,000 from the principal was appropriated for war work.

SCIENTIFIC NOTES AND NEWS

DR. JACQUES LOEB, of the Rockefeller Institute for Medical Research, Dr. Robert Andrews Millikan, of the University of Chicago, Dr. Arthur Gordon Webster, of Clark University, and Dr. W. W. Campbell, of Lick Observatory, have been elected honorary members of the Royal Institution of Great Britain and Ireland.

DR. OTTO KLOTZ, director of the Dominion Observatory, Ottawa, has been appointed the representative of Canada on the "Committee on Magnetic Surveys, Charts and Secular Variation" of the International Geodetic and Geophysical Union, recently formed at Brussels.

DR. C. O. MAILLOUX, who was elected president of the International Electrotechnical Commission for the next period of two years at the plenary meeting in London on October 24, was the president of the American committee. He is the second American to hold that honor. Previous presidents have been Lord Kelvin, Dr. Elihu Thomson, Professor E. Budde and Maurice Leblanc. He is a past-president of the American Institute of Electrical Engineers, and was the first editor of *The Electrical World* serving in that capacity in 1883.

DR. HERRICK E. WILSON, having resigned his position as assistant to Mr. Frank Springer, of the U. S. National Museum, will continue research work upon fossil crinoids at his home in Oberlin, Ohio.

THE American Institute of Baking, founded by the American Association of the Baking Industry, has begun work in Minneapolis under the direction of Dr. H. F. Barnard assisted by an advisory committee of the National Research Council and in cooperation with the Dunwoody Institute. Dr. Barnard has been connected with the State Board of Health of Indiana for nearly nineteen years and was federal food administrator of that state during the war.

DR. PAUL G. WOOLLEY, who recently resigned from the chair of pathology at the University of Cincinnati, is reported to have accepted the direction of a laboratory for medical diagnosis at Detroit.

PROFESSOR A. E. GRANTHAM, for twelve years head of the department of agronomy in Delaware College and agronomist to the Delaware Agricultural Experiment Station, has resigned, his resignation to become effective on February 1, to become manager of the Agricultural Service Bureau of the Virginia-Carolina Chemical Company, with headquarters at Richmond, Va.

DR. L. W. STEPHENSON, of the Geological Survey, has been granted a six months' leave of absence in the early part of 1920, in order to do stratigraphic work for one of the oil companies in the Tampico oil field.

PROFESSOR J. C. MCLENNAN, F.R.S., has resigned as scientific adviser to the British Board of Admiralty, to return to his duties as professor of physics in the University of Toronto.

DR. WICKLIFFE ROSE, general director of the International Health Board of the Rockefeller Foundation, and Dr. Richard M. Pearce, recently appointed director of a new division of medical education, sailed on December 11 for Europe to secure information about public health administration and methods of medical education in England and on the Continent.

DR. THEODORE C. LYSTER, former colonel of the U. S. Army, is now in Mexico representing the yellow fever commission of the Rockefeller Foundation of which General Gorgas is the head.

DR. O. HOLTEDAHL is organizing a Norwegian exploring expedition to Novaya Zemlya, and expects to sail in June. A botanist, a zoologist and a meteorologist will accompany the expedition. Dr. Holtedahl will devote his time to geological and geophysical problems.

At the dedication of the new pathological laboratory of the Philadelphia General Hospital the principal address was delivered by Dr. William H. Welch, of The Johns Hopkins University, who spoke of the important part played by morbid anatomy in the advancement of medicine. Drs. Arthur Dean Bevan, Chicago, and Louis B. Wilson, Rochester, Minn., also spoke.

Nature records the death on November 25 of Frederick Webb Headley, at the age of sixty-three years. Mr. Headley spent nearly forty years of his life as an assistant master at Haileybury College, where he succeeded in maintaining a body of active boy-naturalists in the college. He was the author of "The Structure and Life of Birds" and "Life and Evolution."

UNIVERSITY AND EDUCATIONAL NEWS

Mr. John Markle has agreed to provide the sum of five thousand dollars a year for five years beginning January 1, 1920, for the continuation of the mining engineering course at Lafayette College, which was suspended during the war.

It is planned to establish a school of engineering under the joint direction of the Carnegie Institute of Technology, Pittsburgh, the U. S. Bureau of Mines and the coal operators of the Pittsburgh District.

Delegates from French and Swiss universities met recently at Geneva and made arrangements for interchange of students and professors with credits for corresponding work.

Dr. Meyer G. Gaba, who was an instructor in mathematics at Cornell from 1915 to 1918, has been appointed associate professor of mathematics at the University of Nebraska.

Dr. James Playfair McMurrich, professor of anatomy in the University of Toronto, has been elected dean of the faculty of arts.

Dr. T. Harvey Johnston has been appointed to the new professorship of biology at the Queensland University. Dr. Johnston was one of the traveling commissioners sent abroad by the Queensland government to investigate the Prickly Pear problem.

At the University of Cambridge Dr. F. H. A. Marshall, fellow of Christ's College, has been appointed reader in agricultural physiology, and Mr. P. Lake, of St. John's College, reader in geography.

DISCUSSION AND CORRESPONDENCE

THREAD MOULDS AND BACTERIA IN THE DEVONIAN [1]

While making a comprehensive survey of the comparative histology of the skeletal parts of ancient vertebrates, in conjunction with the study of paleopathology, my attention was attracted to the enlarged and distorted shapes of many lacunae in the carapace of *Borthriolepis* and *Coccosteus*. Closer examination under the oil immersion revealed the occurrence of thread moulds and bacteria in the almost disrupted lacunar spaces, and since these organisms have never before been noted in the osseous elements of such ancient vertebrates, a brief description will be given of them here. There is a great gap in our knowledge of ancient bacteria especially between the Pre-Cambrian bacteria described by Walcott and the Carboniferous forms described by Renault, so that we know nothing of the occurrence of bacteria especially in bony material during the early and middle Paleozoic.

The occurrence of thread moulds (*Mycelites ossifragus*) in the hard parts of invertebrates and vertebrates, from molluscs to man, has been noted for more than eighty years and the literature is very extensive. The canals made by the penetrating moulds, known as the *canals of Roux or Wedl,* have been noted by Kölliker in the hard parts of invertebrates, fossil and recent, by Triepel in recent human bones, by Shaffer in ancient human teeth, by Sonders in a Neolithic skull, by Roux in the skeletal parts of vertebrates, Carboniferous to recent. They have been recently seen in the bony parts of Devonian vertebrates, doubtless they have a very wide distribution and may be regarded as one of the most ancient types of organisms in existence There is nothing peculiar in their occurrence in the ancient vertebrates except that their course of growth is modified by the histology of ancient bone. In the absence of definite lamellæ the mycelia often seek out a lacuna, enter it and growing out along the direction of the brief canaliculi, expand both the lacuna and canaliculi until the entire structure is disrupted and the canals meet other canals growing out from adjoining lacunæ. In modern human bone the mycelia very often follow the interlamellar spaces, but ancient bone has seldom any definite spaces of this kind and more often is to be regarded as an osteoid substance. That the appearances described for the enlarged lacunæ are not normal is easily checked by a study of normal lacunæ in the adjacent material. A single microscopic field will show both normal and invaded lacunæ. The canals, from 2–4 *micra* in diameter have an undulating course and offer easy channels of entrance to invading bacteria.

The presence of these thread moulds would seem to indicate that the piece of bone showing them was preserved in a moist sandy or muddy place close to the shore, thus agreeing with our previous conceptions of the preservation of fossil material. It is difficult to see how the moulds would find entrance if the material were embedded under sand or silt in deep water. The ancient Egyptian mummies, buried for thousands of years in the dry sand of Nubian deserts do not show such canals, nor do the Cretaceous vertebrates from Kansas show them. Seitz has figured them, though apparently did not recognize their nature, in the bones of Labyrinthodonts and dinosaurs, and I have seen evidences of them in sections from the vertebra of an American sauroped dinosaur.

The bacteria doubtless have entered the bone along the course of the *Canals of Roux* and may be detected at first by the beady, nodular appearance of the canal. Often the bacteria, in *Bothriolepis,* for instance, have invaded a canaliculus which the *Mycelites* did not find. The small clumps, or nodes, may clearly be regarded as colonies of bacteria and doubtless as a form of the *Micrococcus,* described by Renault in the canaliculi of Permian fish bone. The beady appearance of an invaded *canal of Roux* or canaliculus recalls exactly the picture of the invaded dentinal tubules in cases of human dental caries. We are, of course, in this case, as in the case of other ancient phenomena, arguing from the known to the unknown. Here is an ancient situation which parallels a similar modern situation and the argument is sound because on it for over one hundred years we have built the science of paleontology.

These conditions can not be regarded as disease in any sense, but are rather to be regarded as the agents of decay in ancient times. They are the agents of decay and disruption at the present time and from present evidences the same agents of decay have been at work for many millions of years, at least since Devonian times.

ROY L. MOODIE

DEPARTMENT OF ANATOMY,
UNIVERSITY OF ILLINOIS,
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VIBRATION RATE OF THE TAIL OF A RATTLESNAKE

THROUGH the courtesy of Professor H. R. Dill, curator of the natural history museum, opportunity was offered to make a brief study of the rate of vibration of the tail of a diamond back rattlesnake, *Crotalus Adamanteus.* This specimen came from Texas on September 15, 1918, but had been in captivity for some time previously. Its age is not known, as that can not be accurately determined from the number of rattles, some of which are known to have been broken off, and two of the nine or ten remaining are in poor condition. A new rattle is formed with each moulting, a process which has occurred twice during the nine months that the animal has been in the laboratory; the second moulting occurred six months after the first. The snake is about five feet four inches in length and rather thin, since it refuses food. It accepts water, however, and in the latter part of March two sparrows were forcibly fed to it. It is exceedingly alert and vigorous, and frequently strikes at any object that is near its wire cage. It has learned some discretion, and does not risk the resultant bump against the wire unless rather strongly provoked. Its fangs are intact.

With the aid of two assistants, Mr. Ledieu, who kept the head out of mischief, and Mr. Bunch, who manipulated the apparatus, it was possible to secure a fairly accurate short time record. A Deprez marker, together with a suitable time indicator, was adjusted to trace upon a smoked drum. With one method of recording a small mesh cap of copper wire was fitted over the rattles and connected with a flexible wire through a battery, the marker, and a curved brass plate. Touching the wire cap to the brass plate completed the circuit. With slight provocation vigorous movement resulted and the writer would hold as far back from the tip of the tail as possible and still be able to direct the tip so that it would strike the plate with each complete vibration. Fearing that the cap might be heavy enough to retard the motion, we tried again using a double strand of very fine copper wire wrapped twice around the rattles bringing this wire in contact with the plate as before. The average time of fifty-three consecutive vibrations, with the first method, was 30σ (1σ.001 sec.) with a mean variation of 10σ. The corresponding result for twenty-five vibrations by the second method, was 28σ, with a mean variation of 3.5σ.

To the writer two surprises are contained in this record, the first being the relatively great variability in rate of movement, the extremes ranging from about 10σ to 50σ. After attention was directed to the variations in speed, they become marked even to the unaided ear, although no distinct rhythm can be detected.

The second unexpected result is that the pitch of the tone produced does not depend upon the speed nor upon the constancy of the tail vibration but upon the natural resonance of the rattles themselves. The pitch of this tone, as determined by two musicians with a very keen sense of pitch, and checked with accurately tuned forks, is between C and C♯; the tone is expressed, therefore, by about 128 to 135 vibrations per second. Very marked changes in rate of tail, from the fastest that could be produced by marked provocation, to the almost quiescent state, did not cause a fluctuation of the pitch beyond this approximate half-tone. The tone itself is exceedingly complex however, and it might conceivably vary with the number and size of the rattles. It was possible to detect, but not to identify, certain overtones.

The popular impression that the rattler uses his rattles as a warning that he is about to strike is regarded by Mr. Dill as quite erroneous. This snake, when striking normally does so first and rattles afterward, if at all. It will, for instance, strike at a bird placed in the cage, rattle, then strike again. It appears that the rattle is rather to terrify than to warn. It is also used as a defensive mechanism. The instinct to vibrate the tail is not peculiar to the rattlesnake, but is common to many other species, as, for instance, to the non-venomous king snake and the blue racer.

Mabel C. Williams

State University of Iowa

A TICKET TO ST. LOUIS

I am a schoolmaster. I am not earning a living for myself and family, though my position is counted a good one. I shall be a schoolmaster till I die: I have chosen teaching as my service, and am too old to change. My three sons will not be schoolmasters.

Before the war I was able to make ends meet. I could then devote all my time and energies to the duties of my position. Then came increase of passenger rates, and a war tax added, and I and my family have since stayed home. I even bought several liberty bonds and my children bought war savings stamps at the beginning.

Then came also increased freight rates and of cost of food, and I and my boys began gardening. Then came also increase of wages and decrease of competence in artisans, and I and my boys began doing our own repair work —carpentry, plastering, roofing, ditch-digging, etc. But, staying always home, and raising beans, and fixing spouts is not what I am paid for doing, nor does it get the best results from the long training I have had. And ever since the close of the war I have been vainly hoping to be allowed to devote my time again to my teaching and research; for I am first and last a schoolmaster.

The war having ended more than a year ago, I thought I should like to go to the meeting of the American Association for the Advancement of Science at St. Louis, to meet my colleagues from the other universities and to talk over plans for the future. Now at the last the poor old decrepit U. S. Railroad Administration, which, I verily believe, has done more than any other single agency to increase the cost of living, decides that this association is not educational! Therefore, its members are not entitled to the reduced fare previously granted to those attending "meetings of religious, charitable, educational, fraternal, or military character." This, the equivalent of 2 cents per mile, which was full fare before the war, may be granted for truly educational gatherings, such as those of public kindergartners; but it is not for such as we are: we pay 3 cents per mile with a war tax added, or we help the railroads by staying at home.

Such is the judgment of a high official in that administration (Mr. Gerrit Fort, assistant director), who is doubtless provided with a salary adequate to support him and his family while he renders such decisions. Hear him: "The term 'educational' taken in its broad sense could be construed to cover a very large number of conventions. It was necessary, therefore, to restrict its definition, and this was done by confining it to those conventions having to do with elementary education, such as meetings of school-teachers."

This is the last straw!

SCHOOLMASTER

SPECIAL ARTICLES

THE PROTECTIVE INFLUENCE OF BLOOD SERUM ON THE EXPERIMENTAL CELL-FIBRIN TISSUE OF LIMULUS[1]

IN the preceding communication we showed that the solutions of different salts, which are constituents of blood serum or seawater, differ in their effect on the cellfibrin tissue and that the amount of regenerative outgrowth of the tissue is different in different solutions. If we cover a wound with 5/8 *m* NaCl healing may take place; a small piece of excised placed on a cover-glass and surrounded by a drop of NaCl solution may show a good outgrowth under the conditions of our experiment in which usually a small amount of blood serum was adherent to the piece. However, all of these solutions are inferior to the blood serum of *Limulus*. It was of interest to determine which constituent or combination of substances in the blood serum was responsible for the superiority of the serum, whether it was caused by the balancing action of salts or by another constituent.

Addition of calcium chloride in various quantities to the sodium chloride solution did not improve the latter and usually made it less favorable for the tissue. The addition of seawater in which the inorganic constituents are present in proportions similar to those found in blood serum, prevented an active outgrowth altogether. Inasmuch as it was possible that the alkalinity of the seawater was injurious to the tissue, we used seawater with a hydrogen ion concentration which corresponded to an approximately neutral solution. This did not improve the effect of seawater. The Van't Hoff solution mixture of salts was likewise much inferior to an isotonic NaCl solution. These results made it improbable that the beneficial effect of blood serum was due to inorganic constituents.

This conclusion was corroborated by the effect of the heating of blood serum. Heating the blood serum to 85° for a short time sufficient to coagulate a certain amount of its proteid destroyed the greater part of the beneficial effect of blood serum. Heating this filtered fraction still further to 100° for a short time, and thus producing an additional coagulation, made the blood serum as unfavorable as seawater; such heated and filtered blood serum had still the blue color of normal oxygenated *Limulus* blood. However, how far a proportionality exists between the intensity of heating and of loss of beneficial properties of the serum needs further investigation.

[1] From the Department of Comparative Pathology, Washington University School of Medicine, St. Louis, Mo.

At present we may conclude that the specifically protective effect of blood serum is due not to the combination or inorganic constituents but to the proteid constituents of the blood. This may perhaps explain the fact that different blood sera may differ in their beneficial effect. We even found that the blood sera of diseased, anemic *Limuli* may become as ineffective or as injurious as sea-water. Whether the action of microorganisms enters as a factor in the case of blood sera of anemic *Limuli* remains still to be determined.

Leo Loeb

A PRELIMINARY NOTE ON SOIL ACIDITY

Whatever may be the cause and nature of soil acidity, apparently part of this acidity is due to some of the materials which constitute the soil itself. This gives rise to the question as to whether the minerals from which the soils are derived are acid; and if not, what changes occur in these minerals to make them acid and what factors cause these changes. Therefore in some work on soil acidity that has recently been done in this laboratory, the problem was attacked along a line somewhat different from that usually followed. Instead of working with acid soils entirely, neutral and basic soils were also chosen and the one factor which probably, more than any other, has to do with the natural changes produced in the soil forming minerals—namely, water leaching through the soil—was investigated. After working with a few soils, it seemed advisable to experiment with the more abundant minerals which constitute certain types of soils, and with a few of their decomposition products.

Such materials as the following were taken for the experiments: soils, rocks, miscellaneous gravel, pure minerals such as quartz, hornblende, microcline and garnet, and some of the decomposition products of the above mentioned minerals and rocks such as silicic acid, kaolin, silica, etc. Nearly all of the rocks, gravel and pure minerals were found to be either neutral or slightly basic. The materials were leached with water containing carbon dioxide, and analyses were made to determine what changes had occurred, both in the samples and in the percolated water.

The results from this work show that of all the samples that were leached, no matter whether the original material was basic or acid, the resulting material was acid; and that with the exception of the decomposition products such as silicic acid, kaolin, etc., nearly all of the samples became more acid. The fact should be emphasized here that all of the materials, with the exception of the soils themselves, were minerals or rocks which contained no organic matter. Hence the acidity was not due to organic matter.

From the above statements, the conclusion may be drawn that the compounds formed from some of the soil-forming minerals due to leaching, are an important factor in making soils acid.

Having shown then that some of the materials of which soils are composed, on being leached with water containing carbon dioxide, make soils acid, the next logical step in this research was to try to determine how these compounds give rise to this acidity.

This problem was attacked by determining the hydrogen ion concentration of neutral water extracts of the materials in question; and by determining the hydrogen ion concentration of similar extracts after different known quantities of standard calcium hydroxide had been added. A curve plotted from the results of these determinations should show (1) any excess of hydrogen ions in the solution; (2) the presence of any compound that is capable of taking up calcium hydroxide as a result of adsorption, by the formation of addition products, or by true chemical action; and (3) any excess of free hydroxyl ions. To illustrate, let the following figure represent the relation between the hydrogen ion concentration (expressed as P_h) in a solution and the amount of calcium hydroxide that has been added. Then line *ab* shows a decreasing excess of hydrogen ions in the solution; *bc* that the hydroxyl ions are being removed from the field of action as fast as they are added; and *cd*, an increasing excess of hydroxyl ions.

The curves plotted from the results of the determinations made on acid soils and on the decomposition products of the soil-forming minerals are similar to the one described above, while those made on neutral or alkaline soils are similar to lines *bc* and *cd* of that curve. This apparently indicates that there are some dissociated acids or acid salts present in the solutions of acid soils, and of the decomposition products; and that with all of the materials some of the calcium hydroxide is entirely removed from the field of action. These statements are interesting, especially when compared with the conclusions drawn in regard to soil acidity from results obtained by the freezing[1] point method. The conclusions

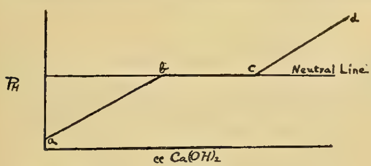

FIG. 1.

by that method are contrary to the former of the above statements, but agree with the latter.

Some other interesting facts concerning these curves are that where they first reach the neutral line, they show a lime requirement as determined by the so-called Jones[2] method; and that where they leave the neutral line, they may indicate what Sharp[3] and Hoagland term "potential acidity" or what Bouyoucos[4] terms "maximum lime requirement." It is also interesting to note that the curves vary somewhat when bases other than calcium hydroxide are added to soils. Barium hydroxide gives rise to curves similar to calcium hydroxide, while sodium and ammonium hydroxides gives curves represented by lines *ab* and *cd* in the above figure.

1 Mich. Agric. Col. Exp. Sta. Technical Bul., No. 27.

2 *Jour. A. O. A. C.*, Vol. I., p. 43.

3 *Jour. Agric. Research*, Vol. VII., p. 123.

4 Mich. Agric. Col. Exp. Sta. Technical Bul. No. 27, p. 37.

This work is being continued with the hope that within a short time sufficient data will be obtained to warrant a more complete discussion of the subject.

O. B. WINTER

MICHIGAN AGRICULTURAL COLLEGE,
EXPERIMENT STATION

ALABAMA MEETING OF THE ASSOCIATION OF AMERICAN STATE GEOLOGISTS

ONE of the most successful and profitable annual field meetings of the Association of American State Geologists was held in Alabama, September 1 to 6, 1919, on invitation and under the able guidance of the state geologist, Dr. Eugene A. Smith. Headquarters were at the Tutwiler Hotel, Birmingham.

An instructive printed guide of 14 pages briefly summarizing the essential geologic features to be observed at each place visited in the state was prepared by Dr. Smith and associates. As originally planned, the program called for a division of the party into two sections (Highland and Coastal Plain), to be together only on the first and last days. This plan was later modified to exclude the Coastal Plain section, but was closely adhered to for the Highland section, which closed with a visit to the University of Alabama, so long and well known to geologists as the home of the distinguished host, Dr. Smith.

Much of the Highland region of the state, long known for its varied and complex geology, was covered by excursions, and many of the interesting features of physiography, structure, stratigraphy and economic geology, were reviewed. Among some of the more important localities visited were the famous Birmingham district, where opportunity was afforded for observing some of its more important geologic features, including visits to iron and coal mines, limestone quarries and industrial plants; the extensive productive graphite area between Lineville and Goodwater, the largest domestic producer of graphite; the marble quarries near Sylacauga; and Sheffield and Florence where are located the government nitrate plant and prospective water-power developments at Mussel Shoals on Tennessee River.

The geologists participating in a part or all of the excursions were: Eugene A. Smith and W. F. Prouty (Alabama), J. A. Bownocker (Ohio), G. F. Kay (Iowa), H. B. Kümmel (New Jersey), I. C. White (West Virginia), W. N. Logan (Indiana), S. W. McCallie and J. P. D. Hull (Georgia), W.

O. Hotchkiss (Wisconsin), Collier Cobb (North Carolina), H. F. Cleland (Massachusetts), Herman Gunter (Florida), W. A. Nelson (Tennessee), George Otis Smith, E. O. Ulrich and Charles Butts (Washington, D. C.).

Thomas L. Watson,
Secretary

THE AMERICAN CHEMICAL SOCIETY. VII

DIVISION OF BIOLOGICAL CHEMISTRY

I. K. Phelps, *Chairman*

R. A. Gortner, *Vice-chairman and Secretary*

Chemotherapy of organic arsenicals: C. N. Meyers. A discussion of the transitions of arsenic therapy leading up to the production of salvarsan. A chart showing the methods of approaching the mother substance is presented. The reduction process is briefly discussed, followed by a consideration of the chemical and physical properties, the toxicology, the impurities, and the preservation of salvarsan. The chemical and physical factors as related to the administration of the drug are discussed based upon clinical observations as a result of an extensive investigation of the methods used by leading dermatologists. Standard methods are recommended in order to eliminate reactions which unnecessarily result from faulty technique and improper use of chemical laws when salvarsan is used in organotherapy.

The chemical composition of arsphenamine (salvarsan): G. W. Raiziss.

A comparative study of the trypanocidal activity of arsphenamine and neo-arsphenamine: J. F. Schamberg, J. A. Kolmer and G. W. Raiziss.

Chemotherapeutic studies with ethylhydrocuprein and mercurophen in experimental pneumococcus meningitis of rabbits: J. A. Kolmer and Goro Idzumi.

Coordination of the principles of chemo-therapy with the laws of immunity and the successful application in the treatment of tuberculosis: Benjamin S. Paschall. The tubercle bacillus is protected by waxy substances consisting chiefly of unsaturated highly complex alcohols and equal quantities of phosphatides with which they form a colloidal complex and which in turn exists in close union, possibly physical, more probably chemical, with the protoplasmic substances of the tubercle bacillus, both proteid and carbohydrate in nature. Saponification breaks up this complex without destruction of the important immunizing substances and makes possible separation by solvents. By this means toxic and caseating substances of the Cholin Muscarin group are eliminated as well as the ordinary poisons elaborated by the tubercle bacillus proteins and protein derivatives. Esterification of the fatty acids with ethyl alcohol forms a valuable immunizing substance as these fatty acids have so far been found not to conform to those found in our common food products. Esterification of the higher alcohols with salicylic benzoic, acetic or other suitable acids establishes a new side chain or anchoring group which greatly enhances the reactivity between the antigens themselves and the receptors of the tissue cells so that absorption of these alcoholic esters takes place in the tissues in a few days without producing caseation and tissue necrosis even when given in doses of from 3 to 5 c.c., and following these injections of the mixed esters specific wax digesting ferments form in sufficient concentration to split the protective waxes from the tubercle bacillus living within the host whereby disorganization and destruction of the organism ensues and the patient absolutely recovers and remains well. Thus combining the principles of chemico-therapy with the laws of immunity, a new substance was found for the treatment of all forms of tuberculosis which was successfully used in our own practise and named by us Mycoleum.

The chlorinated antiseptics: Chloramine-T and dichloramine-T: Isaac F. Harris, Ph.D., Research Laboratories, E. R. Squibb & Sons, New York. Toluene-p-sodium-sulfonchloramine (chloramine-T) when prepared in state of high chemical purity is an extremely stable compound, both in crystalline form and in solution. Toluene-p-sulfondichloramine (dichloramine-T) is quite stable when prepared in very high purity chemically dry and protected from dust, organic matter and sunlight. Pure dichloramine-T can be kept in pure, anhydrous chlorcosane, without appreciable decomposition, for several months, if protected from continuous action of direct sunlight. In the reactions between the proteins of the tissues and Dakin's solution, chloramines of the proteins and free sodium hydroxide are formed. The latter furnishes the solvent power attributed to Dakin's solution. When the chloramines react with bacteria and necrotic protein matter, chloramines of the proteins are formed and toluene-p-sulfonamide is set free. The latter is inert and innocuous. The chloramines can be employed with more precision and in greater concentration than Dakin's solution.

An agent for the destruction of vermin-method of application: Albert A. Epstein. (By title.)

The purpose of the communication is to put on record the composition of an active vermicide and a suitable method of its application, which was primarily intended for the army. The vermicide is a solution, the base of which is kerosene. The odor and irritating properties of kerosene are disposed of by a special process. To this as a base are added heavy oils and demulcents which promote the retention of the vermicide and repellent properties, by the objects to which the solution is applied. The solution destroys lice within one minute, and nits fail to develop after about eight minutes contact with the solution. As proven by various tests the solution is destructive not only to lice, but to a large variety of insect-parasites affecting man, animals and plants. The solution is applied by means of a spraying device.

An iodine preparation for intravenous and intraspinous use: ALBERT A. EPSTEIN. (By title). It is possible by means of heat under pressure to dissolve native iodine in solutions of dextrine without the aid of the usual solvents. The amount of iodine thus brought into solution bears the approximate relation of 1: 35 to the quantity of dextrine present. The solution thus obtained is homogeneous and fairly permanent. It is strongly bactericidal, its potency ranging from 2½ to 25 times that of the better known antiseptics. Its action is rapid. It is relatively non-toxic when given intravenously and intraspinously. Animals rendered septic by experimental means have been freed of bacteria by intravenous injection of the solution. Clinical application has been made in cases of bacterial endocarditis and typhoid; the clinical course of the disease having been modified by its use. One of the constant effects of intravenous injection is a febrile reaction followed by a very marked leucocytosis. Intraspinous injection has been attempted in tuberculous meningitis. Although the ultimate course of the disease has not been modified by this procedure the solution itself proved to be innocuous. The subject is undergoing further investigation.

The local anesthetic actions of saligenin and other phenolic alcohols: A. D. HIRSCHFELDER, A. LUNDHOLM, H. NORRGARD AND J. HULTKRANS. Since Macht had shown that benzyl alcohol has local anesthetic properties, other members of the phenolic alcohol series, phenylethylalcohol $C_6H_5CH_2CH_2OH$, phenylglycol $C_6H_5CHOHCH_2OH$, cinnamic alcohol $C_6H_5CH{=}CHCH_2OH$, saligenin $C_6H_4OHCH_2OH$ (salicylic alcohol), methyl saligenin $C_6H_4OCH_3CH_2OH$, ethyl saligenin $C_6H_4OC_2H_5CH_2OH$, piperonylic alcohol $C_6H_3<^{O}_{O}>CH_2CH_2OH$, and homosaligenin $C_6H_3OHCH_2OHCH_3$ (1: 2: 4) were investigated. Lengthening of the side chain diminishes the local anesthetic power. Saligenin is the best of the series. It is the least irritating to the tissues, much less so than benzyl alcohol. It is only half as toxic as the latter, longer and in half the concentration. It is a practical surgical anesthetic, and in six tonsillectomies and one tumor removal in man proved to be as good as procaine. Lethal dose for man would be more than a liter of 4 per cent. solution. Covering the phenolic hydroxyl diminishes the local anesthetic power. Homosaligenin is a good local anesthetic, but more irritating.

The effects of drugs which inhibit the parasympathetic nerve endings upon the irritability of intestinal loops: A. D. HIRSCHFELDER, A. LUNDHOLM H. NORRGARD AND J. HULTKRANS. Drugs which inhibit the parasympathetic nerve endings, such as atropin, amyl nitrite, benzyl alcohol, benzyl benzoate and saligenin cause a definite elevation of the threshold of irritability of loops of intestine to intermittent electrical stimuli. The normal rabbit's intestine responds with an annular contraction to a stimulus from a Harvard induction coil at 10 to 12 cm. After painting the mesenteric border of the intestine with any of the above-mentioned drugs in 2 per cent. solution or emulsion the stimulus must be raised to one with the coil at 4 cm. This rise in the threshold, or decrease in the irritability, is probably due to the transition from response by the nerve to response by the muscle after the nerve impulse has been blocked. The same strength of impulse was required after all the paralyzing drugs.

The effect of fever upon the action and toxicity of digitalis: A. D. HIRSCHFELDER, J. BICEK, F. J. KUCERA AND W. HANSON. The action of the drug was studied in cats and frogs whose body temperature had been raised by immersion in a water-bath. Increasing the body temperature in both cats and frogs diminished the size of the dose necessary to cause death. This is less marked at the lower ranges of temperature than in the higher temperatures, and it is most marked within one or two degrees of the thermal death-point of the animal. At 41° the lethal dose for cats is not reduced, at 42° it is one half to two thirds the normal, at 43° it is only one third to one half the lethal dose in normal animals. This proves the necessity of caution in the administration of large doses of digitalis to patients with high fever.

The toxicity of tobacco smoke from cigars, cigarettes and pipe tobacco: A. D. HIRSCHFELDER, A.

E. Lange and A. C. Feaman. Previous investigators had shown that the amount of nicotine in the smoke from a cigar or a cigarette or from smoking pipe tobacco bears no relation to the nicotine in the tobacco itself. "Light" tobacco may give smoke rich in nicotine, "strong" tobacco may give smoke poor in nicotine. Storm van Leuven in Holland showed that smoke from the so-called nicotine-free cigars gives a smoke that contains a good deal of nicotine. Since nicotine is not the only poisonous constituent of smoke, Hirschfelder and his collaborators studied the poisonous action of the smoke itself, or rather the poisonous action of extracts made from passing the smoke through salt solution and through ether. The amount necessary to kill a frog was determined. Using several popular-priced brands of cigar, cigarette and pipe tobacco, it was found that the smoke coming from a given weight of tobacco varied somewhat, but not very greatly in its poisonous action on frogs. When the same weight of the same sample of tobacco was smoked in the form of a cigarette and in a pipe and as a cigar there was sometimes very little difference in the poisonous quality of the smoke, but usually that which was smoked as a cigarette was somewhat less poisonous. Nevertheless, cigars and pipes seem much stronger than cigarettes. This is because since the burning occurs chiefly along the surface of the tobacco, so much more tobacco is being converted into smoke at each instant in these than in the cigarettes. It is largely a question of cross section. Cigars have about four times the cross section of cigarettes, pipes nine or ten times. If all three were smoked equally fast, the smoker would get an overwhelming dose of nicotine from cigar and pipe. Therefore, these must be smoked more slowly than the cigarette and can not be inhaled. If the smoker did not inhale the smoke, the cigarette would be the lightest form of tobacco.

Some applications of protein chemistry to medicine and pharmacy: I. F. Harris.

Action of trichlorotertiary butyl alcohol (chloretone) on animal tissue: T. B. Aldrich and H. C. Ward. The action of chloretone on animal tissue has not been studied, although glands of various kinds have been preserved in a sterile condition in chloretone water for a number of years, without any apparent injury to the active principles they contain. In order to test the action of a saturated aqueous solution of chloretone on animal tissue pieces of various organs were removed from the animal (dog) as quickly as possible after death, cut into small pieces and distributed among several sets of bottles containing water saturated with chloretone. One set was kept at 37°, one at 15°, while others at summer room temperature. One set at room temperature was inoculated with *B. Proteus*. Control tissue with only distilled water showed a high degree of putrefaction in two days. Every few days the tissues were examined and the general appearance, color, odor, etc., noted. In general the tissues became soft and spongy and lost much of their normal color. There was at no time a suggestion of putrefaction. In fact, cultures made every few days from all the bottles showed their contents to be sterile. Histological studies show that while there is no evidence of bacteria, there is evidence of autolytic changes, since some normal cell constituents are entirely lacking. It would seem that chloretone is one of the few substances (in weak dilution) that will allow autolysis to proceed under sterile conditions.

Conclusions. (1) Chloretone in saturated aqueous solution exerts a definite bactericdal action at all temperatures. (2) Chloretone in saturated aqueous solution prevents the development of the common molds. (3) Chloretone solution is not suitable as a fixative for histological materials. (4) Chloretone solution while acting as a bactericide, does not inhibit autolytic action as evidenced by our histological findings. (5) Chloretone solution is a desirable agent for preserving glands and gland extracts from which the active principles are to be obtained.

The outlook for chemotherapy in the chemical industry of America: C. L. Alsberg. (By title.)
Blue eyes: W. D. Bancroft.

Charles L. Parsons,
Secretary

(*To be continued*)

SCIENCE

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CONTENTS

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THE UNTILLED FIELDS OF PUBLIC HEALTH[1]

A SHORT time ago two Yale undergraduates came to my laboratory to consult me in regard to the choice of a career. One of them was a son of a public health administrator of the highest eminence; and they particularly wanted to know something about the field of public health, what it included, what was the nature of the work involved, what were the qualifications required, and what the financial rewards and the more intangible emoluments to be expected by those who might enter upon this career. I told them what I could of the current tendencies which to me seem to make public health one of the most stimulating and attractive openings lying before the college student of the present day; but I found that the answer to their question was by no means a simple one to formulate. The public health movement has been expanding so rapidly that what was "the New Public Health" fifteen years ago includes only the more conventional interests of the present day.

It seemed to me as I talked with these young men that we needed a formulation of current tendencies in the protean field of public health and an outline of the lines of future development so far as they can safely be forecast. It is essential that the worker in this domain of applied science should see clearly the goal toward which he is aiming, however far ahead of the immediate possibilities of the moment it may appear to be. Above all, it is desirable that we should have a definite and inspiring program to lay before the young men and women of the country who hesitate in the choice of a career. On every hand we hear the question, put by an eager young

[1] Address of the vice-president and chairman of Section K—Physiology and Experimental Medicine—St. Louis, January 2, 1920.

woman to the brilliant head of the instructive District Nursing Association of Boston, "Miss Beard, I want to go into public health. What it it?" It behooves us to answer this question; for the greatest of all needs in this field is undoubtedly the need of a personnel, larger in quantity, and better in quality, than that which has been available in the past.

For these reasons I have determined to devote my address as retiring chairman of the Section on Physiology and Experimental Medicine to a tentative, if necessarily imperfect, formulation of the scope and tendencies of the modern public health campaign.

I spoke of the public health movement as protean, and it is indeed true that the emphasis in this field has shifted with a rapidity almost phantasmagoric.

To a large section of the public, I fear that the health authorities are still best known as the people to whom one complains of unpleasant accumulations of rubbish in the back yard of a neighbor—accumulations which possess those offensive characteristics which somehow can only originate in a neighbor's yard and never in one's own. Sanitation, the maintenance of cleanly and healthful environmental conditions, does indeed represent the first stage in public health. When Sir John Simon initiated the modern public health movement in London three quarters of a century ago his primary task was the elimination of the masses of accumulated filth which kept alive the pestilences of the Middle Ages. When General Gorgas undertook the task of making safe and feasible the building of the Panama Canal he was in the same way confronted with problems that were primarily those of environmental sanitation. The removal of excretal wastes, the purification of sewage, the protection of water supplies and the elimination of conditions which permit the breeding of insect carriers of disease—these are always and everywhere the first tasks for the public health expert; and in the early phases of the public health movement in any country it is natural to visualize public health, primarily in terms of sanitation.

There is still much to do in this most fundamental branch of public health. That terrible scourge of the Middle Ages, typhus fever, was only held in control during the war by a systematic and organized attempt to destroy the louse which carries the parasite of this disease; while the infection of bubonic plague, the black death of the Middle Ages, has been spread broadcast throughout the world during the past twenty-five years, and is held in check only by a vigorous campaign against the rats, ground squirrels, and other rodents which harbor the germ of this peculiar pestilence. The control of malaria, which takes a heavy toll of strength and vitality from the populations of our southern states and is estimated to cost the nation over $100,000,000 a year, is one of the mightiest tasks which confronts the sanitarian, but a task which, as the demonstrations conducted by the International Health Board have made clear, is easily within the range of practical accomplishment, by systematic drainage and other measures taken against the mosquitoes which carry the germs of this disease. Malaria is with us always, but there are many maladies which like yellow fever arise from endemic foci in certain particular regions of the globe, and thence spread wherever the steamship and the railroad train can carry their inciting causes. Of recent years the bold idea has suggested itself of undertaking an offensive against these primary endemic foci of disease without waiting until the invaders cross our own national boundaries. In this way General Gorgas has carried the war against yellow fever into the enemy's own country at Guayaquil, and an organized campaign against such disease on a basis of world cooperation, perhaps through the agency of the International Red Cross, is full of promise of achievement in the future.

There is much then to be done in the field of environmental sanitation, yet as the public health movement progresses the tasks of sanitation in the narrow sense are gradually accomplished and therefore become relatively less important. Constant attention is of course required to maintain the environment in a healthful condition, but in most civilized communities, in temperate climates, environmental sanitation has become a matter of routine, and the pestilences spread by polluted water and by insect carriers have ceased to figure as important factors in the death rate.

As the aims of sanitation are approximately realized in a given community, the attention of the health official turns from the water-borne and insect-borne diseases to the more subtle and more baffling maladies that are spread by direct contact from one individual to another. As typhoid, cholera, plague and typhus fever approach the vanishing point, measles, pneumonia and influenza become relatively more and more important. The control of community infections tends to replace the sanitation of the environment in the first rank of public health problems. The predominating tasks in this phase are tasks for the bacteriologist rather than for the engineer.

The leaders of the public health movement in the United States fifteen years ago were concerned primarily with problems of this sort. Their interest lay in the detection of incipient cases and of well carriers—those individuals who while in normal health themselves are cultivating and distributing from their bodies the germs of specific communicable diseases—in isolation, in bedside disinfection, in the breaking by any possible means of the vicious circle which transfers the discharges of the infected individual to the mouth or nose of the susceptible victim.

In the case of certain of the acute communicable infections we are fortunately able to invoke another weapon against our microbic enemies, by the prophylactic or therapeutic use of vaccines and immune sera, and so far the production of artificial immunity against attacks of the microbes of disease has proved on the whole more effective than our attempts at breaking the chain of contagion by isolation and disinfection. Smallpox, for example, has dwindled from the position of the chief pestilence menacing the human race to almost the condition of a medical curiosity, solely and directly as a result of the use of vaccine. Typhoid fever has been practically eliminated from the army by an analogous procedure. Antitoxic serum has placed the control of diphtheria within our grasp and diphtheria persists as a cause of death simply because of the failure to recognize the disease with sufficient promptness and to apply the protective measures at our disposal.

In general this second or bacteriological phase of the public health movement, while it can boast such remarkable achievements as those to which reference has just been made, is still far from the complete success which has attended the applications of environmental sanitation. It may be stated with some confidence that there is not one of the diseases originating in the non-living environment which we do not know how to control and which it is not entirely practical to control, given adequate funds and personnel. Before some of the contact-borne diseases on the other hand we still stand almost helpless. We may be able to reduce the death rate from pneumonia by the use of protective vaccines, but there has been as yet no actual victory won sufficiently clear to admit of statistical demonstration. We can do much to mitigate the after effects of infant paralysis, but we have no effective method of controlling its spread. Before the ravages of a pandemic of influenza, such as swept the world in 1918, we are still practically without defense. Sanitarians have been accustomed to quote with horror the fact that bubonic plague killed 6,000,000 people in India during a period of ten years. Influenza carried off more than this number of persons in India in the four autumn months of 1918, and if this should happen again next year we should still be powerless to help.

There is much then to be done in the field of the community infections, many problems yet to be solved by the bacteriologist and serologist, before this group of diseases will pass under our control. Yet the suppression of community infections, like the sanitation of the environment, is but a part of the broad public health movement of the present day. The task of the health officer is to save lives, and to save as many lives as possible, by the intelligent application of the resources placed at his disposal. If he be wise he will direct his energies and his appropriations according to the indications derived from a study of vital statistics. He will apply his resources at a point where the greatest number of lives can be saved with the least expenditure of effort. From this standpoint there are two aspects of the public health program which tend, and rightly tend, to overshadow all the rest, the campaigns against infant mortality and tuberculosis. These are the two lines of endeavor which promise the largest results in actual life saving; and in both these fields of effort the part played by sanitation and bacteriology in the narrow sense is a relatively small one. We can reduce infant mortality by the pasteurization of milk, by the elimination of flies, and by protecting the baby from contact with infected persons; but these are after all incidents in a broad program which involves the education of the mother in the whole technique of infant care, feeding, clothing, airing and bathing. What we are really aiming at is a reform in personal hygiene.

The campaign against tuberculosis offers another illustration of the same general principle. We can do something by providing a sanitary environment in which the worker is protected against vitiated air and harmful industrial dusts. We can do something by control of the careless consumptive and the consequent reduction of the menace of specific infection. Our main weapon against tuberculosis is, however, again, the weapon of personal hygiene. The principal machinery upon which we rely is designed to detect the early case and to impose upon the individual in the home or in the sanatorium a regimen of daily living that will make it possible for his own tissues to wage a winning fight against the invading microorganisms. Once more the problem is primarily a problem in the personal conduct of the individual life, and we see the teacher of personal hygiene emerging as a supremely important factor in the present-day compaign for public health.

According to the Director of the Census the five principal causes of death in the Registration Area of the United States for 1916, with the number of deaths caused by each were as follows:

Heart diseases	114,000
Tuberculosis	101,000
Pneumonia	98,000
Bright's disease	75,000
Cancer	58,000

Of these five causes of death there are two, pneumonia and tuberculosis, in which the sanitation of living and work places, the isolation of the infected individual, and in the case of pneumonia, the use of sera and vaccines do play an important part. Even with tuberculosis and pneumonia, however, education in personal hygiene fills a large place in the modern preventive campaign. Heart disease and nephritis may of course often be the end results of bacterial infections, but the immediate problem of their control is not to be sought along conventional sanitary and bacteriological lines. In the past they have indeed been considered as beyond the range of control measures of any kind. With these diseases too it seems clear, however, that education in personal hygiene offers large possibilities of effective results. If the weakness of the heart or arteries be known in time the adoption of proper rules for daily living can at least postpone the fatal result, if it can not effect organic cure.

It is for these reasons that the public health campaign of the present day has become pre-eminently an educational campaign. There are those who maintain that because the public health authority alone possesses the power to enforce regulations with the strong arm of the law such authorities should confine themselves to the exercise of police power, leaving educational activities to develop under the hands of private agencies. The actual amount of life-saving that can be accomplished by purely restrictive methods is, however, small, and such exercise of police power as may be necessary can only gain in effectiveness if it forms an integral part of a general campaign of leadership in hygienic living.

We have now added to the function of the sanitarian and the bacteriologist that of a new figure in the public health campaign, the teacher of personal hygiene; but we can not stop here if we are prepared to follow the courageous public health official in his determination to adopt whatever machinery may prove necessary for the saving of a maximum number of lives at a minimum cost.

Education in personal hygiene is in part a general propaganda applicable to all alike. There are certain fundamental principles as to food, fresh air, exercise and rest, which every one should know in order to manage wisely the delicate physical machine entrusted to his charge. Unfortunately, however, each living machine is in some respects different from every other living machine, and in many cases deviations from the normal are so marked that they demand fundamental modifications in the regimen of daily life. The man with the weak heart needs less exercise, the man with weak lungs more air and more rest, the man with diabetes a special kind of food. In addition to the hygiene for the normal, which we may teach to all, there is a hygiene for the abnormal which requires an adaptation to each specific case. But it is obvious that the teaching of this kind of hygiene demands first of all an individual diagnosis. We are here face to face with the problem of the relation of the physician to the modern public health campaign.

In the past a sharp line was drawn between the measures taken by public health authorities to check the spread of epidemic disease and the daily routine of the practitioner in the treatment of the individual case. The first was public health, the second private medicine. With the passing of every year it becomes harder to draw such a sharp line, more difficult to say where public health should end and private medicine begin. The history of medical school inspection offers an excellent example of the tendency to obliterate such arbitrary lines. The physician was first sent into the schools in Boston in 1894 to perform a definite police function, to detect cases of communicable disease and by so doing to protect one child against the danger from another. If it had been proposed at that time to organize clinics for free treatment of disease among school children, the proposal would probably have been denounced as socialism of the most dangerous kind. Just so soon, however, as the physicians began actual work in the classroom they found that acute infections passing from one individual to another played but a small part in the total burden of preventable disease borne by the children in the schools. They found defects of teeth, defects of vision, defects of hearing, enlarged glands. Nine tenths of the time of the school inspector of to-day is devoted to problems of this kind. He is no longer protecting one child against another. He is helping each child to attain its maximum possibilities of health and efficiency.

The discovery of non-contagious physical defects was the first step in bringing the public health movement into intimate contact with the individual child. Very soon, however, it became evident that the detection of remediable defects was of little value unless something was done to remedy them, and the school nurse was drafted into service to follow the child into the home and to persuade the parents to take the measures indicated by the medical examiner's report. The development of a school nursing service as an educational agency of this sort resulted in New York City in increasing the proportion of defects actually treated from 6 to 80 per cent. In a certain number of cases, however, a new difficulty arose. Remediable defects were present and the parents were willing and anxious to have them treated, but they were without funds to pay for the special medical care that was needed. The next step was as logical as the preceding ones. It involved the establishment of school clinics for the treatment of children unable to obtain the necessary care in any other way. So, with the establishment of nose and throat clinics, eye and ear clinics, dental clinics, for the school child the obliteration of the line between public health and private medicine was well-nigh complete.

If it is good public policy to provide for the school child whatever machinery is necessary to make possible the attainment of a reasonable standard of physical health, it is difficult to see why the same arguments do not apply to the adult as well. As a matter of fact exactly the same tendencies to provide (*a*) diagnosis, (*b*) hygienic advice, (*c*) treatment when necessary, are already manifest in our tuberculosis clinics and our venereal disease clinics, and are beginning to develop in connection even with diseases of the heart and arteries and cancer. If it is sound economy to provide for the early diagnosis and sanatorium treatment of tuberculosis, it is just as sound to provide for the early diagnosis and surgical treatment of cancer. The two diseases are equally dangerous, and equally burdensome to the community; they are equally preventable, if the right educational and clinical procedures are organized for their control.

From both sides of the artificial boundary line between public health and private medicine comes the appeal for a closer correlation. The public health worker needs the physician because in so many diseases education depends on diagnosis and demands the application of medical skill. The far-sighted physician is equally eager to link up his science with the public health program, because on his side he realizes that medicine can never attain its full potentialities of service unless it is made really preventive through some type of effective professional and social coordination. It is a striking fact that in spite of the great advances in medical science diseases like heart disease and nephritis and cancer, which have been handled in the past along strictly medical lines, have shown no decrease comparable to that which has been manifested in the group of maladies with which the sanitarian has dealt. This is not because medical science is helpless but it is because medical knowledge has generally been applied only when disease has gone so far that the damage is irremediable. Medical knowledge will be highly effective only when applied in the incipient stages of disease. When this comes to pass "preventive medicine" will become a reality and not merely a catch word.

It is not for us to say to-day in just what fashion the reorganization of medical service which will make it effective for prevention can best be brought about. In the working out of such a scheme there must be first of all, within the profession itself, effective coordination of specialties in clinical and laboratory lines to provide the type of expert service which is furnished by our best hospitals and which no individual private practitioner can possibly supply. In the second place such organized medical care must be made available not merely for the very poor and very rich but for the entire community, for those who can afford to pay the whole or a part of the cost of the service they require, and for those who can not pay at all. Finally, if medical care is to be made really preventive in its application its cost must be so distributed as to encourage systematic recourse to the physician as an agent for the detection and control of incipient disease, rather than as a last resort when illness has become too grievous to be borne.

There are those who believe that these ends may be attained through group medicine and it is interesting to notice that very similar ends have actually been reached in the nursing field through private initiative as manifested in our best visiting nurse organizations. There are others who claim that medical and nursing service can best be provided in connection with a plan for sickness insurance and there are still others who urge that the insurance problem should be handled as a distinct and separate one, and that the early diagnosis and preventive care of incipient disease should be attained through a definite system of state medicine.

The working out of the best plan for securing such ends as these is a fascinating task for the publicist of the future, and it is quite possible that the problem may be solved in true Anglo-Saxon fashion by no single logical procedure but by diverse methods, suited to local ends and local circumstances. The remarkable developments during the past ten years in the field of industrial medicine may have a wide bearing on the general solution of our problem as a whole. Some 900 different industrial establishments employ at this time 1,500 industrial physicians, and the plant hospitals under their charge, from first-aid dressing stations, are developing into educational centers and diagnostic clinics and laboratories for the study of industrial physiology and vocational guidance and rehabilitation.

We have seen the emphasis of the public-health campaign move steadily inward from the environment to the individual. The primary interest of the health officer has been transferred from the swamp and the dung heap to the control of infections and thence to the detection of non-contagious physical defects and the hygienic guidance of the individual living machine.

In the development of the public health campaign to the realization of its fullest opportunities there is taking place to-day a swing of the pendulum backward to a new interest in the environment, but an environment of a nature very different from the simple environment with which Simon dealt. General Gorgas at Panama fully grasped the significance of the wider and more subtle environment which most of us are just beginning to glimpse as an essential problem in the public health campaign. He eliminated yellow fever and malaria by the drainage of marsh lands, but he attempted to deal with pneumonia by raising the wages of the employees upon the Isthmus, for he realized that in the case of this and many other diseases the most effective weapon at our disposal is the building up of general vital resistance, which depends upon the maintenance of a satisfactory social and economic level.

Dr. Emmett Holt has said that there are two causes of infant mortality—poverty and ignorance. In the infant welfare movement, the anti-tuberculosis campaign and every other field of public health, we come sooner or later to a realization of the fact that education and medical and nursing service, while they can accomplish much, can not cope successfully with the evil effects of standards of living too low to permit the maintenance of normal physical health.

As I have elsewhere pointed out, in the Johnstown survey, Miss Duke tells us that the infant mortality in one ward was 271 deaths per 1,000 births against 134 for the city as a whole and 50 for the ward which showed the lowest rate and the explanation is that "this is where the poorest, most lowly persons of the community live—families of men employed to do the unskilled work in the steel mills and the mines." Dr. Sydenstricker and his associates in the U. S. Public Health Service in a report on the relation between disabling sickness and family income among cotton mill operatives in South Carolina find that a monthly income equivalent to less than $12 per person (on an adult male unit basis) the sick rate was 70.1 per 1,000; with an income between $12 and $14 it was 48.2 per 1,000; with an income between $16 and $20 it was 34.4, and with an income of $20 and over it was 18.5.

We can conclude from these figures and from many similar investigations that poverty and sickness are closely correlated. We can not conclude that the poverty is responsible for the excess of sickness. In some instances the relation of cause and effect may be reversed. In other cases both poverty and disease may be due to underlying inheritance. People do not usually live in the poorest quarters of a city or work at its underpaid employments by choice or by accident. In general, and on the average, we shall find in such districts and such employments a concentration of tuberculous stock, of alcoholic stock, of feeble-minded stock—poor protoplasm and a bad environment supplementing each other in a vicious circle.

No one can perhaps tell just how far poverty in such cases is the real and effective cause of the failure to achieve and maintain a normal standard of physical health. It is clear, however, that there is a certain standard of income below which the maintenance of health is impossible; and it seems reasonably sure from the studies of Royal Meeker, of the U. S. Bureau of Labor Statistics, that a certain not inconsiderable proportion of the population of the United States has to-day a family income below that figure.

If an initially normal family can not gain a livelihood adequate for its minimum physical needs, there is evidently a problem of social readjustments which our nation must face as a fundamental of post-war reconstruction; but what shall we say of the family which on account of inherent physical or mental defects is unable to reach a minimum level under a wholly fair and equable basis of compensation? There are but two alternatives as I can see it; since the moral sense of mankind repudiates the rigorous application of the principle of unhindered natural selection. We can let the combination of defective protoplasm and crippling environment accomplish the major portion of its work and then salvage what we can from the wreck by some form of institutional relief. Or we can apply our social energy and our community funds to make good the deficiencies in the beginning. I have little doubt as to which will be found in the long run the cheaper way, and I am quite certain that the preventive method will prove more conducive to a high national morale.

If the foregoing outline of the problems of public health be accepted as correct, it will be obvious that the field as thus visualized is no small and restricted one. The claim to so large a province will be denied by many, within, as well as without, the public health profession. The logic of the situation and the tendencies of social development are, however, sweeping the public health movement forward to a future of wider possibilities than those dreamed of by its own protagonists. If we are looking to the future we must conceive our subject in terms no smaller than those of the following definition:

Public health is the science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing service for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health.

Public health conceived in these terms will be something vastly different from the exercise of the purely police power which has been its principal manifestation in the past.

Even to-day it is still possible to make an effective argument for increasing health department budgets by showing that appropriations for the protection of health are in most cities far less than those which are made for police and fire protection, matters of far less moment in actual possibilities of community service. As a matter of fact the police department and the fire department furnish criteria much too modest for the public health department of the future. It is rather to education that the possibilities of public health should be compared. I look to see our health departments in the coming years organizing diverse forms of sanitary and medical and nursing and social service in such fashion as to enable every citizen to realize his birthright of health and longevity. I look to see health centers, local district foci for the coordination of every form of health activity, scattered through our cities, as numerous as the school houses of today and as lavishly equipped; while the public health services of the city and state will constitute a corps of experts comparable in size and influence to the great educational organizations of the present day.

In the development of the public health campaign of the future along such lines as these it is obvious that many different experts, of fundamentally distinct training, must contribute their special resources to the common task. Ignoring all minor specialties there must be at least the following seven types of highly qualified persons in this field:

The physician	The epidemiologist
The nurse	The engineer
The bacteriologist	The statistician
The social worker	

In addition there must be inspectors to supervise sanitary conditions, housing conditions, food stores and the like, for whom no special training is provided anywhere in this country, but who should be offered brief practical courses to fit them for the relatively modest duties which their task entails. Finally there is the administrator who organizes and develops the work of all the rest.

The physician in the public health field practises medicine but with a difference, in that the goal before his eyes is prevention as well as cure, and that he has always in view not merely the individual but the community as well. In the infant welfare station and the school clinic and the tuberculosis dispensary he visualizes not merely the individual case but its family environment and its physical background. He is constantly striving to find the incipient causes of disease and to deal with those causes before they reach their deadly fruition. He must be much more than a physician in order to fulfil this task; for he must have a knowledge of bacteriology and sanitation, of health administration and statistics, above all of social relationships and social machinery which the curriculum of even the best medical schools can not attempt to supply.

So the public health nurse must be a trained nurse skilled in the relief of suffering and the bedside care of the sick, but she must be much more. Her work is primarily that of the health teacher, the messenger who carries into the home and interprets to the individual mother the gospel of good health. She must work largely alone, not under the immediate direction of a physician. She must know her bacteriology and her physiology, her sanitation and hygiene, well enough to teach their principles to others; and she too must deal with the individual, not merely as an individual, but as an element in a complex social group.

The bacteriologist in the laboratory and the epidemiologist in the field are two more of the specialists needed, whose work is concerned primarily with the war against the community infections. The former offers aids in early diagnosis and prepares sera and vaccines for the prophylactic and therapeutic treatment of these diseases; the latter by his detective work makes it possible to trace out the subtle pathways of infection by which they spread from one person to another through the complex web of community life.

The public health or sanitary engineer is again an engineer *plus*. He must have mastered the underlying sciences of physics and chemistry, of structures and hydraulics, and he must also be familiar with the technical applications of his art to the particular problems of sewage disposal and water supply, ventilation, illumination and the like.

The statistician correlates and analyzes the records of births, deaths and illnesses, keeping an expert finger as it were on the pulse of the nation's health. His work is the bookkeeping of public health, indicating the lines of profitable expansion and furnishing us with the credit balance of lives saved to the community as a result of various public health endeavors.

In the case of each of these experts, and in the case of the social worker who is operating in the field of public health, there is required sound elementary education in some fundamental branch of science with the addition of specific training in its applications to the field of public health. For the nurse who desires to become a public health nurse there are offered four-month and eight-month courses of special training in public health nursing. The physician who desires to become a public health physician, the engineer who desires to become a sanitarian, the bacteriologist who desires to become a public health bacteriologist, the social worker who desires to apply a fundamental knowledge of the principles of social readjustment within the field of public health, must similarly undergo a special training, if their services are to be made promptly and fully available. It is for this purpose that our leading universities and technical schools offer the Certificate in Public Health, which like the Master's degree is the equivalent of a year's graduate study. The C.P.H. course gives to the medical graduate the special training needed to equip him for the application of medicine in the field of public health, and in the same way enables men and women who have had college training in the fundamentals of bacteriology, engineering, sociology or statistics to fit into their special places in the general scheme of health protection.

To turn from these special phases of the public health campaign to the organization of the movement as a whole, it seems probable that the ideal public health administrator of the future will be the man or woman who has been first medically trained and has then specialized in a school of public health. If I am right in my belief that the public health movement of the future will go far in the direction of including medical and nursing service within its ample bounds, it is clear that a man who has both a medical and a public health training will possess peculiar advantages as an administrator. It is for this reason that the principal eastern universities offer the highest degree in this field, the Doctor of Public Health, only to medical graduates and require that it be earned by a rigorous course of two years of academic study.

It will be long, however, before the supply of doctors of public health is nearly adequate to the demand, and for some time to come administrative positions, as well as laboratory and statistical positions, and those concerned with social reorganization, will be open to the college man or woman of marked ability who devotes a single graduate year to study for the Certificate in Public Health.

It can be said with very literal truth of the field of public health to-day that the harvest is ready and that the laborers are few. On all hands there comes to us the call for bacteriologists and statisticians, for industrial physicians and school physicians, for public health nurses, and for health officers. The American Red Cross is inaugurating a nation-wide campaign for the development of health centers throughout the country. Each one of the thousands of health centers to be started under this plan will call for an expert personnel which does not exist at present. The state of Ohio has just conducted a civil service examination for a list of candidates for 110 positions as full-time health officers within that state, at salaries ranging from $2,000 to $6,000 a year, with permanent appointment under the civil service law; and it was necessary for the state to organize a special course of instruction in order to have anything like the number of fairly qualified candidates for the responsible positions within its gift.

The science and the art of public health have progressed to a point where they can render to the public a service to be measured in the saving of hundreds of thousands of lives in this country every year. Public authorities and private agencies from one end of the land to another are realizing these possibilities of service and are ready to provide the necessary funds and to give the necessary powers to properly qualified experts. The lack in the whole scheme of things at the present moment is the lack of personnel. As a prominent official of the Rockefeller Foundation said to me the other night, "The way they are appropriating money for public health in the southern states frightens me, because we haven't the men to send to them to help them spend it wisely." We stand, I believe, at the beginning of a new phase of human history, a phase in which the physical and mental health and efficiency of the human being will be transformed by science as the physical background of civilization has been transformed in the past half century. In the name of the need that confronts us for the personnel to carry on this work I believe we have the right to say boldly to the college men and women of America that we need them in this great business. We can promise to the college graduate, whether his leanings be toward work in the laboratory, toward sanitation in the field, toward the tasks of social propaganda and social reconstruction—we can promise to the medical student, and we can promise to the graduate nurse—that each and all of them will find in the public health movement of the future careers which will compare favorably in security and in material rewards with the average return which is won by the college and medical graduate in other fields. Above all we can promise the opportunity of a kind of service which brings a satisfaction deeper than any material reward.

There are great unsolved problems waiting for the Pasteurs of the future. Influenza, pneumonia, cancer and the rest of the unconquered plagues will some day yield to the patient assault of science, and it may well fall to the lot of young men who are entering our laboratories to-day to write the obituary of these diseases as Walter Reed did that of yellow fever in 1900. Two of Reed's letters to his wife after he and his associates had made the great discovery that ensured the conquest of yellow fever in the ensuing year, are so full of the solemn dignity of such a victory that I will quote them.

Six months ago, when we landed on this island, absolutely nothing was known concerning the propagation and spread of yellow fever—it was all an unfathomable mystery—but to-day the curtain has been drawn.

And later on New Year's Eve, he wrote:

Only ten minutes of the old century remain. Here have I been sitting, reading that most wonderful book, "La Roche on Yellow Fever," written in 1853. Forty-seven years later it has been permitted to me and my assistants to lift the impenetrable veil that has surrounded the causation of this most wonderful, dreadful pest of humanity and to put it on a rational and scientific basis. I thank God that this has been accomplished during the latter days of the old century. May its cure be brought out in the early days of the new.

Yet we need not wait for any of the great discoveries of the future to make the public health campaign of the present day bear fruit. We want sanitary statesmen as much as investigators. We need organizers and propagandists for the cause of health, capable of building wisely the great scheme of health protection of the future and of enlisting in its support the enthusiastic cooperation of the peoples of the earth To the administrator, as much as to the investigator comes the consciousness of a reward for his labors, fuller and more immediate than that which can be earned in many walks of life, for he can know that in a given city in a given year so many hundreds or thousands of men and women and children are alive and well who would have been in their graves except for him. What old Sir John Simon said of industrial diseases is true of every kind of preventable malady which afflicts mankind.

The canker of . . . disease gnaws at the very root of our national strength. The sufferers are not few or insignificant. They are the bread winners for at least a third part of our population. . . . That they have causes of disease indolently left to blight them amid their toil . . . is surely an intolerable wrong. And to be able to redress that wrong is perhaps among the greatest opportunities for good which human institutions can afford.

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THE ORGANIZATION OF RESEARCH[1]

THIS is an age of organization. Almost within the lifetime of some of us the industries, with the exception of agriculture, have passed in large degree from the individualistic to the corporate form. Combinations not merely of national but of international scope exercise a large measure of control over manufacturing and commercial activities, while associations of the greatest variety—commercial, charitable, reformatory, labor—have multiplied until their name is "legion." Almost every conceivable calling, from the midwife's to the undertaker's, is organized.

Since science is a product of human activity its methods must necessarily be influenced by the spirit of the time. In particular, the successes of groups of scientific men in making important contributions to the solution of the technical problems raised by the entry of the United States into the world war has led to an emphasis upon the advantages of organization and cooperation in research which was very much in evidence at the last meeting of this association. This was particularly evident, perhaps among the biologists where it was, in the words of another, "the dominant note," but the same note has been sounded by various prominent writers both before and since that meeting. It seems desirable, therefore, in view of this apparently strong trend of both public and scientific opinion, to inquire somewhat carefully into the extent to which it is justified and as to the probability that a more complete organization of research will enable it to render more efficient public service. In attempting to do so I shall, of course, have reference particularly to agricultural research—implicitly if not explicitly.

In the early history of science, research was necessarily upon an almost purely individualistic basis. Men of genius here and there were laying the foundations of the present amazing superstructure not only without

[1] Address of the vice-president and chairman of Section M—Agriculture, American Association for the Advancement of Science, St. Louis, December, 1919.

public support but subject sometimes to scorn and even persecution but more often to an indifference not reaching the level of contempt. By slow degrees, however, it began to dawn upon the public that the investigations of these dreamers really had some significance for the practical conduct of life. Very gradually at first, but with an accelerated velocity as time went on, the scientist came to be recognized as a useful member of society although even yet he seems too often regarded in the light of a sort of "medicine man" who can be called upon to work magical incantations in times of need or peril or as a magician who, by some sort of legerdemain, can accomplish the seemingly impossible.

Along with this growing recognition of the economic and commercial value of its results, scientific research began in time to be regarded more and more as a public function and to be more or less adequately supported, either by private endowment or notably by governmental action. The latter has been especially the case with agricultural research. I need not rehearse to this audience the familiar story, beginning with the foundation of the first public experiment station at Moeckern in 1852, the growth of the European experiment stations, the founding of the early American stations by state action, the enactment of the Hatch and Adams Acts, the increasing appropriations by the states and the enormous growth of the United States Department of Agriculture. For agricultural research it has been a period of expansion and organization upon an unprecedented scale and it is scarcely to be wondered at that the real nature of the end aimed at was sometimes lost sight of in the consideration of the means by which it was to be reached nor that the proper freedom of research should have been in some degree menaced, on the one hand by bureaucratic administration and on the other by the pressure for immediately useful results.

It is unnecessary to remind you that this tendency gave rise to a wholesome reaction. For several years it appeared necessary to stress the fundamental significance of the initiative and independence of the individual investigator but by the time the United States entered the war it may be said that this view had received fairly general recognition and there was perhaps a tendency to excessive individualism and a certain lack of coordination and cooperation in agricultural research.

With our entry into the war began a new era in scientific activity as well as in world politics. Urgent war needs led to a concentration of scientific effort upon special problems of the most varied character and to a degree of cooperation and coordination until then unknown. The results were almost spectacular and as a natural consequence there has come a revival of interest in cooperative work and the demand for better organization of research which has already been referred to. Probably the most conspicuous as well as the most familiar example of this is found in the statement made by The Hon. Elihu Root before the Advisory Committee on Industrial Research of the National Research Council.[2] He says:

> Scientific men are only recently realizing that the principles which apply to success on a large scale in transportation and manufacture and general staff work apply to them; that the difference between a mob and an army does not depend upon occupation or purpose but upon human nature; that the effective power of a great number of scientific men may be increased by organization just as the effective power of a great number of laborers may be increased by military discipline.
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> All other (than very great) minds need to be guided away from the useless and towards the useful. That can be done only by the application of scientific method to science itself through the purely scientific process of organizing effort.
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> It remains to be seen whether peoples thoroughly imbued with the ideas and accustomed to the traditions of separate private initiative are capable of organizing scientific research for practical ends as effectively as an autocratic government giving direction to a docile and submissive people.

Similarly Whetzel[3] writes:

2 Science, November 29, 1919.

3 Science, July 18, 1919.

The fact remains that while the rest of mankind has gone far along the way which we (the scientific men) have discovered and pointed out we still remain largely isolated and intrenched in the feudal towers of our individualism. Here behind moat and wall we shape and fashion those intellectual darts with which at our annual tourneys we hope to pierce the haughty pride of some brother baron. Yet common sense, the common good, the very progress of our profession demands that we abandon this ancient outworn attitude.

And Coulter[4] says:

Our isolated, more or less competitive investigations have resulted in a certain amount of progress; but it has been very slow compared with what cooperation would have secured.

Nor do the advocates of organization lack apparently convincing examples of success in scientific cooperation. Not to speak of the striking wartime achievements in the applications of chemistry, physics and engineering, one may name such typical illustrations in the field of agriculture as those cited by Shear,[5] namely, the cooperative work of several bureaus of the Department of Agriculture upon the chestnut blight problem and upon the spoilage of fruits and vegetables in transit and especially the work of the War Board of the American Society of Phytopathologists, while in a related field the work of the Interallied Scientific Food Commission, although cut short by the German collapse, may also be cited. Shear speaks of this trend cooperation as a "tide in the affairs of men."

But not withstanding all these emphatic dicta, may it not be well to call a moment's halt to consider whither this tide is carrying us and whether it really "leads on to fortune." May there not be a certain danger of overlooking the significance of the individual? We must beware of being stampeded by the brilliant successes of the war time into an undue exaltation of the virtues of cooperation and organization. Both are doubtless very valuable but many of their ardent advocates seem to overlook the fact that the recent highly successful essays in cooperation which they emphasize were chiefly directed to the solution of immediate technical problems by the application of knowledge acquired largely by individual research. The striking results of war-time cooperation were very largely of the nature of inventions rather than of discoveries. The achievements in sound-ranging, in ballistics, in submarine detection, in aviation, in gas warfare, in the control of plant diseases and the like were possible only as the fruition of long and patient researches into the fundamental laws of physics, chemistry, and biology conducted quietly by individuals or by little groups without public notice or applause. It is just as true to-day as it ever was that the permanent and significant advances of science depend in the last analysis on the initiative and originality of individuals. Nothing can alter this fundamental fact.

But on the other hand the fullest recognition of the paramount importance of the individual investigator should not blind us to the great significance of the experiences of the last few years. Let us first consider what they teach us as to the sort of problems best suited for cooperative effort. What is the field of cooperation as contrasted with individualism?

As just noted, the problems of war-time cooperation were largely the problems of practise and it is these practical problems which seem to offer the greatest opportunity for cooperation. Such problems, however, constitute one extreme of an intergrading series whose other extreme is the problems of so-called "pure" science. Using Coulter's[6] terminology and speaking of the former as superficial and of the latter as fundamental problems, it may be said that in general as we pass from the superficial toward the fundamental, cooperation becomes a less and less promising method for research. Usually the best thing that can be done for the man of scientific vision, who is capable of the most fundamental kind of research, is to supply him with the necessary equipment and facilities and then let him alone. Committees and cooperators are in danger of being hindrances rather than helps. Comparatively few of us

[4] SCIENCE, April 18, 1919.

[5] *Scientific Monthly*, October, 1919, p. 342.

[6] SCIENCE, April 18, 1919, p. 365.

can be ranked in that class, however. The majority of investigators must be content to be journeymen rather than master builders on the edifice of science and the rate of progress of the structure depends very largely on the persistent, conscientious work of the ordinary investigator. The advance of science as a whole is, after all, a rather prosaic affair, including a vast amount of drudgery and requiring patient "plugging" rather than genius.

Furthermore, the problems of more immediate importance to mankind are often the less fundamental ones or those near the middle of the series. It is for the more superficial or practical problems and for the ordinary investigator that organized cooperation seems most promising. It is investigators of this type, possessing varying degrees of initiative and inspiration, who can profit most largely by mutual association, particularly in connection with the more superficial problems, while it is in this type of investigation that the initiative and inspiration of the individual is at once most significant and most in danger of being suppressed. They, more than the genius, need the inspiration and stimulus to initiative which comes from close contact with their fellow workers.

Another class of problems in which cooperation seems especially called for are those requiring the application of diverse branches of science. Such was notably true of many war problems and is perhaps particularly the case with the larger agricultural problems of a more or less practical nature—especially regional problems such as the development of farming in the semi-arid regions, the study of plant diseases or, in a different field, such questions as sewage disposal.

In brief the teaching of our war experiences, as I see it, is that our rate of future scientific progress will depend, not exclusively upon cooperation on the one hand nor upon individualism on the other but upon a wise combination and adjustment of the two in varying proportion according to the nature of the problem attacked and the abilities of the investigators concerned.

Granting the truth of this view, a second fundamental question is, "How can cooperative effort, where desirable, be most efficiently organized?"

Substantially three things are to be effected. First, that effort shall be directed to really significant and fundamental problems. The issues of civilization are too vast for us to lapse into dilettanteism. Second, that the methods employed shall be sound, so that effort may not be frittered away in empirical experiments leading nowhere. Third, to secure that stimulus to zeal and persistence which comes from association in a common cause.

How can these objects be realized? How can we gain the advantages of association and cooperation without sacrificing that initiative of the individual upon which, in the last analysis, the efficiency of even practical research depends. I think we should all agree that this can not be effected by any such bureaucratic or even military organization as would seem to be contemplated by the words of some writers—notably by Mr. Root in the passages which I have quoted. Let me repeat a single phrase:

> That the effective power of a great number of scientific men may be increased by organization just as the effective power of a great number of laborers may be increased by military discipline.

Such expressions as these, like a certain notorious report on academic efficiency, if taken at their face value, betray an almost ludicrous misconception of the conditions of productive scientific activity and are particularly surprising in a man of Mr. Root's breadth of view, who in the same statement has shown so clear an appreciation of the value of abstract research. Organization of this sort may serve for a works laboratory doing routine control work or perhaps for the law offices of a great firm but we can not stimulate scientific investigation by strangling personal initiative. The question is how investigation can be coordinated without destroying the individuality of the investigator. This can not be done by laying down hard and fast plans involving any sort of factory system of division of labor.

And yet, as I have tried to make clear, reasonable cooperation and coordination in research offer possibilities for greatly increasing the rate of scientific progress. Individualism and cooperation must not be antagonists but yokefellows in the chariot of science. What then shall be the binding force which shall fuse these two ideas? Precisely the same that held together the various groups of scientific men during the war, viz.; the tie of a common interest and a common purpose. I have compared the great body of investigators to journeymen but this does not mean that they are merely "hands." They are self-directed workers and therefore any organization of them must be democratic. They are all partners in the enterprise and sharers in its profits. The men who worked together almost night and day to devise efficient gas masks or means of submarine detection or methods of sound ranging were not workmen under the orders of a superior, but free associations of scientists with training in common or related fields of research and under the inspiration of a common patriotism. Precisely this is what is needed to achieve the victories of peace. Effective cooperation can not be imposed from above by administrative authority but can only come by free democratic action of investigators themselves. In saying this I am not charging administrators with either indifference or incompetency. The difficulty lies in the nature of things. There must be the will to cooperate.

We may, I think, distinguish two distinct forms of cooperative organization which we may call for convenience institutional organization and subject-matter organization.

In the agricultural field, at least, much emphasis has been laid in the past upon institutional cooperation as between different experiment stations, between the stations and the U. S. Department of Agriculture, and to some extent at least between some of the bureaus of the latter department. Much anxiety has been expressed over the real or supposed duplication of work by the state stations and Section 3 of the Hatch Act seems to contemplate more or less coordination of experiments. It is within the memory of some present, too, that the first conception of the Office of Experiment Stations was that of a central directing agency. While this idea was early abandoned, numerous voluntary efforts toward the coordination of projects have been attempted through committees of the Association of Colleges and Experiment Stations, one recent suggestion, that of a sort of Agricultural Research Council, constituting more or less of a reversion to the early conception of the Office of Experiment Stations.

On the whole, however, it may be doubted whether the results reached in this way have been commensurate with the conscientious and praiseworthy efforts put forth by the experiment stations and the Department of Agriculture. These institutions and to a large degree the individual bureaus largely go their own way, with the exception in the case of the stations of the restrictions involved in the approval of projects by the Office of Experiment Stations, and this condition seems likely to continue.

Meantime the various forms of war work have afforded striking illustrations of the success of the second type of cooperative effort, *viz.*, cooperation by subject-matter. The significant lesson of war-time organization is the efficiency with which scientific men in the same field have got together, largely independent of institutional or administrative subdivisions. I believe that this same principle can be applied to the more fundamental research problems—that scientific men may to advantage organize in this way, forming group or regional conferences which might be especially profitable for those living in somewhat isolated localities and not in such ready contact with their fellows as is the case with those situated on the Atlantic seaboard. Such free conferences, formulating the common judgment of workers in identical or related fields can scarcely fail to furnish both guidance and inspiration for the progress of research. In brief, I believe we can very effectively promote research by consultation and conference of those interested in particular subjects or groups of subjects. We should thus have a loose organization at right angles, so to speak, to the administrative organization, which would bring the collective judgment of experts to bear upon the choice of scientific problems and upon the adoption of adequate methods for their solution and which would not be in any sense antagonistic to the official organization.

Much progress has already been made in this direction. For example The American Society of Animal Production has formulated a valuable set of standard methods for the conduct of feeding experiments, while the very effective work of the War Board of the American Society of Phytopathologists is familiar to us all and still another illustration is the Association of Southern Agricultural Workers. But the most significant and comprehensive achievement in the organization of American research is one which has been prominently before the scientific public and with which we are all familiar, viz; the National Research Council. From the point of view advocated in this paper its organization is peculiarly significant because it was effected by the voluntary initiative of the investigators themselves and because, therefore, it is thoroughly democratic in form and has been careful both in its initiation and development to conserve the individuality of the research men. The past successes of this wise combination of organization and individualism demonstrate its essential soundness and constitute the best guarantee of its future achievements.

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SCIENTIFIC EVENTS

CONFERENCE OF BRITISH RESEARCH ASSOCIATIONS

A conference of research associations—the second of a series—organized by the British Department of Scientific and Industrial Research, was held according to *Nature* on December 12 in the lecture-theater of the Institution of Civil Engineers. The Right Hon. A. J. Balfour, Lord President of the Council, appropriately presided, the Department of Scientific and Industrial Research being a committee of the Privy Council. Mr. Balfour, who was warmly greeted on his first public appearance in his capacity of head of the department, delivered a short introductory address on the national need for scientific research, especially in its application to industry. Three points emphasized by Mr. Balfour were that, though man does not live by bread alone, the amelioration of the material lot of mankind can come only through progress in scientific knowledge; that we must not imitate, but follow the example of the Germans in realizing a helpful and close alliance between science and industry; and that in the prosecution of this aim the paramount interests of pure science must not be overlooked. Papers were afterwards read by Major H. J. W. Bliss, director of the British Research Association for the Woollen and Worsted Industries, on "Research Associations and Consulting Work and the Collection and Indexing of Information," and by Dr. W. Lawrence Balls on "The Equipment of Research Laboratories." There was a general discussion on the subject-matter of the two papers, from which it was clear that, although there is a large common measure of agreement among the different associations, there is also enough variety of circumstance and character to make it desirable for each association to work out its own salvation in many problems of organization and method. It is the intention of the Department of Scientific and Industrial Research to continue periodically these conferences of research associations. As the department, in fostering the associations, is engaged in a novel adventure in government enterprise, the research associations have to set sail on uncharted seas, without maps or precedent experience to guide them, and these periodical conferences must be of great help to them in mapping out their courses and taking their soundings.

THE MEDICAL STRIKE IN SPAIN

The *Journal* of the American Medical Association states that the town of Jerez de la Frontera, which has a world reputation on account of its famous wines, has just witnessed the first general strike of physicians. This strike originated because the municipal authorities, disregarding all statutory provisions and trusting to political influence, failed to keep their pledges, and the salaries due the employees finally amounted to 1,000,000 pesetas (about $200,000). When the physicians became tired of seeing that, in this period of better compensation for labor, they were the only ones who could bring home the wages they had earned, they unanimously decided to go out on strike. The mayor and the members of the town council were very indignant at this action, their arguments running somewhat as follows: "It is very strange that the physicians should be so rebellious, and especially now, when the town council has just spent several thousand dollars for celebrations and bull fights, thus showing our desire to please the people and attract foreigners. The physicians do not bear in mind the fact that we can not pay their salaries, since to do so would be to show partiality in their favor; in a place where no one is paid, it is an imposition to ask for money. If we have spent so much for festivals it has been only because the bull fighters and actors would not have come otherwise; but every one understands that if we could have got out of paying them, we would not have paid them either." These reasons did not influence the physicians, who suspended all official relations with the municipal authorities, and who, while continuing their care of the poor, refused to submit any reports, would not sign any official certificates, or attend the municipal dispensaries, and let public opinion and the government decide the matter. At first the local authorities threatened the physicians, at whose head was Dr. Aranda, one of the most prominent surgeons of Andalusia. The physicians proved adamant against all kinds of pressure that was brought to bear on them for over a month. At last the government decided to enforce the law; it dismissed the municipal council and appointed new counselors so as to help solve the situation. The result has been that the physicians will immediately receive one half of the amount due them, and the balance very shortly. This is the first medical strike that ever took place in Spain. It has received support not only in the country in general, but also at the hands of the government.

RESOLUTIONS OF THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE attention of the Anthropological Society of Washington having been called to an open letter published in *The Nation* of December 20 by Dr. Franz Boas under the title "Scientists as Spies," and after said article was read and duly considered, the following resolution was adopted and ordered to be submitted to the American Anthropological Association at its meeting in Boston; to Section H of the American Association for the Advancement of Science meeting in St. Louis; and to the Archeological Institute of America at its meeting in Pittsburgh, with a request that suitable action be taken by these associations. Also, that a copy of this resolution be sent to *The Nation* and SCIENCE, with a request for its publication.

Resolved: That the article in question unjustly criticizes the President of the United States and attacks the fundamental principles of American democracy;

That the reflections contained in the article fall on all American anthropologists who have been anywhere outside the limits of the United States during the last five years;

That the information thus given is liable to have future serious effects on the work of all anthropologists outside the boundaries of the United States; and

That the accusation, given such prominent publicity and issuing from such a source, will doubtless receive wide attention and is liable to prejudice foreign governments against all scientific men coming from this country to their respective territories, particularly if under government auspices; therefore

Be it resolved, that in the opinion of the council of the Anthropological Society of Washington, the publication of the article in question was unwarranted and will prove decidedly injurious to the interests of American scientists in general; that the author has shown himself inconsiderate to the best interests of his American colleagues who may be obliged to carry on research in foreign countries; and that his action, therefore, deserves our emphatic disapproval.

BIOLOGICAL SURVEYS OF STATES BY THE UNITED STATES DEPARTMENT OF AGRICULTURE DURING 1919

Work in biological investigations of birds and mammals by the Bureau of Biological Survey, U. S. Department of Agriculture, and cooperating institutions, while somewhat interrupted by the war, is rapidly getting back to normal. The work falls into three principal divisions, namely, investigations of habits, distribution, migration, and systematic studies of birds, investigation of the habits and relationships of mammals, and natural history surveys of the states. This note deals with work under the latter head only.

In Wisconsin the State Geological and Natural History Survey is cooperating with the United States Department of Agriculture in the work, which is in charge of Dr. Hartley H. T. Jackson for the Department of Agriculture, and Professor George Wagner of the University of Wisconsin for the State of Wisconsin. Work was begun May 15 and continued until September 20. The principal field of cooperation was the northwestern part of the state, special attention being devoted to the Apostle Islands in Lake Superior. Mr. Harry H. Sheldon for the Biological Survey, and Mr. Arthur J. Poole for the Wisconsin Survey assisted throughout the season.

In Montana, Mr. Marcus A. Hanna, assisted by Mr. Harry Malleis, worked the valley of the Missouri and the bordering plains and mountains from the mouth of Milk River westward, under the general direction of Mr. Edward A. Preble. The Little Rockies, Moccasin Mountains, Big and Little Belt Mountains and Castle Mountains were visited during the latter part of the summer. Victor N. Householder was a member of the party during the early part of the season.

The biological survey of Florida was continued by Mr. Arthur H. Howell. Field studies were carried on during March and April over a large part of Lee County and in the region around Lake Okeechobee. The collections in the Florida State Museum were examined and the specimens carefully identified. A collection of bird records from Florida, both published and unpublished, shows approximately 390 species and subspecies recorded from the state.

Cooperating at different times with the Biological Survey in field work in the state of Washington were the following: Professor William T. Shaw, State College of Washington, Pullman; Professor H. S. Brode, Whitman College, Walla Walla; Professor J. W. Hungate, State Normal School, Cheny; Professor J. B. Flett, National Park Service, Longmire; Mr. William L. Finley and Mrs. Finley, Portland, Oregon; and Stanton Warburton, Jr., of Tacoma. The Biological Survey was represented for a part of the time by Mr. Stanley G. Jewett, Pendleton, Oregon; and throughout the season by Mr. George G. Cantwell, Puyallup, Washington, and Dr. Walter P. Taylor, of the Biological Survey, the last named in charge of the work. Investigations were made in the Blue Mountains area of extreme southeastern Washington, in which occurs an unusual mixture of Rocky Mountain and Cascade Mountain types; and in Mount Rainier National Park, in connection with which the circuit of Mount Rainier was made for the first time, so far as known, by any vertebrate zoological expedition.

In North Dakota Mr. Vernon Bailey worked through September and October to get data on the hibernation of mammals and on the stores of food laid up for winter by non-hibernating species. He has returned with many valuable notes to be added to his report on the mammals of the state, and with an interesting collection of live rodents for study of habits in captivity.

SCIENTIFIC NOTES AND NEWS

Sir William Osler, regius professor of medicine at Oxford University, died on December 29, aged seventy years.

Dr. L. O. Howard, chief of the Bureau of Entomology of the United States Department of Agriculture and for twenty-two years permanent secretary of the American Association for the Advancement of Science, was elected president of the association at the St. Louis meeting. Dr. Edward L. Nichols, who last

June retired from the chair of physics at Cornell University, was elected general secretary of the association. The other officers elected and a report of the meeting are given elsewhere in this issue.

DR. SHEPHERD IVORY FRANZ was elected president of the American Psychological Association at the meeting held in Cambridge last week.

PROFESSOR RALPH B. PERRY, of Harvard University, was elected president of the American Philosophical Association at the meeting in Ithaca last week. Professor Alfred H. Jones, of Brown University, was elected secretary.

AT the Boston meeting of the Paleontological Society, officers were elected as follows: *President,* F. B. Loomis, Amherst; *Vice-presidents,* C. C. Case, Ann Arbor; Ralph Arnold, Los Angeles; E. M. Kindle, Ottawa; *Secretary,* R. S. Bassler, Washington, D. C.; *Treasurer,* Richard S. Lull, New Haven; *Editor,* W. D. Matthew, New York.

AT the Society of American Bacteriologists, also meeting in Boston, the following officers were elected: Dr. Charles Krumweide, of the research laboratory of the New York Health Department, *president;* Dr. F. C. Harrison, president of the MacDonald College in Montreal, *vice-president;* Dr. A. Parker Hitchens, of Indianapolis, was reelected *secretary-treasurer,* and Dr. J. W. M. Bunker was chosen *assistant secretary,* a new position in the organization. New members of the council are Dr. F. P. Gay, professor of pathology and bacteriology at the University of California, and Dr. C. G Bull, professor of immunology at the Johns Hopkins School of Hygiene in Baltimore. A committee on national research was created, consisting of all the past presidents, with Dr. Bunker as executive secretary, and Dr. S. C. Prescott, of Boston, as chairman.

THE William H. Nichols medal of the American Chemical Society will be conferred on Dr. Irving Langmuir for his work on "the arrangement of electrons in atoms and molecules," at the March meeting of the New York Section of the society.

THE Perkin medal for 1919 has been awarded by the American Section of the Society of Chemical Industry to Dr. Chas. F. Chandler, for his work on the standardization of kerosene. The committee in making the award called especial attention also to the work Professor Chandler, as head of the chemistry department of the school of mines at Columbia University, has done in training men for the chemical industry. The medal will be presented to Dr. Chandler, "dean of American chemists," at the regular meeting of the Society of Chemical Industry, American Section, at the Chemists' Club, New York City, on January 16.

DR. LOUIS A. BAUER will repeat his illustrated lecture on "The Solar Eclipse of May 29, 1919, and the Einstein Effect" at the Johns Hopkins University, Monday afternoon, January 12; at Yale University, under the auspices of the Society of Sigma Xi on the evening of January 13; and at Brown University on the evening of January 16. At the stated meeting of the American Academy of Arts and Sciences at Boston on January 14, he will give an illustrated address on "Observations of the Solar Eclipse at Cape Palmas, Liberia, and other Stations."

AT the meeting of the Philosophical Society of Washington on January 3 the following papers were read: Enoch Karrer: I. "Diffusion of light in a searchlight beam." II. "The contrast sensibility of the eye at low illumination." F. E. Wright: "The contrast sensibility of the eye as a factor in the resolving power of the microscope." L. A. Bauer: "Further results of observations of the solar eclipse of May 29. 1919.

SIR OLIVER LODGE delivered the Trueman-Wood lecture on "Some Possible Sources of Energy," at the Royal Society of Arts on December 10.

WE learn from *Nature* that on December 10, a memorial tablet with a medallion portrait and a suitable inscription was unveiled in memory of Sir Ramsay in the presence of Lady Ramsay and a large number of friends and members of the University of Glasgow.

The address of presentation was delivered by Professor G. G. Henderson, of the Regius chair of chemistry, and the custody of the memorial was accepted on behalf of the University Court by the vice-chancellor. The medallion is the work of Mr. Paulin, and is an excellent likeness; the design of the memorial is due to Sir John J. Burnet. The mural tablet is placed at the head of the great staircase leading to the Bute Hall and the Hunterian Museum. It is set in an arched recess lined with grey marble, and bears reliefs illustrating Sir William Ramsay's numerous decorations and honors.

The trustees of the American Medical Association have made an appropriation of money to further meritorious research in subjects relating to scientific medicine and of practical interest to the medical profession, which otherwise could not be carried on to completion. Applications for grants should be sent to the Committee on Scientific Research, American Medical Association, 535 North Dearborn Street Chicago, before February 1, 1920, when action will be taken on the applications at hand.

We learn from the *Journal* of the American Medical Association that on the initiative of Professors Forssner, Forssell, Holmgren and Dr. Key, of Stockholm, and Professors Quensel and Petrén, of Upsala, and Lund, a meeting was held recently to organize the Svenska Sällskapet for medicinsk forskning to promote scientific research in Sweden. Already 169 members are enrolled and the officers elected. They include a number of prominent laymen, directors of banks, consuls and others besides leading professors in the medical sciences. Professor Quensel in the opening address emphasized that the rapidly changing world has brought the necessity for new orientations and the blocking out of new routes, and he cited the saying, "If the human race can be perfected, it is in the medical sciences that the means for this must be sought." The aim of the new society is to provide funds for medical research, and the treasury starts with a donation of 5,000 crowns from a legacy.

The next annual congress of the Royal Institute of Public Health, which suspended these meetings during the war, is to be held at Brussels from May 20 to 24, inclusive, by invitation of the Burgomaster, M. Adolphe Max. Delegates will be invited from all the universities, municipalities and other public bodies in due course. Meanwhile, all wishing to take part should communicate with the Hon. Secretaries, the Royal Institute of Public Health, 37 Russell-square, London, W.C. 1.

The magnetic-survey vessel *Carnegie* left Washington on October 9, on a two year cruise of 64,000 nautical miles. She arrived at her first port of call, Daker, Senegal, West Coast of Africa, on November 23, but owing to bubonic plague sailed a few days later and is now en-route to Buenos Aires, Argentina, arriving there about the end of January. Mr. J. A. Fleming, Chief of the Magnetic Survey Division of the Department of Terrestrial Magnetism, has been designated to represent the director of the department in the inspection of the work and vessel at Buenos Aires, and he accordingly sailed from New York on December 31. The scientific personnel of the present cruise consists of the following: J. P. Ault, in command; H. F. Johnston, magnetician, second in command; Russell Pemberton, surgeon and observer; A. Thomas, H. R. Grummann and R. R. Mills, observers.

According to the *Journal* of the American Medical Association during a recess in sessions of the International Conference of Women Physicians in New York, thirty-five distinguished women physicians from foreign countries visited the Johns Hopkins Hospital recently and studied facilities at the institution. The general program for the day was arranged by Dr. Florence R. Sabin, Baltimore, who received the delegates. The first inspection was of the gynecologic department, where Drs. Howard A. Kelley, Guy Hunner and Thomas S. Cullen acted as pilots. At the Harriet Lane Home, an exhibition of children's diseases was prepared. Dr. John J. Abel, gave a short address on the general subject of physiology, followed by a talk on dietetics by E.V. McCollum. Dr. George L.

Streeter gave a talk on embryology. Luncheon was served at 1 o'clock, after which Dr. Adolf Meyer, head of the Henry Phipps Psychiatric Clinic, lectured on the work of his department. The remainder of the afternoon was devoted to a study of the obstetric departments.

Professor George C. Whipple, of Harvard University, as has been noted in Science, has been appointed director of the division of sanitation in the Bureau of Hygiene and Public Health of the League of Red Cross Societies. He has been granted leave of absence from Harvard University for the second half year and will go to Geneva in February, returning to Cambridge in September, 1920. The organization referred to will be virtually the Health Department of the League of Nations, and it will offer exceptional opportunities for sanitary engineers. Heretofore the Red Cross has chiefly engaged in relief work. It is now to add to this work that of preventing disease by improving sanitary conditions. Professor Whipple is a member of the engineering firm of Hazen, Whipple & Fuller, New York City. Another member of this firm, Colonel Francis F. Longley, has been appointed associate director of the division and will go to Geneva about the first of December in order to be ready to undertake emergency work in the Balkans should typhus fever break out there.

The fall meeting of the Bureau of Personnel Research, which was recently held at the Carnegie Institute of Technology, was attended by representatives of the following cooperative concerns: the American Multigraph Sales Company, the American Rolling Mill Company, the Burroughs Adding Machine Company, the Carnegie Steel Company, the Commonwealth Edison Company, Crutchfield and Woolfolk, Equitable Life Insurance Company, B. F. Goodrich Company, John Hancock Mutual Life Insurance Company, H. J. Heinz Company, Kaufmann Department Stores, Miller Saw-Trimmer Company, Packard Motor Car Company, Philadelphia Company, Phœnix Mutual Life Insurance Company E. W. Woods Company, and The Westinghouse Electric and Manufacturing Company. Dr. Bingham, the head of the division of applied psychology of the Carnegie Institute of Technology, was one of the speakers at the meeting.

A bill recently has been passed by the Canadian House of Commons creating a federal department of health and providing for a minister of health and advisory committee. The authority of the department will extend to all matters affecting health within the jurisdiction of the Dominion of Canada.

At the recent Bournemouth meeting of the British Association for the Advancement of Science a meeting was held with the object of eliciting opinions as to whether the recently formed Scientific Research Association should be continued or wound up. Professor A. Gray presided over a small attendance. It was explained by Mr. A. C. Tansley, the acting secretary, that the functions of the new association were the establishment of adequate means of communication and coordination in science, the organization of the endowment for research, and publicity and propaganda. Circulars sent out last spring to 2,000 scientific people had elicited only 230 replies. There appeared to be a certain amount of hostility to the association on the part of leading scientific men, and there was apathy on the part of the general mass of scientific workers. No decision was arrived at, but Professor Gray said that they must press upon already existing bodies the desirability of conserving to the very utmost the interests of pure science.

UNIVERSITY AND EDUCATIONAL NEWS

A school of public hygiene has been established as a separate department of the University of Pennsylvania. This department, which has been under the supervision of the medical school, and which was the first school of public hygiene in America, will continue under the direction of Dr. Alexander C. Abbott as director.

A new $150,000 chemistry building has been completed at the State College of the University of Montana, Bozeman. Appropriate dedicatory exercises will be held on January 14. Professor W. F. Coover, head of the chemistry department of the Iowa State College, will deliver the principal address. The occasion of the dedication marks the completion of twenty-five years of service in the institution by Professor W. M. Cobleigh, head of the department of chemistry.

Dr. Harold Hibbert has been appointed assistant professor of chemistry in the research department of organic chemistry, Yale University, New Haven, Conn.

Dr. Louis E. Wise has severed his connection with E. I. du Pont de Nemours and Company, where he held a research position at their Jackson Laboratory, Wilmington, Del., and has accepted the position of professor of forest chemistry at the New York State College of Forestry, Syracuse University, Syracuse, N. Y.

Dr. Harlan H. York, head of the botanical department at Brown University, has resigned to take charge of similar work at the University of West Virginia, Morgantown, West Virginia.

Mr. G. H. Hardy, fellow and mathematical lecturer of Trinity College, Cambridge, has been appointed to the Savilian professorship of geometry at Oxford University.

Dr. John Cruickshank, pathologist to the Crichton Royal Institution, Dumfries, has been appointed Georgina M'Robert lecturer in pathology in the University of Aberdeen.

Professor C. H. Desch has been appointed professor of metallurgy at the University of Sheffield, in succession to Professor J. O. Arnold. Since September, 1918, Professor Desch has been professor of metallurgy in the Royal Technical College, Glasgow.

DISCUSSION AND CORRESPONDENCE

A SPLENDID SERVICE

Apart from the eminent contribution rendered to science and the Pan-American spirit by Dr. Branner in the publication of his fine geological map and monograph,[1] it is a particularly distinguished and generous service to common American interests made by the Geological Society of America at the expense of its own treasury. For the first time the Geological Society has ventured so far afield and freely invested its resources in what might seem at passing glance purely the scientific welfare of an alien country; but it is not to be denied that the claim of fraternity had no little to do with the attitude of the Geological Society toward this enterprise. The bond of geological brotherhood between the United States and Brazil has been a long and strong one. Out of the little village of Aurora on Cayuga Lake, New York, came the first impulse toward the establishment of this tie, when the generosity of the late E. B. Morgan enabled a Cornell professor and some of his students in 1871 to begin the systematic study of the rock geology of the Amazonas valley.

Thus started the Brazilian careers of Professor Charles Fred Hartt and his young associates, Orville A. Derby, Herbert H. Smith and John C. Branner who joined the work in 1874, and their labors are now a historical part of the development of geology on the South American continent. So perhaps it is eminently appropriate that an American Geological Society should now come to the help of one of these pioneers in Brazilian geology and enable him to summarize and commemorate the results of his own and his associates' life-long work in that country. Dr. Derby became a Brazilian subject; Dr. Smith, after a life of rich experience as a scientific collector, recently met a tragic end. Upon Dr. Branner has fallen the mantle, for during his active years he has been a frequent visitor to Brazil and an unremitting student of her geology. To him thus comes the privilege of preparing the first geological map of the whole area of that vast country so far as exploration has gone, and of setting forth the conclusions drawn by himself and by many colleagues and collaborators in this great field.

This note is not intended to be a review or critique of Dr. Branner's map. It is a most illuminating production, of necessity drawn on broad lines and with a few simple explanatory devices, thus intimating at a glance how much remains for future students of the

[1] "Outlines of the Geology of Brazil; to accompany the Geologic Map of Brazil," by John Caspar Branner, *Bulletin Geological Society of America*, Vol. 30, No. 2, June, 1919.

science in this fertile land. We applaud the author on his achievement; others may express this appreciation more analytically; but in this paragraph we acclaim the high-minded attitude of the Geological Society of America in making so wise a use of its money and so excellent a contribution to the common good of the Pan-American States and to geological science.

J. M. C.

WEIGHT OF BODY MOVING ALONG EQUATOR

TO THE EDITOR OF SCIENCE: A prominent engineer, Dr. Carl Herring, recently proposed to me the following question: "Does a body in motion along the earth's equator weigh less (or more) than the same body at rest?" Since this question, in some form or other, has come up several times in recent discussions, the following solution, although entirely elementary, may be not without interest.

Let us picture the body as supported by a string from the roof of a train running westward at speed v along the equator, and let S = the tension in the string.

The question then is: What is the relation between S and v?

Let V (= 1,038 miles per hour) be the absolute velocity of a point on the earth's equator (neglecting the motion of the earth in its orbit and the motion of the solar system in space). Then V-v is the absolute velocity of the train (eastward) in a circular path of radius R (= 3,963 miles).

Hence, by a well-known formula of kinematics, $(V-v)^2/R$ = the absolute acceleration of the body toward the center of the earth.[1]

Further, let W = the ordinary weight of the body (that is, the value of the supporting force S when the train is at rest on the earth's surface), and g = the ordinary falling acceleration (that is, the acceleration, with respect to the earth's surface, with which the body would begin to fall, from rest, if the supporting string were cut); and let E = the force with which the earth pulls the body toward the center of the earth. Then E-S = the net force acting on the body in the direction toward the center.

Hence, by the fundamental principle that forces are proportional to the accelerations they produce,[2] we have

$$\frac{E-S}{W}=\frac{(V-v)^2/R}{g}, \tag{1}$$

whence

$$S=E-\frac{W}{g}\frac{(V-v)^2}{R}. \tag{2}$$

To determine E, we note that if $v=0$ then $S=W$, so that

$$E=W+\frac{WV^2}{gR}=(1.00345)W. \tag{3}$$

Hence finally,

$$S=W\left\{1+\frac{V^2}{gR}\left[1-\left(1-\frac{v}{V}\right)^2\right]\right\}. \tag{4}$$

From these equations we see that as v, the westward train-speed, increases from 0 to V, the supporting force S will increase from W to (1.00345) W, which is its maximum value; as v increases from V to $2V$, S will decrease again from its maximum value to W; and if v is increased further to about 18 V, S will become zero.

For reasonable train-speeds, therefore (up to one or two thousand miles per hour!), *a body moving westward will require an increased force to support it against falling.*

For example, let $v = 60$ miles per hour. Then if $W = 1$ lb., we find $S = 1.000387$ lb., an increase of about 1/25 of one per cent.

[1] Dr. Hering's surprising statement in SCIENCE for October 24, 1919, implying that engineers do not generally recognize the idea of "acceleration" in a direction perpendicular to the path, is not borne out by an examination of engineering text-books, all of which (fortunately) define acceleration in the standard way as the rate of change of vector velocity. For further comment on Dr. Hering's paper, see Professor C. M. Sparrow's letter in SCIENCE for November 21.

[2] Reasons for preferring the form $F/F' = a/a'$ to the form $F = ma$ as the fundamental equation of mechanics may be found in two articles by E. V. Huntington: "The Logical Skeleton of Elementary Dynamics," *American Mathematical Monthly*, Vol. 24 (1917), pp. 1–16; "Bibliographical Note on the Use of the Word Mass in Current Text-Books," *ibid.*, Vol. 25 (1918), pp. 1–15; also in controversial papers in SCIENCE from December, 1914, to October, 1917.

Of course if the train runs *eastward,* the required supporting force will be *less* than if the train were at rest. In particular, if the eastward train-speed is about 16 V, S will be zero.

There are thus two speeds, one westward of about 18,700 miles per hour, and one eastward of about 16,700 miles per hour, at which the "weight" of the body as measured by an observer on the train (that is, the tension in the supporting string S) would be zero.

Edward V. Huntington

Harvard University,
November 22, 1919

AN ODD PROBLEM IN MECHANICS

To the Editor of Science: In a recent discussion the writer offered the following problem which seems to be new and of interest, judging from the answers and lack of answers.

Assuming the earth to be a perfect sphere, the net weight of a body on this earth is G—C, in which G is the force due to gravity and C the centrifugal force due to the rotation of the earth. Hence the net weight of a body at the equator when moving east at a velocity (relatively to the earth) equal to that of the surface of the earth, about 1,000 miles per hour would be G—4C, that is, less than when at rest, while when moving west at the same velocity it would be G, that is, greater than when at rest.

If therefore a flywheel were revolved at the equator with that circumferential speed and in a horizontal plane, the northern part moving east, it would seem to follow that it will tilt to the south, as the southern half should be heavier than the northern half. Due to a time lag the tilting might be to the southwest. It is here assumed that its gyroscopic tendency to get into a vertical plane has been duly counteracted and may be neglected.

Or stated in a different form, suppose a light disc be revolved at this speed in a vertical plane at the equator, and to have two equal symmetrically placed, heavy masses on its rim. When the plane of rotation is north and south it would be dynamically balanced, but when that plane is east and west it would seem to follow that the masses at the moment they are at the bottom would be heavier than when at the top and if so the disk would be unbalanced dynamically, vibrating with a period double that of the period of revolution. Its center of gravity would oscillate below its center of rotation.

It is acknowledged to be possible, theoretically at least, to move a mass so rapidly over the earth that G = C hence the net weight then is zero; it would then go on encircling the earth, if the air friction were eliminated; the moon is an illustration. At lower speeds therefore there should be a part of this loss in effective weight.

The two cases cited, if the results are as described, would afford a basis, theoretically at least, for a mechanical compass, like the gyroscope compass.

Carl Hering

Philadelphia,
October 27, 1919

QUOTATIONS

SCIENCE AND THE NEW ERA PRINTING COMPANY

Old wood to burn,
Old books to read,
Old wine to drink,
Old friends to cling to.

It takes a near-millionaire to burn "old wood" on his hearth these days; "old books" are the delight of the bibliophile, but are poor stuff in producing the wherewithal of a printing establishment; "old wine" will soon be only a hollow mockery—

But "old friends to cling to!" Ah! there is the kernel, the gem that glitters from the quadruplet!

All of which is just by way of introduction to an acknowledgment of one of the most gracious compliments ever paid to The New Era Printing Company.

As the year fast nears its close, it marks the twenty-fifth anniversary of The New Era Printing Company's production of Science, a magazine whose contributors embrace the ablest men in all scientific lines in the world, and weekly finds its way through the mails to all parts of the Eastern and Western hemispheres.

From its distinguished editor, J. McK. Cattell, this morning a magnificent silver vase was received as a token of appreciation for The New Era Printing Company's efforts. With it came this letter:

SCIENCE,
Editorial Department.
GARRISON-ON-HUDSON, N. Y., Dec. 28, 1919.
THE NEW ERA PRINTING COMPANY,
Lancaster, Pa.

Dear Mr. Hershey: In order to express recognition of the admirable manner in which The New Era Printing Company has printed SCIENCE for twenty-five years, and of our friendly relations during this long period, I am sending a token of appreciation.

Sincerely yours,
J. MCK. CATTELL

From base to top the sterling silver vase measures twenty and one-half inches, and is modeled and embellished along exquisitely chaste lines. It is a Lebolt production, hand-hammered, of uncommon weight, and bears this inscription:

SCIENCE,
1894–1919.
To The New Era Printing Company.
In Grateful Appreciation.

The New Era Printing Company is constrained to a public appreciation of Editor Cattell's handsome remembrance. "Old friends to cling to!"—what more apt response or hope for the years to be?—The Lancaster *Daily New Era.*

SCIENTIFIC BOOKS

Fossil Plants. By A. C. SEWARD. Vol. IV. Pp. 543. Cambridge, University Press.

This, the concluding volume of the Cambridge text on fossil plants, is devoted to a consideration of the Ginkgoales, Coniferales and Gnetales. The final proofs were passed in the spring of 1918, but the printing was held up because of war conditions so that a number of recent contributions could not be considered. The method of treatment in the present volume is consistent with that of the preceding volumes and the same lack of balanced treatment is shown in the present work. To cite but a single instance of this, six lines are devoted to the remains of *Ginkgo* from North America although *Ginkgo* is exceedingly well represented in the Mesozoic and early Eocene on this continent.

As regards the subject matter, a chapter is devoted to the Ginkgoales, recent and fossil. The second chapter considers *Ginkgoidium, Czekanowskia, Feildenia, Phoenicopsis* and *Desmophyllum*—genera that are believed to belong to the Ginkgoales. The third chapter includes supposed Ginkgoalan genera of still more doubtful allegiance. The nine following chapters are devoted to the Coniferales. There is a rather full and excellent account of recent Conifers. These are grouped in the following nine families: Araucarineæ Cupressineæ, Callitrineæ, Sequoiineæ, Sciadopitineæ, Abietineæ, Podocarpineæ, Phyllocladineæ and Taxineæ. They are considered as probably monophyletic, the Araucarineæ being regarded as the most ancient and the Abietineæ as the most modern. There are some illuminating discussions of vascular anatomy and the view is expressed that the cone scales in the Araucarineæ are morphologically simple ovuliferous leaves, the double cone scales of the Abietineæ being derivatives of a simple form of sporophyll. *Mesembrioxylon* is proposed for the fossil woods formerly referred to *Podocarpoxylon* and *Phyllocladoxylon*. The final chapter is devoted to the Gnetales and is without noteworthy features.

Opinion will differ as to the necessity or desirability for some of the new generic terms that are proposed, *e. g., Ginkgoites* for *Ginkgo* leaves, on the ground that even in the Tertiary forms the confirmatory evidence of flowers and fruits is lacking: *Cupressinocladus* for vegetative shoots of conifers of a cupressoid habit: and *Pityites* for abietineous fossils of uncertain generic relationship. There is but slight profit in compounding confusion and although a conservative attitude is warranted in dealing with the vegetative remains of conifers there is but slight evidence in the more recent history of the study of fossil conifers to show that stem anatomy or strobilar morphology furnish any easier read or more definite criteria than vegetative habit, and from the nature of the remains we can not hope to have all of the criteria in individual cases. Even the older students in dealing with foliar impressions were not guilty of more pretentious absurdities than have been put forward under the banner of anatomy during the past decade.

The present volume contains 190 illustrations which on the whole appear rather uniformly better than those of volume III. although it is difficult for the reviewer to understand why paper and presswork were wasted on such illustrations as that forming the frontispiece of the present volume. The bibliography which has a certain air of completeness really contains not more than about twenty per cent. of the literature, but perhaps this should not be criticized since it avowedly contains only "papers and works referred to in the text."

On the whole it seems to the reviewer that Professor Seward has performed a difficult task about as well as could be expected, and despite their obvious shortcomings, which have been freely criticized, these four volumes are a mine of information for the student interested in the floras of the past.

Edward W. Berry

Johns Hopkins University

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
REPORT OF THE ST. LOUIS MEETING

The seventy-second meeting of the American Association for the Advancement of Science and the affiliated national scientific societies was held in St. Louis, December 29, 1919, to January 3, 1920, under the presidency of Dr. Simon Flexner.

In spite of the adverse ruling of the United States Railroad Administration on the granting of reduced fares and other difficulties attending travel, the attendance was most satisfactory. All sections held sessions except Section C, and twenty-two affiliated societies presented attractive programs. The experiment of holding all meetings under one roof, namely the Soldan High School, is believed to have been a success, for the advantages of this concentration, including registration headquarter and luncheon facilities, more than offset certain minor difficulties.

The formal opening of the meetings of the association took place in the spacious auditorium of the Soldan High School on Monday evening, December 29, Chancellor Hall of Washington University delivering the address of welcome. President Flexner responded fittingly, after which he introduced the retiring president, Professor John M. Coulter who then delivered the address on "The Evolution of Botanical Research," which was printed in the issue of Science for January 2.

At the conclusion of his address the revised constitution was read and unanimously adopted. The following changes were made in the copy of the revised constitution as it appeared in the November 21 issue of Science.

Article II. Increasing the annual dues from $4 to $5 and the fee for life membership from $75 to $100.

Article V. Changing the title of Section H from Anthropology and Archeology to Anthropology and that of Section I from Psychology and Philosophy to Psychology. That the proposed Section J be designated as Section K and that the letters assigned to sections following be dropped back one letter alphabetically in the order given.

The Committee on Policy submitted an amendment to the Constitution to be acted upon at the next meeting providing for a section R, Conservation of National Resources.

The new constitution was declared in effect at the end of the present Convocation.

A reception was tendered to the members of the association at the close of this meeting.

On Tuesday evening at the Soldan High School an address complimentary to the members of the association and affiliated societies and the citizens of St. Louis was delivered by President Flexner. His subject was "Present Problems in Medical Research."

Throughout the meetings the usual number of vice-presidential and other addresses were delivered covering a wide range of subjects. Many of these dealt with scientific problems of present day interest and attracted wide attention. Since the names of the speakers and their subjects have already appeared in the preliminary announcement printed in Science and on the final program there is no need of repeating the list here.

Smokers and dinners provided by the various affiliated societies were held and entertainment for visiting ladies in numerous private functions contributed to the social success of the meetings.

Matters of general interest to members eminating chiefly from the committee on policy acted upon favorably by the council were:

1. That the amount to be paid per member to the management of Science be $3 and that it be requested to fix the subscription price of Science for non-members at $6.

2. That approval be given of certain measures under consideration with the Carnegie Endowment for International Peace as set forth in a letter addressed to Dr. North, but embodying substantially the following recommendation; that the British, French and Italian equivalents of the American Association for the Advancement of Science be invited to send delegates to the meeting to be held a year hence in Chicago.

3. That the American Meteorological Society be admitted as an affiliated society and that entrance fees be remitted in the case of those of its members who join the association during the coming year. The council further declared itself as looking with favor on the affiliation of any national society which is interested primarily in scientific research.

4. That the president be authorized to appoint a committee on international auxiliary languages to cooperate with a corresponding committee of the International Research Council.

5. That Dr. George H. Perkins and Dr. C. J. S. Bethune be made emeritus life members under the Jane N. Smith fund.

6. That pursuant to certain resolutions advocated by the National Physical Education Service, the American Association for the Advancement of Science will be pleased to cooperate with the National Physical Education Service in promoting physical education.

7. That the general adoption of the metric system by national and state governments be approved.

8. That the executive committee be requested to consider the possibility of paying the mileage of secretaries of sections to and from annual meetings.

9. That sectional officers avoid placing on their programs papers relating to acute political questions on which public opinion is divided.

10. That the association will look with favor on any plan approved by the men of science in the country for the encouragement of research in engineering under the auspices of the government.

11. That the association endorses and "commends the general purposes of The Save the Redwoods League" in its effort to preserve some of the oldest trees in the world.

12. That the Southern Educational Society be admitted to affiliation and that the admission fee be remitted in the case of those members of the Southern Educational Society who join the association during the coming year.

13. That there be authorized the organization of members of the American Association for the Advancement of Science in New Mexico, all or part of Texas and such other territory as may seem advisable into a Southwestern Division of the American Association for the Advancement of Science and that Dr. D. T. MacDougal be the representative of the executive committee for such an organization.

14. That the sum of $4,500 be made available to the committee as grants for the ensuing year.

15. That the by-laws as printed in Science, November 21, be adopted, with the following amendment to be added at the end of Article 6,

Section 1. "State and city academies affiliated with the association may also be allowed for their expenses, the entrance fees collected through their efforts and an amount for their expenses not to exceed $1 for each member in good standing."

Under the head of new business Professor John M. Coulter and Professor H. B. Ward presented a verbal report for the committee on affiliation of state and local academies. The report dealt with preliminary steps looking towards the affiliation of state academies in accordance with the following general plan:

1. That state and local academies may be affiliated with the association on a financial basis that will yield the associaton $4 net per member.

2. Any state or local academy which concludes arrangements for affiliation within the first six months of 1920 may be accepted for the entire year 1920, fees paid to the association before that date to be adjusted in accordance with the detailed plan.

3. Two alternative plans are considered with respect to membership in the academies, namely:

(*a*) All members of the academies to become members of the association.

(*b*) To establish two grades of membership, of which one will be national, involving membership in both academy and association, the other local, consisting of academy members only.

4. The academies will collect joint dues and transmit the association's share to the treasurer.

It was voted that this report of the committee on affiliation of state and local academies be received and approved.

In accordance with the provision of the new constitution which calls for an executive committee of eight elected members to replace the old council, the following gentlemen were duly elected members of this committee: J. McK. Cattell, H. L. Fairchild, Simon Flexner, W. J. Humphreys, D. T. MacDougal, A. A. Noyes, Herbert Osborn, H. B. Ward.

Under the terms of the revised constitution Dr. H. L. Fairchild and Dr. Franz Boas were duly elected members of the council.

Dr. R. M. Yerkes and Dr. G. T. Moore were elected members of the committee on grants.

The seventy-third meeting of the association and of the affiliated societies will be held at Chicago, beginning on Monday, December 27, with the first general session on Tuesday evening. It was recommended that the four succeeding meetings be held in Toronto or Buffalo, Boston, Cincinnati and Washington.

Officers were elected as follows:

President: Dr. L. O. Howard, Bureau of Entomology, Washington, D. C.

General Secretary: Professor E. L. Nichols, Cornell University.

Vice-presidents:

Section A, Mathematics: D. R. Curtis, Northwestern University, Evanston, Ill.

Section B, Physics: J. C. McLennan, University of Toronto.

Section C, Chemistry: S. W. Parr, University of Illinois.

Section D, Astronomy: Joel Stebbins, University of Illinois.

Section E, Geology and Geography: Charles Schuchert, Yale University.

Section F, Zoological Sciences: J. S. Kingsley, University of Illinois.

Section G, Botanical Sciences: R. H. True, Bureau of Plant Industry, Washington, D. C.

Section H, Anthropology: G. R. Gordon, American Museum of Natural History, New York.

Section I, Psychology: E. K. Strong, Jr., Carnegie Institute of Technology, Pittsburgh.

Section M, Engineering: C. L. Mees, Rose Polytechnic Institute, Terre Haute, Ind.

Section N, Medicine: J. Erlanger, Washington University, St. Louis.

Section Q, Education: C. H. Judd, University of Chicago.

George T. Moore,
General Secretary

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CONTENTS

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RECENT ADVANCES IN DYNAMICS[1]

A HIGHLY important chapter in theoretical dynamics began to unfold with the appearance in 1878 of G. W. Hill's researches in the lunar theory.

To understand the new direction taken since that date it is necessary to recall the main previous developments. In doing this, and throughout, we shall refer freely for illustration to the problem of three bodies.

The concept of a dynamical system did not exist prior to Newton's time. By use of his law of gravitation Newton was able to deal with the Earth, Sun, and Moon as essentially three mutually attracting particles, and by the aid of his fluxional calculus he was in a position to formulate their law of motion by means of differential equations. Here the independent variable is the time and the dependent variables are the nine coordinates of the three bodies. Such a set of ordinary differential equations form the characteristic mathematical embodiment of a dynamical system, and can be constructed without especial difficulty.

The aim of Newton and his successors was to find explicit expressions for the coordinates in terms of the time for various dynamical systems, just as Newton was able to do in the problem of two bodies. Despite notable successes, the differential equations of the problem of three bodies and of other analogous problems continued to defy "integration."

Notwithstanding the lack of explicit expressions for the coordinates, Newton was able to treat the lunar theory from a geometrical point of view. Euler, Laplace, and others invented more precise analytical methods based upon series. In both cases the bodies which are disturbing the motion of the

[1] Address of the vice-president and chairman of Section A—Mathematics and Astronomy—American Association for the Advancement of Science, St. Louis, December, 1919.

Moon are assumed first to move in certain periodic orbits, and the perturbations of the Moon are assumed to be the same as if the other bodies did move in such hypothetical orbits. The principle of successive approximations characterizes these methods.

The chief other advance made was based on the following principle: if a function is a maximum or minimum when expressed in terms of one set of variables it is also a maximum or minimum for any other set; hence, if the differential equations of dynamics can be looked upon as the equations for a maximum or minimum problem, this property will persist whatever variables be employed. This principle, developed mainly by Lagrange, W. R. Hamilton, and Jacobi, enables one to make the successive changes of variables required in the method of successive approximations by merely doing so in a single function.

Here too the results are chiefly of formal and computational importance.

The last great figure of this period is Jacobi. His "Vorlesungen über Dynamik" published in 1866 represents a highwater mark of achievement in this direction.

Nearly all fields of mathematics progress from a purely formal preliminary phase to a second phase in which rigorous and qualitative methods dominate. From this more advanced point of view, inaugurated in the domain of functions of a complex variable by Riemann, we may formulate the aim of dynamics as follows: to characterize completely the totality of motions of dynamical systems by their qualitative properties.

In Poincaré's celebrated paper on the problem of three bodies, published in 1889, where he develops much that is latent in Hill's work, Poincaré proceeds to a treatment of the subject from essentially this qualitative point of view.

A first notion demanding reconsideration was that of integrability, which had played so great a part in earlier work. In 1887 Bruns had proved that there were no further algebraic integrals in the problem of three bodies. Poincaré showed that in the so-called restricted problem there were no further integrals existing for all values of a certain parameter and in the vicinity of a particular periodic orbit. Later (1906) Levi-Civita has pointed out that there are further integrals of a similar type in the vicinity of part of any orbit.

Thus it has become clear that the question as to whether a given dynamical problem is integrable or not depends on the kind of definition adopted. However, the most natural definitions have reference to the vicinity of a particular periodic motion. The introduction of a parameter by Poincaré is to be regarded as irrelevant to the essence of the matter.

From the standpoint of pure mathematics, a just estimate of the results found in integrable problems may be obtained by reference to the problem of two bodies, or, more simply still, of the spherical pendulum. The integration by means of elliptic functions shows that the pendulum bob rotates about the vertical axis of the sphere through a certain angle in swinging between successive highest and lowest points. But the form of the differential equation renders this principal qualitative result self-evident, while the most elementary existence theorems for differential equations assure one of the possibility of explicit computation. Hence the essential importance of carrying out the explicit integration lies in its advantages for purposes of computation.

The series used in the calculations of the lunar theory and other similar theories were given their proper setting by Poincaré. He showed that they were in general divergent, but were suitable for calculation because they represented the dynamical coordinates in an asymptotic sense.

The fact that the first order perturbations of the axes in the lunar theory can be formally represented by such trigonometric series had led astronomers to believe that the perturbations remained small for all time. But the fact of divergence made the argument for stability inconclusive.

It is easy to see that this question of stability, largely unsolved even to-day, is of fundamental importance from the point of view formulated above. For, in a broad sense, the question is that of determining the general character of the limitations upon the possible variations of the coordinates in dynamical problems.

We wish to mention briefly four important steps in advance in this direction.

The first is due to Hill who showed in his paper that, in the restricted problem of three bodies, with constants so chosen as to give the best approximation for the lunar theory, the Moon remains within a certain region about the Earth, not extending to the Sun. In fact here there is an integral yielding the squared relative velocity as a function of position, and the velocity is imaginary outside of this region.

In his turn, Poincaré showed that stability exists in another sense, namely for arbitrary values of the coordinates and velocities there exist nearby possible orbits of the Moon which take on infinitely often approximately the same set of values. His reasoning is extremely simple, and is founded on a hydrodynamic interpretation in which the orbits appear as the stream lines of a three-dimensional incompressible fluid of finite volume in steady motion. A moving molecule of such a fluid must indefinitely often partially reoccupy its original position with indefinite lapse of time, and this fact yields the stated conclusion.

In 1901 under the same conditions Levi-Civita proved that, if the mean motions of the Sun and Moon about the Earth are commensurable, instability exists in the following sense: orbits as near as desired to the fundamental periodic lunar orbit will vary from that periodic orbit by an assignable amount after sufficient lapse of time. This result, which is to be anticipated from the physical point of view, makes it highly probable that instability exists in the incommensurable case also.

These three results refer to the restricted problem of three bodies.

Finally there is Sundman's remarkable work on the unrestricted problem contained in his papers of 1912 and of earlier date. Lagrange had proved that if a certain energy constant is negative, the sum of the mutual distances of the three bodies becomes infinite. Sundman showed that, even if this constant is positive, the sum of the three mutual distances always exceeds a definite positive quantity, at least if the motion is not essentially in a single plane. Thus he incidentally verified a conjecture of Weierstrass that the three bodies can never collide simultaneously. These and other results seem to me to render it probable that *in general* the sum of the three distances increases indefinitely. Thus, if this conjecture holds, in that approximation where the Earth, Sun and Moon are taken as three particles, the Earth and Moon remain near each other but recede from the Sun indefinitely. The situation is worthy of the attention of those interested in astronomy and in atomic physics.

As we have formulated the concept of stability, it is essentially that of a permanent inequality restricting the coordinates. We may call a dynamical system transitive in a domain under consideration if motions can be found arbitrarily near any one state of motion of the domain at a particular time which pass later arbitrarily near any other given state. In such a domain there is instability. If we employ the hydrodynamic interpretation used above, the molecule of fluid will diffuse throughout the corresponding volume in the transitive case, and will diffuse only partially or not at all in the intransitive case. The geodesics on surfaces of negative curvature, treated by Hadamard in 1898, furnish a simple illustration of a transitive system, while the integrable problem of two bodies yields an intransitive system. Probably only under very special conditions does intransitivity arise.

It is an outstanding problem of dynamics to determine the character of the domains within which a given dynamical system is transitive.

A less difficult subject than that of stability is presented by the singularities of the motions such as arise in the problem of three bodies at collision. The work of Levi-Civita and Sundman especially has shown that the singularities can frequently be eliminated by means of appropriate changes of variables. In consequence the coordinates of dynamical systems admit of simple analytic representation for all values of the time. In particular Sundman has proved that the coordinates and the time in the problem of three bodies can be expressed in terms of permanently convergent power series, and thus he has "solved" the problem of three bodies in the highly artificial sense proposed by Painlevé in 1897. Unfortunately these series are valueless either as a means of obtaining qualitative information or as a basis for numerical computation, and thus are not of particular importance.

From early times the mind of man has persistently endeavored to characterize the properties of the motions of the stars by means of periodicities. It seems doubtful whether any other mode of satisfactory description is possible. The intuitive basis for this is easily stated: any motion of a dynamical system must tend with lapse of time towards a characteristic cyclic mode of behavior.

Thus, in characterizing the motions of a dynamical system, those of periodic type are of central importance and simplicity. Much recent work has dealt with the existence of periodic motions, mainly for dynamical systems with two degrees of freedom.

An early method of attack was that of analytical continuation, due to Hill and Poincaré. A periodic motion maintains its identity under continuous variation of a parameter in the dynamical problem, and may be followed through the resultant changes. G. Darwin, F. R. Moulton and others have applied this method to the restricted problem of three bodies. Symmetrical motions can be treated frequently by particularly simple methods. Hill made use of this fact in his work.

Another method is based on the geodesic interpretation of dynamical problems. This has been developed by Hadamard, Poincaré, Whittaker, myself, and others. The closed geodesics correspond to the periodic motions, and the fact that certain closed geodesics of minimum length must exist forms the basis of the argument in many cases. As an example of another type, take any surface with the connectivity of a sphere and imagine to lie in it a string of the minimum length which can be slipped over the surface. Clearly in being slipped over the surface there will be an intermediate position in which the string will be taut and will coincide with a closed geodesic.

Finally there is a less immediate method of attack which Poincaré introduced in 1912, and which I have tried to extend. By it the existence of periodic motions is made to depend on the existence of invariant points of certain continua under one-to-one continuous transformation. The successful application of this method involves a preliminary knowledge of certain of the simpler periodic motions.

Periodic motions fall into two classes which we may call hyperbolic and elliptic. In the hyperbolic case analytic families of nearby motions asymptotic to the given periodic motion in either sense exist, while all other nearby motions approach and then recede from it with the passing of time. In the elliptic case the motion is formally stable, but the phenomenon of asymptotic families not of analytic type arises unless the motion is stable in the sense of Levi-Civita.

In a very deep sense the periodic motions bear the same kind of relation to the totality of motions that repeating doubly infinite sequences of integers 1 to 9 such as

. . . 2323 . . .

do to the totality of such sequences.

In trying to deal with the totality of possible types motion it seems desirable to generalize the concept of periodic motion to recurrent motion as follows: any motion is recurrent if, during any interval of time in the past or future of sufficiently long duration T, it comes arbitrarily near to all of its states of motion. With this definition I have proved that every motion is either recurrent or approaches with uniform frequency arbitrarily near a set of recurrent motions.

The recurrent motions correspond to those double sequences specified above in which every finite sequence which is present at all occurs at least once in every set of N successive integers of the sequence.

In any domain of transitivity the two extreme types of motion are the recurrent motions on the one hand and the motions which pass arbitrarily near every state of motion in the domain on the other. Both types necessarily exist, as well as other intermediate types.

The precise nature of such recurrent motions has yet to be determined, but Dr. H. C. M. Morse in his 1918 dissertation at Harvard has shown that there exists non-periodic recurrent motions of entirely new type in simple dynamical problems.

Such are a few of the steps in advance that theoretical dynamics has taken in recent years. I wish in conclusion to illustrate by a very simple example the type of powerful and general geometric method of attack first used by Poincaré.

Consider a particle P of given mass in rectilinear motion through a medium and in a field of force such that the force acting upon P is a function of its displacement and velocity. In order to achieve simplicity I will assume further that the law of force is of such a nature that, whatever be the initial conditions, the particle P will pass through a fixed point O infinitely often.

If P passes O with velocity v it passes O at a first later time with a velocity v_1 of opposite sign. We have then a continuous one-to-one functional relation $v_1 = f\ (v)$. If v is taken as a one-dimensional coordinate in a line, then the effect of the transformation $v_1 = f\ (v)$ is a species of qualitative "reflection" of the line about the point O.

If this "reflection" is repeated the resultant operation gives the velocity of P at the second passage of O, and so on. But the most elementary considerations show that either (1) the reflection thus repeated brings each point to its initial position, or (2) the line is broken up into an infinite set of pairs of intervals, one on each side of O, which are reflected into themselves, or (3) there is a finite set of such pairs of intervals, or (4) every point tends toward O (or away from it) under the double reflection.

Hence there are four corresponding types of systems that may arise. Either (1) every motion is periodic and O is a position of equilibrium, or (2) there is an infinite discrete set of periodic motions of increasing velocity and amplitude (counting the equilibrium position at O as the first) such that, in any other motion, P tends toward one of these periodic motions as time increases and toward an adjacent periodic motion in past time, or (3) there is a finite set of periodic motions of similar type such that, in any other motion, P behaves as just stated, if there be added a last periodic motion with "infinite velocity and amplitude" as a matter of convention, or (4) in every motion P oscillates with diminishing velocity and amplitude about O as time changes in one sense and with ever increasing velocity and amplitude as time changes in the opposite sense.

Here we have used the obvious fact that there is a one-to-one correspondence between velocity at O and maximum amplitude in the immediately following quarter swing.

This example illustrates the central rôle of periodic motions in dynamical problems. It is also easy to see in this particular example that the totality of motions has been completely characterized by these qualitative properties in a certain sense which we shall not attempt to elaborate.

What is the place of the developments reviewed above in theoretical dynamics?

The recent advances supplement in an important way the more physical, formal, and computational aspects of the science by providing a rigorous and qualitative background.

To deny a position of great importance to these results, because of a lack of emphasis upon the older aspects of the science would be as illogical as to deny the importance of the concept of the continuous number system merely because of the fact that in computation attention is confined to rational numbers.

GEORGE D. BIRKHOFF

SIR WILLIAM OSLER (1849–1919)

AFTER a tedious and painful illness, Sir William Osler, Regius professor of medicine at Oxford, died at his home in Norham Gardens on December 9, 1919. In spite of intermediate convalescence, a severe attack of bronchitis, due to exposure through attending a professional consultation, developed into a pneumonia with pleurisy and empyema, necessitating surgical drainage; and although he had been cheerful three days before his death, the end was gravely apprehended by those around him. He is survived by his widow, Lady Osler, and two brothers, his only son having been killed in the war.

Sir William Osler, the son of Rev. F. L. Osler of Falmouth, England, was born at Bond Head, Province of Ontario, Canada, on July 12, 1849. A medical graduate of McGill University (1872) with the customary post graduate study in the London clinics and German universities, he became lecturer and professor of the institutes of medicine at McGill in 1874 and easily rose, without stress or undue effort, to the top of his profession. In succession, he was professor of medicine at the University of Pennsylvania (1884–9) and the Johns Hopkins University (1889–1904), was appointed Regius professor of medicine at the University of Oxford in 1904 and received his baronetcy in 1911. On July 11, 1919, his seventieth birthday was honored by the presentation of two anniversary volumes made up of contributions by English and American colleagues.[1] Due to delays in printing, the completed volumes reached him only a few days before his death.

Of Osler's scientific work, it may be said that no great physician has been more firmly grounded in the fundamental disciplines of his calling. Of the arduous years of post-mortem work at Montreal the Pathological Reports of the Montreal General Hospital (1876–80) are a permanent record, as also the eight editions of the great text-book on Practice of Medicine (1892), which has been translated into French, German, Spanish and Chinese. The disciple of Morgagni and Virchow is equally apparent in the hundreds of clinical papers, the larger monographs in Osler's "Modern Medicine" (1907–10), the Gullstonian lectures on malignant endocarditis (1885), and the separate treatises on the cerebral palsies of children (1889), chorea (1894), abdominal tumors (1895), angina pectoris (1897), and cancer of the stomach (1900). From the start he did much original investigation of high quality. At the age of twenty-five (1874), he described the blood platelets associated with the name of Bizzozero, and defined their status as the third corpuscle of the blood and their relation to the formation of thrombi. Such early papers as those on the blood in pernicious anemia (1877), overstrain of the heart (1878), fusion of the semi-lunar valves (1880) reveal the born clinical and pathological observer. Osler was a profound student of all modes of aneurism, of tuberculosis, of typhoid fever, of disorders of the circulation. He was the first to emphasize the relation between mycotic aneurism and mycotic endocarditis, first described the ball-valve thrombus at the mitral orifice, the visceral complication of erythema multiforme (1895), chronic cyanosis with polycythemia, known as Vaquez' disease (1895), multiple telangiectasis (1901), the erythematous spots in malignant endocarditis (1908), and he discovered the parasite of verminous bronchitis in dogs (*filaria Osleri*, 1877). But to sense the magnitude of Osler's clinical work, it must be taken by and large in the 730 titles of the recently published Osler Bibliography (1919).

At the farewell banquet given him in New York in 1904, Osler said that he desired to be remembered in a single line: "He taught clinical medicine in the wards." He found his great opportunity when he became physician to the Johns Hopkins Hospital. During the six years intervening between the opening of the hospital (1889) and the beginning of undergraduate instruction in medicine (1893), Osler blocked out the arrangements for a graded whole-time upper resident staff of men of exceptional promise, a lower resident staff of one year internes, careful instruction in case-taking and clinical laboratory work for third year students and the appointment of fourth year students as "clinical clerks," in actual charge of patients in hospital, for three months each. The feeling of confidence and of personal responsibility acquired by these advantages was further strengthened by assigning advanced pupils to

[1] Science, September 12, 1919, p. 244.

teach extempore, to read and report on foreign literature, to cultivate the history of their profession. In his Saturday night meetings at his home in West Franklin Street, his aim with young students was to make good physicians of them, to make good men out of them, to teach them to think for themselves and to be themselves. As Dr. H. M. Thomas has said, Osler "put the students in the wards, but he did not leave them there; he stayed with them"; and he adds: "What good there is in me as a teacher and a physician I owe to him." This is the common sentiment, that he took his students with him into the upper reaches of their profession and the broad sunshine of actual life. Only Astley Cooper or Carl Ludwig could have produced such a train of loyal disciples; only Pasteur could have inspired such universal regard and affection.

Space permits but a passing reference to Osler's work on the history of medicine, to which, through his personal interest and his many unique contributions, he gave a greater impetus than any other; to his civic activities, his labors in behalf of medical libraries, his splendid service to his country in wartime. His great collection of original texts and documents relating to discoveries and advances in the science and art of medicine, the hobby of his later years, was all but completed as to items, but the big human touch which would have made its catalogue one of the unique things in medical bibliography could only have been given by Osler himself.

Essentially English in character, Osler had, through his forebears, Cornish and Spanish elements in his composition, easily sensed in the "hauntings of Celtism" in his ringing eloquent voice, the suggestion of the hidalgo in his slender, aristocratic figure, the clean-cut features and the tropical brown eyes. His was the longish head of the man of action, the active practitioner against disease and pain. Osler's warm glance and utter friendliness of manner told how naturally fond he was of people. He had the gift of making almost any one feel for the moment as if he were set apart as a valued particular friend, and so became, in effect, a kind of universal friend to patients, pupils and colleagues alike. But there was nothing of the politician in him. He rather paid with his person through the demands made by importunate patients and visitors upon his time. Such an effective concentration of the "fluid, attaching character" has seldom been found in a single personality, possessed, as it were, by the impartial, non-exclusive spirit of all pervading Nature, "which never was the friend of one,"

> But lit for all its generous sun,
> And lived itself, and made us live.

Many are the tales of the clever hoaxing and practical joking put over by Osler on his boon companions and professional fellows in his salad days, but the chaffing was carried on in such a jolly spirit that it left no sting behind. In his address on the male climacteric, delivered on the occasion of his retirement from the Johns Hopkins faculty, he found to his dismay that he had chaffed a whole nation. The hazards incurred by his chance reference to Trollope's fable about "chloroforming at sixty" have been set forth at undue length in the public press and even on the stage. But Osler's reasoning about the comparative uselessness of men at sixty, in the face of the imposing array of exceptions in Longfellow's "Morituri Salutamus," was obviously an expression of his essential preference for and innate sympathy with the oncoming race of younger people, whose worth he had sensed many times over in his beloved pupils.

The last two years of Sir William Osler's life were clouded by the death of his only son, Lieutenant Revere Osler, an artillery officer and a youth of great promise, who was killed in the action about Ypres in 1917. This he bore bravely, concealing his grief from his friends and busying himself with his own duties to the sick and wounded, but, the war at an end, his loneliness increased in spite of the companionship of his wife and his ever-generous hospitality to American officers and physicians. Toward the end, his intimates began to realize that he had "trod the upward and the downward slope" and was done with life. Up to that time he had remained cheerful, buoyant, resilient, as if, like the beloved of the gods, he was predestined to die young. Yet the supreme test was nobly borne, and to many of his pupils and colleagues, who see in the death of this great, benignant physician, the loss of their best friend, the expressions of ancient belief will not seem unavailing: *Requiem æternam dona ei, Domine, et lux perpetua luceat ei.*

F. H. Garrison

Army Medical Museum

SCIENTIFIC EVENTS

A BOTANIC SCHOOL IN REGENT'S PARK

The report of the committee appointed last April by Lord Ernle, the former president of the British Board of Agriculture, to consider what steps should be taken to improve the usefulness of the Royal Botanic Society in London, is now published and an abstract is given in the London *Times.* The members of the committee, all of whom sign the report, were: Lieutenant-Colonel Sir David Prain, F.R.S., director of the Royal Botanic Gardens, Kew (chairman); Sir W. H. Dunn; Surgeon-General Sir A. Keogh, Imperial College of Science and Technology; Sir Malcolm Morris; Major R. C. Carr;Mr. Morton Evans, joint secretary of the Office of Woods; Mr. H. J. Greenwood, L.C.C.; and Professor F. W. Keeble, F.R.S., Board of Agriculture and Fisheries and Royal Horticultural Society; with Mr. G. C. Gough, B.Sc., secretary.

The society was incorporated in 1839, and was granted a lease of 18 acres in Regent's Park until 1870. This lease was renewed by the Commissioners of Woods and Forests in 1870, and in 1901 at an increased rental. The present lease terminates in 1932.

The committee have formed the opinion that the Royal Botanic Society could be made more useful both from the scientific and educational point of view by the establishment of: (1) A school of economic botany, at which a knowledge of the economic plants and their products including those of tropical regions, might be obtained; (2) an institute which might be made a center for research, more especially in plant physiology where the living plant is essential; (3) a center for teaching in horticulture, the students of which could receive their necessary training in pure science at existing London colleges; (4) courses in school gardening, at times suitable for teachers in elementary, continuation, and other schools. In addition, the committee consider that the gardens might extend their present utility as a center from which colleges and botany schools could be supplied with material for teaching and research, and in which students could make use of the existing facilities for the study of systematic botany.

In an appendix the committee deal with the financial side of the scheme. They consider that the suggestions need not entail, in their initial stages, any very great expenditure. Buildings should be of a temporary nature and of not more than two stories, and might be erected near the present greenhouses. After giving details of the laboratories and rooms required, the committee suggest that the staff should consist of the following:

A director at a salary of £800 to £1,000, able to cooperate with the teachers of botany in London, and with a knowledge of economic problems or of vegetable physiology. An assistant director, salary £500 to £700, to be appointed after the director. His knowledge should supplement that of the director—*e. g.*, if the former be an economic botanist the latter should be a physiological botanist. An assistant, salary £250 to £400, to act as curator of the museum and librarian, with a general knowledge of plant diseases. At least one of the officers should have a practical knowledge of the tropics, tropical plants, and their products.

The committee estimate the total cost of the staff, with attendants, etc., at £3,000 to £3,500 per annum; the cost of the buildings, £4,000; and the cost of equipment, including books, plants, etc., £500.

THE ATTITUDE OF GERMAN PHYSICIANS TOWARDS INHUMAN ACTION

It will be remembered that a protest signed by M. Calmette and four other members of scientific organizations who had remained at Lille during the occupation by the Germans, charged acts of inhumanity, saying in conclusion: "The high command in Germany willed the war, but the people in arms approved it, and resolutely waged war with the most ferociously cruel means, even the physicians with the army doing the most odious acts without a word of excuse, regret or pity." The *Deutsche, medizinische Wochenschrift* of April 10, 1919, as quoted in the *Journal* of the American Medical Association, related that the matter was brought up in the Berlin Medical Society, and Calmette's protest and the resolutions voted thereon by the Académie de médecine at Paris were discussed. Dr. Fuld offered a resolution that the society should go on record as expressing its regret at such happenings as were specified in the Calmette protest, but his suggestion was opposed by Orth and others, the speakers saying that there was no proof of the truth of the statements made by Calmette, and no voting should be done on a matter of which only one side had been presented. Finally a committee was appointed to report after obtaining an official copy of the resolutions that had been adopted by the Académie. The *Wochenschrift* of November 6, 1919, relates that this committee recently presented its report. It was in the form of a resolution which was adopted without a dissenting voice. The members of the committee were Fuld, Kraus, Krause, Morgenroth and Schwalbe, the latter the editor of the *Wochenschrift*. The resolution in translation reads:

The Berlin Medical Society is not in a position to pass judgment on the Manifesto of the Lille professors and the Académie de Médicine and on the published justification issued by the German authorities, entitled "Lille under German Rule and the Criticism of the Foe." But the society does not hesitate to declare openly that it condemns in the most unqualified manner all inhuman actions, wherever, whenever, and by whomsoever they may be committed. This attitude corresponds to the spirit of medicine always held high by the German medical profession, that really international spirit to which we are loyal and to which we assume all other physicians are loyal wherever they may be and to whatever nation they may belong.

CONFERENCE ON WASTE OF NATURAL GAS

A public conference of governors, public utility commissioners, state geologists, home economic experts, natural gas companies, owners and officials, and appliance manufacturers has been called by Secretary of the Interior Lane to meet under the auspices of the Bureau of Mines at the Interior Department Building, Washington on January 15, to discuss the waste of natural gas in this country both by consumers and gas companies. As a result of the work of the experts of the bureau on this question, it is declared that in using natural gas the consumers through faulty appliances obtain an efficiency of about 13 per cent. from a gas cook stove, 25 per cent. from a house-heating furnace, and 10 per cent. from a hot-water heater, although in good practise these efficiencies can be trebled. Dr. Van H. Manning, director of the Bureau of Mines, writes in regard to the purposes of the conference:

Domestic consumers waste more than 80 per cent. of the gas received. The efficiency of most cooking and heating appliances could be trebled. By making natural gas worth saving the 2,400,000 domestic consumers in the United States could get the same cooking and heating service with one third the gas; that is, make one foot of gas do the work of three and greatly delay the day when the present supplies will be exhausted and consumers must go back to more expensive manufactured gas.

It is time for the public to take a new viewpoint on the waste of natural gas. It is time for the domestic consumer to realize that his duty is not done when he cries out against the flagrant wastes occurring in the gas fields and demands of his government that such wastes be abated; he must realize that he himself is likewise at fault and that it is time for him to set his own house in order. Furthermore, the domestic consumer must realize that these wastes do not concern him alone, and consequently he has not the right, merely because he pays for the gas, to employ it in any manner that pleases him, no matter how wasteful. Natural gas is a natural resource in which every inhabitant of this country has an equity. Those who waste the gas do so at the expense of those who would use it efficiently. Natural gas is not replaced by nature, and in comparison with the life of the nation the duration of the supply will be brief.

The public has a right, therefore, to demand that this natural asset be used to the greatest advantage of all and that no one be allowed to waste it. Natural gas in each ctiy is a community asset and every consumer has a right to demand that wasteful use shall be prohibited in the interest of the public service. This is particularly important during cold spells in the winter when the supply is insufficient and actual suffering may occur. Clearly, it is not right that any consumer suffer at such times because of the extravagance and waste of other consumers, even though they are willing to pay for the gas wasted. Nor can the citizens justify demands for better service from the public utilities without making provision to correct abuses in their own homes. It must be recognized that the public has been and is to-day just as much a party to the crime of wasting this natural resource as are the companies that produce and market it.

SCIENTIFIC LECTURES

Under the auspices of the division of geology of Harvard University, Dr. James Mackintosh Bell, former government geologist of New Zealand, will give a series of nine lectures on topics in economic geology. These lectures are given in the Geological Lecture Room, Geological Museum, at 4.30 o'clock, and will be open to the public. The dates and titles are as follows:

January 5. "The Waihi goldfield, New Zealand."

January 7. "The Mount Morgan copper mine, Queensland."

January 9. "The Mount Bischoff tin mine, Tasmania."

January 12. "The Mount Lyell copper mine, Tasmania."

January 14. "The Spassky copper mines, Siberia."

January 16. "The Atbasar copper mines, Siberia."

January 19. "The Sadbury nickel-copper area, Ontario."

January 20. "The Cobalt Silver Camp, Ontario."

January 21. "The Porcupine goldfields, Ontario."

The following are among the lectures to be given at the Royal Institution: Professor W. H. Bragg, six lectures adapted to a juvenile auditory on The World of Sound; Sir John Cadman, two lectures on (1) Modern Development of the Miner's Safety Lamp and (2) Petroleum and the War; Professor G. Elliot Smith, three lectures on The Evolution of Man and the Early History of Civilization; Professor Ernest Wilson, two lectures on Magnetic Susceptibility; Professor Arthur Keith, four lectures on British Ethnology: The Invaders of England; Professor A. E. Conrady, two lectures on Recent Progress in Photography; Professor A. H. Smith, two lectures on Illustrations of Ancient Greek and Roman Life in the British Museum; Lieutenant-Colonel E. Gold, two lectures on The Upper Air; Sir F. W. Dyson, Astronomer Royal, three lectures on The Astronomical Evidence bearing on Einstein's Theory of Gravitation; and Sir J. J. Thomson, six lectures on Positive Rays. The Friday evening discourses will begin on Friday, January 16, 1920, at 9 o'cock, when Sir James Dewar will deliver a discourse on Low-temperature Studies. Succeeding discourses will probably be given by Sir C. A. Parsons, Mr. S. G. Brown, Professor W. M. Bayliss, Dr. E. J. Russell, Mr. W. B. Hardy, the Hon. J. W. Fortescue, Professor J. A. Fleming, Mr. E. McCurdy, Sir J. J. Thomson, and others.

SCIENTIFIC NOTES AND NEWS

At a meeting of the Société de Pathologie exotique at the Institut Pasteur of Paris, held on December 10, Dr Simon Flexner of The Rockefeller Institute for Medical Research, in New York, was elected an associate member. Dr. Flexner was also elected to associate membership in the Société Royale des Sciences Médicales et Naturelles of Brussels, at a meeting held on December 1, and to the Société Belge de Biologie of Brussels, at its meeting of December 6. On December 22, Dr. Flexner was made a corresponding member of the Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte of Rotterdam, Holland.

Official notice has been issued by the French Academy of Sciences of the award of the Bordin prize in mathematics to Dr. S. Lefschetz, assistant professor of mathematics in the University of Kansas, and of the Lalande prize in astronomy to Dr. V. M. Slipher, director of the Lowell Observatory at Flagstaff.

FORMER assistants of Dr. Edwin R. Le Count, professor of pathology in Rush Medical College, tendered him a banquet on December 17 and presented him with two paintings as a recognition of esteem and gratitude. The presentation address was made by Dr. Frank R. Nuzum, Janesville, Wis., who presided. Addresses were also made by Drs. Herman A. Brennecke, Aurora; George E. Clements, Crawfordsville, Ind.; William H. Burmeister, George H. Coleman, Arthur H. Curtis, Morris Fishbein, Edward H. Hatton and James P. Simonds, Chicago.

SURGEON GENERAL SIR ALFRED KEOGH and Sir Almroth E. Wright have had the honorary degree of doctor of science conferred on them by the University of Leeds.

SIR DONALD MACALLISTER, superintendent of the British Medical Council, has been invested by President Poincaré, with the cross of the commander of the Legion of Honor.

DR. A. S. LOEVENHART, professor of pharmacology and toxicology at the University of Wisconsin, was elected president of the Pharmacological Society at the annual meeting held in Cleveland last week.

MR. ELMER H. FINCH, geologist of the U. S. Geological Survey, has recently been appointed chairman of the Mineral Division Land Classification Branch, U. S. Geological Survey, succeeding Mr. A. R. Schultz, resigned.

DR. FOREST B. H. BROWN, research fellow at Yale University, has been appointed botanist on the staff of the Bishop Museum at Honolulu. Dr. Elizabeth Wuist Brown has been appointed research associate in cryptogamic botany in the same institution.

DR. P. G. AGNEW, physicist in the Electrical Division of the Bureau of Standards, has resigned to become secretary of the American Engineering Standards Committee, with headquarters at the Engineering Building, 29 West 39th Street, New York City.

DR. ARTHUR LACHMAN, a well-known chemist of San Francisco, formerly professor in the University of Oregon, was last seen on the street at noon on December 11, 1919. Since then his family and friends have been unable to obtain any clue or any trace of his whereabouts. It seems probable that he had an attack of amnesia with loss of identity and wandered away. Dr. Lachman is known to many readers of SCIENCE. Any one having information in regard to him is requested to communicate with his family or with Dr. Felix Langfeld, 272 Post St., San Francisco, California.

LANCASTER D. BURLING, invertebrate paleontologist of the Geological Survey of Canada, has accepted the position of geologist with S. Pearsons and Sons, Limited, of London, England. His first assignment is to work in the old fields of Trinidad, for which he will leave upon the first available sailing.

CAPTAIN W. E. BROPHY, C.E. (Columbia, '15), formerly of the Barrett Company and later of the Chemical Warfare Service, U. S. A., has joined the engineering staff of Arthur D. Little, Inc., at Cambridge, Mass. In the early part of the war, Captain Brophy had charge of the construction and operation of the plant at Astoria, Long Island, for the manufacture of high absorbent carbon for use in gas masks and later he designed, constructed and operated an additional unit for the purpose at San Francisco.

DR. HIDEYO NOGUCHI, of the Rockefeller Institute for Medical Research, has landed at the port of Progreso from which he will proceed to Merida in order to carry on confirmatory studies of his discovery of *L. icteroides* and to try on a larger scale the curative properties of the specific serum prepared by him.

MR. N. H. DARTON, geologist of the U. S. Geological Survey, will spend two months in the Dominican Republic early in 1920 to investigate oil conditions for a New York company.

At the thirty-sixth Annual Convention of the Association of Official Agricultural Chemists held at Washington beginning on November 17 the following officers were appointed for the ensuing year: *President* H. C. Lythgoe, State Department of Health, Boston, Mass.; *Vice-president,* W. F. Hand, Agricultural College, Agricultural College, Miss.; *Secretary-Treasurer,* C. L. Alsberg, Bureau of Chemistry Department of Agriculture, Washington, D. C. Additional members of the Executive Committee are C. H. Jones, University of Vermont, Burlington, Vt., and W. W. Skinner, Bureau of Chemistry, Washington, D. C.

At the annual meeting of the Washington Academy of Sciences, held on January 13, Dr. F. L. Ransome, delivered the address of the retiring president on "The Functions and Ideals of a National Geological Survey."

The sixth lecture of the series of The Harvey Society will be by Dr. Carl Voegtlin, professor of pharmacology, United States Public Health Service, on "Recent Work on Pellagra" at the New York Academy of Medicine on January 24 at 830.

Dr. George Macloskie, professor emeritus of biology of Princeton University, died at Princeton, on December 4 in his eighty-fifth year.

The death is announced of Professor A. Ricco, director of the Observatory of Catania and vice-president of the International Astronomical Union.

The death is announced of Professor E. H. Bruns the director of the University Observatory at Leipzig.

UNIVERSITY AND EDUCATIONAL NEWS

An anonymous gift of $1,000,000 has been offered to Throop College of Technology, at Pasadena, California, conditional upon an equal amount being raised from other sources.

Mr. Gustavus F. Swift, of Chicago, has added $8,000 to the previous endowment of the Gustavus F. Swift Fellowship of the University of Chicago, making the income from that fellowship amount to $925. This fellowship is awarded for the encouragement of research, and is given only to a student who has already proved his capacity for investigation.

Dr. William H. Walker, head of the Research Library of Applied Chemistry at the Massachusetts Institute of Technology, has been appointed head of the new division of industrial cooperation and research.

Dr. M. G. Seelig, has accepted the position of professor of clinical surgery, at the School of Medicine of Washington University at St. Louis, Mo.

Dr. Walter H. Eddy, of Teachers College, Columbia University, associate in physiological chemistry, has been appointed assistant professor of physiological chemistry. Dr. Eddy has recently returned from France, where he served fifteen months with the A. E. F., as major in the Sanitary Corps.

Harold S. Palmer, instructor in geology in Trinity College, Hartford, Conn., leaves on February 1 for Honolulu to take charge of the department of geology in the University of Hawaii.

Sir Richard Glazebrook, who recently returned from the directorship of the British National Physical Laboratory, has been appointed to the Zaharoff chair of aviation tenable at the Imperial College of Science and Technology, founded by Sir Basil Zaharoff, who gave to the university the sum of £25,000 for this purpose.

Dr. G. M. Robertson has been appointed to a professorship of psychiatry and Dr. J. H. Ashworth to a professorship of zoology in the University of Edinburgh.

Dr. Fritz Paneth, director of the chemical department of the German technical high schools at Prague, has been appointed professor of chemistry at the University of Hamburg.

DISCUSSION AND CORRESPONDENCE

MUSICAL SANDS

The article on "Singing sands of Lake Michigan" by W. D. Richardson, in Science, November 28, gives suggestion for the present writing.

The phenomenon of sonorous sands was very thoroughly studied in the years 1882–1889 by Dr. H. Carrington Bolton and Dr. Alexis A. Julien, both of New York City. The very interesting results of their enthusiastic research were published in several short articles in the *Proceedings* of the American Association for the Advancement of Science and in the *Transactions* of the New York Academy of Sciences. A brief review of their work may be worth the space.

The preliminary paper was read at the Minneapolis meeting of the Association, 1883, describing their study of the musical sands at Manchester, Mass., and on the island of Eigg in the Hebrides; with reference to many other localities. This paper is printed in the *Proceedings,* volume 32, pages 251–252.

After a year of extensive travel and study of the phenomenon, and with voluminous correspondence, a second paper was read at the Philadelphia meeting, 1884, and printed in abstract in volume 33 of the *Proceedings,* pages 408–415. In this article the sounds emitted by the sands are indicated by musical notation. Some search of old writings had shown that allusions to the phenomenon were found in the literature of the past one thousand years; and that famous localities, like Jebel Nagous, had been visited by many travelers. A brief chronology of the study and writings from the sixteenth century was included.

In Volume 3 of the New York Academy *Transactions,* pages 72–76 and 97–99, for 1884, Dr. Bolton described the phenomenon on the Baltic coast, and in the sand-hill of Arabia and Afghanistan, especially at Jabel Nakous, or "Mountain of the Bell" on the Gulf of Suez. A paragraph at the close of that article is worth quoting.

> The localities in which sonorous sand is found may be divided into three classes: first, sea- and fresh-water beaches, where all the sand possesses the sound-producing quality permanently, as at Eigg, Manchester, Plattsburg, etc.; secondly, sea-beaches where small tracts of the sand possess acoustic properties transiently, as along the Atlantic coast, in New Jersey, North Carolina, and on the Baltic; thirdly, sand-hills in the interior or otherwise, whose steep slopes give rise to acoustic phenomena of great magnitude, as at Kauai, in Nevada, and at Jebel Nakous and Reg Ruwan.

Volume 8 of the Academy *Transactions,* 1888, pages 9–10, prints a letter giving the conclusion of the authors as to the cause of the sounds. And on pages 181–184 is given a very interesting letter of Dr. Bolton, from Egypt, describing his visit to Jabel Nagous. In Volume 9, 1889–1890, pages 21–25, Dr. Bolton gives a fuller account of his visit to Arabia Petraea, and also a summary of the conclusions reached by Dr. Julien and himself, as follows:

> Dr. Julien and I believe that the true cause of sonorousness in the sands of singing beaches and of deserts is connected with thin pellicles or films of air, or of gases thence derived, deposited and condensed upon the surface of the sand-grains during gradual evaporation after wetting by seas and lakes or by rains. By virtue of these films, the sand-grains become separated by elastic cushions of condensed gases, capable of considerable vibration, and whose thickness we have approximately determined. The extent of the vibration and the volume and pitch of the sound thereby produced, after any quick disturbance of the sand, we also find to be largely dependent upon the forms, structures and surfaces of the sand-grains, and especially upon their purity or freedom from fine silt or dust.

In Volume 8, page 10, of the New York Academy *Transactions,* is described the opening by Dr. Bolton of two packages of sea sand collected at Rockaway Beach four and five years previous, and which gave distinct high notes when quickly rubbed or shaken.

The present writer has a large bottle of the Rockaway Beach sand, collected with Dr. Bolton on that summer day in 1884, when the beach was singing clearly. The bottle has been closed with a cork stopper, but was opened, for a minute, a few years ago for removing a sample. The bulk of the sand has been in the bottle over thirty-five years. This day, December 2, it has been poured into a stocking, and when quickly compressed has given clearly the characteristic high note, audible at considerable distance. But since it has been spread out in the warm dry room, and received some handling, it has lost the sonorous quality.

H. L. Fairchild

University of Rochester

MORE ON SINGING SANDS

To the Editor of Science: The comment of Mr. Richardson in a recent number of Science (November 28, 1919) on the singing sands of Lake Michigan, calls to mind some observations made a number of years ago that should be considered in connection with the hypothesis he advances to explain the singing quality of the sand.

These sands were encountered by us in connection with the soil survey of Allegan, county, Michigan. The singing quality was particularly well developed within four to six rods of the lake shore. We collected a sample of several hundred pounds which was forwarded to the Bureau of Soils at Washington. After the material was in the sack on the beach, the singing quality could be developed by merely running the fingers through the sands.

The material was shipped by freight and stored in the basement of the building then occupied by the bureau. Some months later the material was looked up and examined. It had completely lost its singing quality. Of course it had dried out. There was no leaching and presumably no change in chemical composition.

It has seemed to me that this quality is associated with two primary factors namely: (*a*) Very well rounded and smooth particles, (*b*) A particular amount and condition of moisture. Neither a very wet nor a very dry condition suffices. We have noticed a slight tendency to this singing quality in walking over the sand dunes in that section of Michigan, if the foot is jammed into the sand so as to get below the very dry surface layer and into contact with the somewhat moist sand immediately below.

I am inclined to think the percentage of moisture when coupled with the smooth, rounded particles is the chief factor in developing singing sand. That per cent. is somewhere in the region of the lento-capillary point or the margin between hygroscopic and free capillary moisture where, due to surface attraction of the sand particle, film movement is very sluggish. It might be defined as the first stage of film solidification.

Elmer O. Fippin

THE INITIAL COURSE IN BIOLOGY

The botanists are more and more loudly proclaiming their academic rights as against the zoologists. In most American universities now there is a course in general biology, and it is given, often entirely, by the department of zoology. It is a very large course, running sometimes to several hundred students a year. It involves a large staff, assistant professors, instructors and assistants, and thus provides places for graduate students without fellowships. Sometimes it carries more patronage than all the other courses in zoology, botany and related subjects combined.

Naturally the botanists feel aggrieved, when they compare the few students who reach their courses, and the inadequacy of the assistantships for their support in botany, with the opulent conditions in the department of zoology.

Professor George E. Nichols has presented recently in Science data bearing on this matter, and has discussed with fairness and ability the question of the initial course in biology. The initial course in any field is a difficult subject: whether it should be designed primarily as introductory for those who intend to go further, or as broadly educational for those who can not.

I take it as axiomatic that there is a certain minimum of information regarding matters biological which every educated man ought to have, and that this would consist particularly in some knowledge of the living human body. In fact, however, a large number of students are passing through our universities, many are even taking courses in biology, who fail to obtain this minimum. I have known of engineering students who believed that the child is born through the umbilicus. I have sat opposite to an astronomer who refused to finish a glass of dark beer when he learned that in passing from his mouth and stomach to his kidneys the black and foaming fluid in the glass in front of him would have to go through his heart.

I am inclined to agree with Professor Nichols that general biology, as given by zoologists, is a course which is suited primarily to introduce students to animal morphology. But I doubt whether a course of this sort half as long, followed in February by an exactly similar course by botanists and introducing students equally to plant morphology, would be a better arrangement.

To my mind neither the zoologists nor the botanists should give the initial course, for if either or both have a hand in it, it will have the emphasis of a specialist. It will deal primarily with morphology plus a single function, that of reproduction.

The initial course should be a course in physiology. I may illustrate what I mean by speaking of zoologists as specialists, by quoting a distinction which I once heard a physicist give of the difference, as he saw it impartially, between zoology, or general biology, on the one hand, and physiology on the other. The former, he said, dealt with reproduction, the latter with all the other functions of life.

Now it is nice to know about amebæ and frogs and the germination of seeds, but a lawyer, or an engineer, or a journalist, or even a doctor, can get along and yet know very little of such matters. If, however, he has no notion of his own insides—of what purpose his food serves, and of why he keeps breathing—well, he simply is not an educated man.

Even for the student who is going far in zoology, or botany, I believe that the first great lesson should be in function, with structure included along with, but not emphasized above, chemical and physical basic facts.

The student should begin, therefore, in that field in which knowledge of function has been most highly developed, a field which has the most powerful appeal for a human being, the field of "human," that is, mammalian, physiology as presented par excellence in that marvelous little book, Huxley's "Lessons in Elementary Physiology."

It seems—at least some of us hope—that today we are about to see a displacement of the academic college course in favor of a junior college, which would give such general subjects as the languages, American history, elementary chemistry and physics, and the one or two other things that every one should have; to be followed in the senior college by groups of increasingly specialized studies, each group aimed to a definite end. If this is to come, neither the course in general biology which Professor Nichols condemns, nor the combined elementary zoology-botany which he favors, is entitled to a place in the curriculum of the junior college.

But a brief course in human physiology is. At least, so thinks a physiologist.

YANDELL HENDERSON

YALE UNIVERSITY

SCIENTIFIC BOOKS

The Fauna of the Clyde Sea Area, being an attempt to record the zoological results obtained by the late Sir John Murray and his assistants on board S. Y. *Medusa* during the years 1884 to 1892. By JAMES CHUMLEY. Glasgow. Printed at the University Press. 1918. Pages vi + 200, 1 map and 3 figures in text.

The former secretary of the Challenger Office and of the Lake Survey of Scotland, Mr. James Chumley, for many years associated with the late oceanographer and marine zoologist, Sir John Murray, has compiled the data regarding the latter's explorations of the Clyde Sea Area in a "Fauna" of that region. The work has been financed by the Carnegie trustees for the universities of Scotland. The work contains brief account of the Scottish biological stations at Granton and Millport, which respectively preceded and succeeded the explorations which are here summarized.

The physiographic investigations made during this survey were published in the Transactions of the Royal Society of Edinburgh in 1892 and 1894 by Dr. H. R. Mill, but the zoological results had never been assembled for publication.

The region surveyed has an area of 1,160 square miles and includes the Arran Basin, the Great Plateau at its mouth, the Estuary of the Clyde, and a series of narrow locks or fiords of which Loch Tyne is the largest. These locks have about 95 per cent. of normal sea water and receive a mean tidal increment of about 4 per cent. of their total volume so that the habitat is typically marine in most essential particulars, but modified by restrictions on circulation and the resulting conditions in temperature typical of fiords.

The seven typical regions are treated separately in the faunistic summaries in which the species are arranged systematically from Protozoa to Vertebrata, with notes on localities, depths and frequencies. All groups are represented except parasitic ones and Protozoa other than Foraminifera, but somewhat unevenly and in the older nomenclatures in some instances. The records are based mainly upon the catches of the dredge rather than those of the plankton net. There are two full bibliographies arranged chronologically and systematically. A grand summary includes 806 species of which only 8 per cent. are found in all of the seven subdivisions. It is highly probable that further explorations will greatly increase the elements of the fauna common to the several subdivisions.

This faunistic study will be useful to American investigators of the North Atlantic fauna as well as to those who will frequent the newly established Bute Marine Laboratory at Rothesay in the Clyde Sea Area, which for research purposes replaces the Scottish Marine Laboratory at Millport, Isle of Cumbrae, which is now in the possession of amateur interests and in the service of more popular aspects of the biological sciences. It is to be hoped that the unparalleled service to marine zoology rendered by Sir John Murray may in time be recognized by a memorial on the shores of Scotland in the form of a marine biological and oceanographical research station whose equipment and work will be worthy of the name it should bear.

Charles A. Kofoid
University of California

THE ECOLOGICAL SOCIETY AND ITS OPPORTUNITY

Perhaps no other scientific body in this country has the opportunities for cooperation possessed by the Ecological Society. Its membership is made up of workers in zoology, botany and forestry; its field is no less than the relation of all life to its environment. Last summer five members of the Ecological Society, representing zoology, botany and forestry, camped together near the summit of Mt. Marcy in the Adirondack mountains of New York for the purpose of doing a concrete piece of cooperative research on the plants and animals at timber line, and to bring together into a list some of the problems in ecology. The persons and institutions cooperating were: Barrington Moore, president of the Ecological Society, Norman Taylor, for the Brooklyn Botanic Garden, George P. Burns for the Vermont Agricultural Experiment Station, Charles C. Adams and T. L. Hankinson for the New York State College of Forestry at Syracuse.

The results of the study at timber-line will be published elsewhere. The list of problems is given below. The list is by no means all inclusive, nor does it attempt to be thoroughly logical. It states general problems, with their subdivisions, and gives also a number of specific problems which in reality form parts of general problems. The purpose of this list is threefold: (1) to show gaps in our scientific knowledge, or subjects in which the fundamental facts needed for further human progress are lacking; (2) to show subjects in which cooperation is essential, subjects which a given science can carry only to a certain point and which must be taken up by one or more other sciences for solution; (3) to suggest specific problems for research workers and students.

GENERAL PROBLEMS

I. Factors influencing the distribution of land plants and animals.
- (1) Geographic position.
- (2) Altitude. How far does altitude per se influence distribution?
- (3) Topography.
  - (*a*) Aspect, steepness of slope, valleys, benches and other land forms.
  - (*b*) Influence of size of land mass of mountains, *i. e.*, isolated mountains *vs.* mountain masses.
  - (*c*) Influence of water masses.
- (4) Historical factors.
  - (*a*) Physical (geology, past climate).
  - (*b*) Biotic.
- (5) Climate.
  - (*a*) Moisture.
  - (*b*) Temperature.
  - (*c*) Solar radiation or insolation.
  - (*d*) Light.
  - (*e*) Wind.
- (6) Soil.
  - (*a*) Physical properties.
    1. Texture, desirability of a physical constant: is wilting coefficient such a constant?
    2. Soil moisture.
    3. Soil air.
    4. Soil temperature.
    5. Soil stratification or profile.
  - (*b*) Chemical properties.
    1. Solutions.
       - (*a*) Aqueous extracts (correlations with fertility.
       - (*b*) Acid extracts.
       - (*c*) Full analyses.
    2. Gases. Chemical properties of soil air.
  - (*c*) Biotic properties. All life plant as well as animal, influencing the soil.

II. Factors influencing the distribution of aquatic plants and animals.
- *A*. Standing water.
  - (1) Geographic position.
  - (2) Altitude.
  - (3) Depth, and fluctuations of depth.
  - (4) Historical factors.
    - (*a*) Physical (geology, past climate).
    - (*b*) Biotic.
  - (5) Climate.
    - (*a*) Temperature.
    - (*b*) Solar radiation or insolation.
    - (*c*) Light.
    - (*d*) Wind. Important in aeration of water.
  - (6) Water solution.
    - (*a*) Color and turbidity.
    - (*b*) Mineral and organic content.
    - (*c*) Gaseous content.
  - (7) Biotic factors.
  - (8) Bottom.
- *B*. Running water.
  - (1) Geographic position.
  - (2) Altitude.
  - (3) Fluctuation.
    - (*a*) Whether it fluctuates at all (streams on east slope of Cascade Mts. of Oregon do not fluctuate).
    - (*b*) Extent of fluctuation.
    - (*c*) Period of fluctuation (diurnal or irregular).
  - (4) Swiftness.
  - (5) Depth.
  - (6) Historical factors.
  - (7) Climate.
    - (*a*) Temperature.
    - (*b*) Solar radiation or insolation.
    - (*c*) Light.
    - (*d*) Wind.
  - (8) Water solution.
    - (*a*) Color and turbidity.
    - (*b*) Mineral and organic content.
  - (9) Biotic factors.
  - (10) Bottom.

III. Studies of factors influencing distribution. (A suggested method of procedure).
- *A*. Field survey of the problem.
  - (1) To determine significant associations of plants and animals.
  - (2) Determination of center and extremes (northern and southern, or east and west, or upper and lower in altitude).
  - (3) Instrumental readings at each of the above points, and their interpretation.
- *B*. Laboratory studies.
  - (1) Growth under controlled conditions (with recording instruments if possible).
  - (2) Analysis of critical effects.

(3) Determination of specific requirements.

C. Field interpretation of laboratory results. (In the case of temperature this will probably mean remeasurements unless recording instruments have been used.)

IV. Studies of plants and animals at the edges of their ranges. Determination of the environment at the edge of the ranges of plants and animals should help to give, for the different environmental factors, the limits within which individual species of plants and animals can grow.

V. Ecological differentiation in plants and animals, structural and functional.

(a) Ecological differentiation in single species.

(b) Growth forms and regional distribution. Frequency of occurrence and abundance, correlated with environmental factors.

VI. Migration of plant and animals.

(1) Wind.

(2) Animals.

(3) Water.

(4) Free movement of organisms.

(5) Landslides and avalanches.

(6) Movement of environment.

VII. Relation of present plant and animal life to past floras and faunas.

(1) In unglaciated regions.

(2) In glaciated regions.

(3) Post-glacial changes.

VIII. Origin and composition of organic soils. Includes forest soils, humus, peat, muck, etc.

IX. Studies of soil organisms. Bacteria, nematodes, fungi and other organisms.

SPECIAL PROBLEMS

X. Relation of osmotic pressure to elongation.

XI. Relation of temperature to root absorption.

XII. Seasonal rhythm in organism, *e. g.:*

(1) Resting period.

(2) Photosynthesis of evergreens in winter.

XIII. Relation of mycorrhiza to root hair development. (Part of general problem of symbiosis.)

XIV. Composition of light under forest canopies. Is this diffused light or light of different composition?

XV. Effect of shade on chlorophyll content.

XVI. Water requirement of forest trees.

XVII. Nutrition of forest trees. Influence of various kinds of soils.

XVIII. Minimum requirement of solar energy for tree seedling growth or leaf development.

XIX. Factors controlling the natural pruning of forest trees.

XX. Factors controlling the non-periodic shedding of the leaves of forest trees.

XXI. Study of seed bed in forests under natural conditions, in relation to germination and establishment; comparison of seed bed in forests with nursery seed beds.

XXII. Sensitiveness of roots of different species to: (a) lack of oxygen, (b) soil acidity, and (c) soil alkalinity.

XXIII. Studies of fungi in forest soils.

(1) With relation to rendering nutrients (chiefly nitrogen) available to plants.

(2) With relation to soil reaction (acidity or alkalinity).

(3) Influence on ventilation.

(4) Effect on plant roots.

XXIV. Selective absorption of roots in soil.

(1) Under different soil moisture conditions.

(2) Under different atmospheric conditions.

XXV. Pull exerted by roots in withdrawing water from soils under different moisture conditions. Influence of atmospheric conditions

BARRINGTON MOORE,
Chairman Committee on Cooperation

THE CANADIAN BRANCH OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE first annual meeting of the Canadian Branch of the American Phytopathological Society was held at the Ontario Agricultural College, Guelph, Ontario, December 11 and 12.

Canadian phytopathologists were well represented at this meeting. Among those taking active part in the proceedings were: Dr. A. H. R. Buller, University of Manitoba; Dr. J. H. Faull, Toronto University; Mr. P. A. Murphy, Dominion Laboratory of Plant Pathology, Charlottetown, P. E. I.; Mr. W. H. Rankin, St. Catharines; Mr. W. P. Fraser, Saskatoon, Sask.; R. J. Blair, Forest Products Laboratories, Montreal; Mr. F. L. Drayton, Central Experimental Farm, Ottawa; Professor L. Cæsar, Professor J. E. Howitt and Dr. R. E. Stone, Ontario Agricultural College.

The president, Professor J. E. Howitt, in his address dealt with what should be the aims of this society. These, briefly summarized, are as follows:

First. To provide adequate facilities for the training of research men in plant pathology in Canada.

Second. To make provision for the publication in Canada of the results of scientific investigations in plant pathology not of interest to the general public.

Third. To make available to the general public the practical application of results obtained from scientific research in plant pathology.

Fourth. The unification of recommendations made by the various pathologists regarding the control of the more common diseases.

Fifth. The carrying out of a plant disease survey to secure information concerning the financial losses caused by disease to agriculture and forestry and the distribution of plant diseases throughout Canada.

Sixth. The adoption of a standard of qualifications required of men entering the field of plant pathology in Canada.

Seventh. The apppointment of an advisory board to confer with the federal and provincial authorities regarding plant quarantine and other restrictive legislation.

Eighth. The maintaining of a bibliography of Canadian plant pathology.

Dr. E. C. Stakman, of the University of Minnesota, was a guest of the Canadian Branch and dealt with the cereal rust problems in the United States and Canada.

The papers on the following program were given at this meeting:

President's address, J. E. Howitt.

"Health and disease in plants," F. L. Drayton.

"Decay in timber of pulp and paper mill roofs." (Illustrated with lantern slides.) R. J. Blair.

"Butt rots of the balsam fir in Quebec Province," W. H. Rankin.

"Leaf blight of the white pine," J. H. Faull.

"Pseudorhiza of certain saprophytic and parasitic agaricinae" (illustrated), A. H. R. Buller.

Address of Welcome, President G. C. Creelman.

Address, Dr. E. C. Stakman.

"Education of plant pathologists." Discussion led by Dr. J. H. Faull.

"Witches broom of the Canada Balsam and the alternate hosts of the causal organism," R. E. Stone.

"Some comparative observations upon the shape of *Basidia* and method of spore discharge in the Uredineæ and Hymenomycetes," A. H. R. Buller. (Illustrated with models and lantern slides.)

"Smut of western rye grass," W. P. Fraser.

Address, E. C. Stakman.

"Some observations made in inspecting for leaf roll and mosaic of potatoes," J. E. Howitt.

"New or little-known diseases of potatoes which cause the running out of seed," P. A. Murphy.

"Breeding beans for disease resistance," G. P. McRoster.

"Combination sprays for apple and potato," G. E. Sanders. (By title.)

"Some data on peach yellows and little peach," L. Cæsar.

"Fungi new to Ontario," A. W. McCallum.

"Some fungi and plant diseases comparatively new to Ontario," R. E. Stone and J. E. Howitt.

The following officers were elected for 1920:

President—Dr. A. H. R. Buller.

Vice-president—Dr. J. H. Faull.

Secretary-Treasurer—Dr. R. E. Stone.

Additional Members of the Council—Professor J. E. Howitt and Mr. F. L. Drayton.

THE AMERICAN CHEMICAL SOCIETY. VI

Colloidal reactions fundamental to growth: D. T. MACDOUGAL. (By title.) Living cell masses from the growing parts of plants in which the H-ion of the sap varies from PH, 3.9 to 7 may show an unsatisfied hydration (absorption) capacity which causes a swelling of 6 to 80 per cent. in thickness in distilled water at 18 to 20 C. Dried (dead) sections of the same material in which the salts originally dissolved in the sap have been adsorbed by solids at high concentrations during the progress of desiccation, show (total absorption) hydration capacities which causes enlargements as high as 550 per cent. of the volume of the dried material. The aspect of comparative swellings in acid and basic solutions (tested between 0.5 M and 0.000001 M) in the two cases are different, probably due to changes in the colloids caused by the adsorption of salts, etc. The actual volume reached by such material in swelling includes some osmotic action and is limited by the morphological or mechanical features of the tissues. Artificial mixtures of pentosans, agar, mucilage and gum, and of plant albumins made up to simulate so far as possible the composition of the plasmatic (living) colloids, show comparative hydrations or total swelling similar to cell masses, and of an equivalent or greater amplitude. Specially prepared and purified agar and albumins prepared by E. R. Squibb & Sons are used in these experiments. Some of the results obtained are not explainable on the basis of the simple action of the H or OH ions, especially in the use of alkaline hydroxides, ammonia and amino-compounds. The reactions noted are fundamental or contributory to growth.

The antiscorbutic value of the banana: H. B. Lewis. (By title.)

A study of various culture media, especially with reference to increasing their buffer effects and adjusting their P_H values: M. R. Meacham, J. J. Hopfield and S. F. Acree. (By title.) Titration or buffer curves of corn meal extract, malt extract and bean extract, culture media and chestnut bark extract, are shown. The desirability of adding acids, bases and salts to these extracts to make them more useful as culture media by increasing their buffer effect is pointed out. The further object of rendering, at the same time, the titration curves as near straight lines as possible is sought. Data and curves are given showing the practical attainment of these objects for two of the media. The preparation of the media is carefully described, so as to make possible their reproduction to within 0.25 to 0.50 of a P_H unit.

The cause of and remedy for certain inaccuracies in Hausmann's nitrogen distribution method: S. L. Jodidi and S. C. Moulton. (By title.) The proportion of acid amide nitrogen obtained by Hausmann's method, as modified by Osborne and Harris, is constant and does not depend upon the quantity of magnesium oxide applied to the distillation. The percentage of nitrogen contained in the magnesium oxide precipitate is the higher, the greater was the quantity of magnesium oxide employed in distillation, and vice versa. Conversely, the proportion of monoamino and diamino nitrogen is the smaller, the larger the amount of magnesium oxide used in distillation. In order to obtain uniform results and a minimum of "humin" nitrogen it is necessary to use the least possible amount of magnesia which is sufficient to render the substance to be distilled alkaline. In the case of plant and animal materials the uniform application of *one gram* of magnesium oxide seems to be satisfactory, while in the case of proteins *one half of one gram* suffices.

The antiscorbutic properties of raw lean beef: R. Adams Dutcher, Edith M. Pierson and Alice Biester. Guinea pigs weighing 250 to 300 grams were divided into experimental groups containing four pigs to the group. Cold water extracts of raw beef (representing 5, 10, 15 and 20 grams of beef) were fed daily to the individuals in each respective experimental unit. Other pigs received oats impregnated with chopped raw beef, the consumption of beef averaging 3 to 5 grams daily. In all cases scurvy developed in the same length of time as when the meat and meat extract were omitted from the diet, indicating that raw beef does not possess antiscorbutic properties so far as these properties can be ascertained by the method described.

Preliminary observations on the influence of the diet of the cow on the antiscorbutic and growth promoting properties of milk: R. Adams Dutcher, Edith M. Pierson and Alice Biester. Guinea pigs receiving a daily diet of oats (ad lib.), water, and 25 c.c. of autoclaved milk (from stall-fed cows) developed scurvy in 15 to 18 days and died in 25 to 30 days with great loss in body weight. When 20 c.c. of autoclaved milk (from cows fed on grain and green grass) were substituted for the "stall fed" milk, scurvy developed 10 to 15 days later and death did not ensue for 40 to 60 days and no great loss in body weight occurred. Raw, pasteurized and separated milk (from cows on green grass) has been fed, and the results indicate that the nutritive value of these milks is higher than milk from other sources.

Rhubarb as an antiscorbutic: Edith M. Pierson and R. Adams Dutcher. Guinea pigs which have developed scurvy may be relieved and cured by introducing into the diet solid rhubarb, raw rhubarb juice, or rhubarb juice which has been boiled for fifteen minutes.

The function of vitamin in the metabolism of Sclerotinia cinerea: J. J. Willaman. (By title.) The brown-rot fungus will not grow normally on purely synthetic media. When these media are supplemented by additions of vitamin, normal growth occurs. The vitamin has been prepared by adsorption on fuller's earth from a large variety of materials, including peach and plumb juices, young tomato leaves, sprouts of beans, wheat and potato, the leaf buds of beans, fungus mycelia and sporophores, yeast, corn pollen, milk and pancreatin. Every material examined yielded the vitamin. Those materials which are characterized by high respiratory activity, either actual or potential, such as yeast, pollen, fungus spores, gave the most active vitamin preparations, both for vegetative growth and for reproduction. It is believed from these results that the vitamin in question will be found universally distributed in plant and animal tissues, and that it plays an essential part in the respiratory process. The evidence favors the view that this vitamin is the water-soluble antineuritic B.

The preparation of a stable vitamine product and its value in nutrition: H. E. Dubin. An active stable vitamine product has been prepared from corn, autolyzed yeast, and orange juice. This vitamine product, containing the antineuritic, antiscorbutic and antirachitic vitamines, has been given the name "Vitaphos." A tentative analysis shows 10 per cent. calcium oxide, 15 per cent. phosphorus (mostly organic), 3 per cent. nitrogen, and 2 per cent. fat. Experiments with pigeons, guinea pigs and finally with children receiving "Vitaphos" in the diet, gave results showing that the product possessed marked growth promoting properties and both preventive and curative properties as regards polyneuritis and scurvy. Cases of rickets treated with "Vitaphos" showed marked improvements and considerable gain in weight. Further experimentation is under way.

Chemical isolation of vitamines: C. N. Myers and Carl Voegtlin. Brief historical discussion of previous chemical work with special reference to the pioneer researches of Casimir Funk. Vitamines are classified as antineuritic, antirachitic and antiscorbutic. Autolyzed yeast filtrate was used in part of the experiments but was found unsatisfactory on account of its complexity. Mastic emulsion, Lloyd's reagent, and ferric chloride were used in removing the active material from the filtrate. These purified fractions were tested for activity on polyneuritic birds. Dried yeast was finally used as the source of active material. Purification by means of heavy metal precipitation was carried out yielding a crystalline substance.

The vitamine content of wheat flour: C. O. Johns, A. J. Finks and M. S. Paul.

The relation of plant carotinoids to growth, fecundity and reproduction in fowls: Leroy S. Palmer and Harry L. Kempster. White Leghorn chicks were raised from hatching to maturity on rations containing the merest traces, if not entirely devoid, of carotinoids. The full grown hens exhibited normal fecundity although the yolks of the eggs were devoid of carotinoids. The carotinoid-free eggs showed normal fertility. A second generation of chicks, free from carotinoids at hatching have been hatched from the carotinoid-free eggs. Carotinoid-free egg yolks contain a residual yellow pigment readily extracted by acetone, which is not related to the normal axanthophyll of the yolk. This paper appeared in full in the September issue of the *Journal of Biological Chemistry.*

The physiological relation between fecundity and the natural yellow pigmentation of certain breeds of fowls: Leroy S. Palmer and Harry L. Kempster. (By title.) The fading of the yellow color from the ear lobes, beak, shanks, etc., of a hen during fecundity is due to the fact that fecundity deflects the normal path of excretion of xanthophyll from these parts of the skin to the egg yolk, with the resulting gradual disappearance of pigment from the epidermis because of natural physiological changes in the structure of the skin. It is impossible to restore xanthophyll to the epidermis or to color the adipose tissue of hens as long as fecundity exists. The loss of pigment from the ear lobes, beak, shanks, etc., as the result of egg laying, is an index of *continuous fecundity* only, not of *heavy egg laying.* This paper appeared in full in the September issue of the *Journal of Biological Chemistry.*

The influence of specific feeds and certain pigments on the color of the egg yolk and body fat of fowls: Leroy S. Palmer and Harry L. Kempster. (By title.) Carotin and annatto are without influence on the color of the visible skin parts and adipose tissue of poultry. Sudan III. colors only the adipose tissue of non-laying hens and is without effect on the visible skin parts. With laying hens the egg yolk is colored in addition to the adipose tissue. Xanthophyll readily colors both the adipose tissue and visible skin parts of fowls of the type of the White Leghorn breed, as long as fecundity does not exist. Yellow corn and green feed are rich in xanthophyll. Hemp seed, barley, gluten feed and red corn contain traces of xanthophyll, while wheat, wheat bran, oats, cottonseed meal, meat scrap and blood meal contain negligible quantities of the pigment. This paper appeared in full in the September issue of the *Journal of Biological Chemistry.*

The relation of the natural enzymes of butter to the production of "tallowiness" through the agency of copper salts: Leroy S. Palmer and W. B. Combs. (By title.) "Tallowy" butter was produced by the addition of 0.017 per cent. copper lactate to both raw cream and cream which had been pasteurized at 79°–80° C. In each of several experiments typical tallowiness and bleaching occurred in the raw cream butter several weeks before it appeared in the butter from the pasteurized cream. The oxidizing enzymes in raw-cream butter apparently accelerate the catalytic activity of the metallic salts which cause the production of typical "tallowy" butter. It was found that over-neutralization of the cream failed to accelerate materially the production of tallowiness by copper lactate. This paper will appear shortly in the *Journal of Dairy Science*.

The nutritive value of commercial corn gluten: C. O. Johns, A. J. Finks and M. S. Paul.

The effect of calcium on the composition of the eggs and carcase of the laying hen: G. Davis Buckner and J. H. Martin. Authors have shown that limiting the calcium supply of laying hens to that naturally occurring in the foods fed, causes a progressive thinning of the shell yet it does not materially change the percentage composition of the egg shells or their contents. The continued laying of eggs under this condition causes a gradual depletion of calcium in the carcase of the hen. It would seem from the figures obtained that as long as the economy of the hens permitted a formation of an egg shell that the contents of the shell would remain constant, thereby permitting an average supply of calcium for the proper development of the embryo of the chick.

Protein requirement in the maintenance metabolism of man: H. C. Sherman. (By title.)

The development of Tribolium confusum Duval in certain foods: Royal N. Chapman. This study has shown that the confused flour beetle, *Tribolium confusum*, grows at about the same rate in the different grades of wheat flour and in some of the so-called wheat flour substitutes, but in certain of the low grade wheat flours and in some of the "substitutes" metamorphosis is retarded. The rate of development in first middlings wheat flour was adopted as the control. The instars were plotted on the ordinate and the time in days on the abscissa in such a way that the curve of development would be a straight line bisecting the angle. When the curves of development in other foods were superimposed upon the controls they were found to be very similar except for a prolongation of the last larval instar. Since metamorphosis takes place during the last instar, this prolongation has been taken as a measure of the nutritive effect upon metamorphosis. Certain low grade wheat flours, rye flour and rice flour prolonged the last instar while corn flour, steel cut oats and a synthetic food prolonged all instars about equally.

The influence of quinine on uric acid excretion in man: H. B. Lewis and W. L. McClure. (By title.)

The uric acid content of normal human saliva: H. B. Lewis and W. S. Griffith. (By title.)

Further studies on the chemical composition of normal and ataxic pigeon brains: Mathilde L. Koch and Oscar Riddle. A second series of analyses made on brains of pigeons affected with hereditary lack of control of the voluntary movements shows deviations from the normal brain in size and chemical composition. The brains are smaller. Eight analyses made on cerebrums and cerebellums show more pronounced changes in the cerebellums. Data for the chemical changes in the brain which accompany age have been obtained for a series of ages in the pigeon. The new and earlier evidence warrants the conclusion that chemical differentiation does not proceed as rapidly in the brain of ataxic birds as in the brains of normal birds.

A comparison of the distribution of various chemical groups in parts of the human and pigeon brain: Oscar Riddle and Mathilde L. Koch. Separate analyses made of anterior and posterior parts of the normal pigeon brain make it possible to compare these with similar parts of the human brain. It is found that the *direction of the percentage differences* in composition of the two parts of the brain is the *reverse* of that of the human in the case of every chemical fraction obtained. Also, from a chemical standpoint the cerebellum of the pigeon is an intermediate of the pigeon cerebrum and the human brain (cerebrum and cerebellum). The pigeon cerebrum is chemically least differentiated, the human cerebrum most differentiated, of the four organs compared.

Charles L. Parsons,
Secretary

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

WHITMAN'S WORK ON THE EVOLUTION OF THE GROUP OF PIGEONS

THE three volumes containing the work of Professor Charles Otis Whitman on pigeons published by the Carnegie Institution of Washington is a fine memorial to one of the leaders of zoological research in America. In the course of the sixteen years devoted to this work Whitman brought together birds from all parts of the world, bred them, studied their juvenile and adult plumages, and their habits, and made many crosses between different species. When he died in 1910, his extensive and valuable collection of living birds was saved through the devotion and sacrifices, both personal and financial, of Dr. Oscar Riddle, the editor of these posthumous volumes. After that first year of precarious existence, the Carnegie Institution met during the five years following the expenses of maintenance, and during this time the birds, under Dr. Riddle's care, were transferred to the laboratory at Cold Spring Harbor where Whitman's work is being carried forward. Without this support only a fragment of Whitman's results could have been preserved or the birds kept to complete many of the important problems that were at the time of Whitman's death still unfinished. The editing of the work has been admirably done by Dr. Riddle. It is a fortunate circumstance that what was left fell into the hands of one familiar with Whitman's ways of thinking, and thoroughly conversant with the many problems that had grown out of Whitman's studies; for "not more than one fifth of the matter" was in shape for publication when Whitman died.

Volume I. gives Whitman's views and his evidence for orthogenetic evolution. The editor says in the preface, Whitman "has accumulated the most weighty evidence for

[1] Posthumous words of Charles Otis Whitman. The Carnegie Institution of Washington, 1919.

continuity as against discontinuity in the phenomena of variation, inheritance and evolution." And with this verdict his reviewer is not inclined to disagree, because as a careful study of Whitman's evidence and meaning shows, there is not much difference between what he understood by continuity and what is to-day called more often discontinuity.

In the introductory chapter from a manuscript written in 1909 that formed part of a lecture given at Clark University, the keynote to Whitman's antagonism to the mutation theory of de Vries is struck—a note that recurs throughout the first two volumes. Weismann, he says, taught us to look to germinal variation as the source of all variation that is hereditary. Then follows a paragraph that takes us to the heart of the matter: "Do we not have, then, in germinal variation, a better criterion of what is specific than we get in sudden appearance? Indeed, is it not here that the seeming suddenness of first appearance finds its explanation, and likewise the fact that so-called mutations involve the whole organism? If we are to accept the physiological conception of development, as is inevitable in my opinion, it is easy to see that a change, however slight, in the primordial constitution of the germ would tend to correlate itself with every part of the whole germ-system, so that the end stage of development would present a new facies and appear as a total modification, answering to what deVries would call a mutation. That some thing of this order does sometimes occur I have indubitable evidence, and in such form as to dispel the idea of discontinuity and sudden gaps in transformation."

With a slight shift of wording and emphasis the essential part of this statement is not very different from what we think to-day, for who will dispute now that a change (mutation) in the germ-plasm may affect many parts of the organism that develops out of such a changed germ-plasm? Such a view has not been found to dispel the idea of "discontinuity" of characters; on the contrary it is in full accord with it.

But the unit character is Whitman's *bête noir*. "The idea of unit-characters, however, as distinct elements that can be removed or introduced bodily into the germ does not appeal to me as removing difficulties, but rather as hiding them; in short, as a return to the old pangenesis view of preformed characters. In this theory, as is well known, we have two miracles involved. The first consisted in a centripetal migration of preformed gemmules, and the second in the centrifugal distribution of the same elements. DeVries dismisses the first of these, but accepts the second, and on it rears the superstructure of his theory of mutable-immutable unit-characters. With all due respect to the distinguished author of this theory, and with abounding admiration for his great work and model methods, which have aroused universal interest and stimulated enormously experimental bionomics, I am strongly persuaded that his hypothesis of unit-character fails as a guide to the interpretation of the species and its characters."

"It is true a great amount of work on Mendelian heredity seems strongly to support the unit-character hypothesis, and that cytology offers some further support. Nevertheless, I have to confess a wholesale scepticism. The germ, as I believe and have long maintained, stands for an organized whole. It is a unit-organism, not an organism of units; all the features that arise in the course of development are within the sphere of the individual unity and integral parts of it, and whatever specificity they possess is completely determined and not of independent origin."

"The strongest suggestion of unit-characters is found in the phenomenon known as segregation. I do not understand the importance of this striking behavior of so-called alternative unit-characters. I am familiar with it and deeply interested; but I am unable to see in them the sum total of all we know about heredity. What I have said in regard to unit-character applies to the Mendelian doctrine. Mendelism, like mutation, neglects the natural history of the characters, it experiments with and is not primarily concerned to know how characters have originated and multiplied."

It may be that the emphasis laid on unit-character by some of the earlier enthusiastic followers of Mendel and the frequent confusion in their writings between the unit-character, so-called, and the change in the germ-plasm that gave rise to it, may justify Whitman's scepticism; but this charge can hardly be brought against de Vries, who stated over and over again that a single change in the germ-plasm may be the cause of manifold although slight changes in the characters throughout the whole organism.

In contrast to change by mutation Whitman opposes orthogenesis. Evidence for the latter he finds in his study of the group of pigeons. The evidence is the familiar argument from comparative anatomy and from the hypothesis of "recapitulation."[2] Before taking up the evidence I can not refrain from quoting a fine and characteristic statement of Whitman's in the same lecture:

"I take exception here only to the implication that a definite variation-tendency must be considered teleological because it is not 'orderless.' I venture to assert that variation is sometimes orderly and at other times rather disorderly, and that the one is just as free from teleology as the other. In our aversion to the old teleology, so effectually banished from science by Darwin, we should not forget that the world is full of order, the organic no less than the inorganic. Indeed what is the whole development of an organism if not strictly and marvelously orderly? Is not every stage, from the primordial germ onward, and the whole sequence of stages, rigidly orthogenetic? If variations are deviations in the directions of the developmental processes what wonder is there if in some directions there is less resistance to variation than in others? What wonder if the organism is so balanced as to permit both unifarious and multifarious variations? If a developmental process may run on throughout life (*e. g.*, the lifelong multiplication of the surface-pores of the lateral-line system in *Amia*) what wonder if we find a whole species gravitating slowly in one or a few directions? And if we find large groups of species all affected by a like variation, moving in the same direction, are we compelled to regard such 'a definite variation-tendency' as teleological, and hence out of the pale of science? If a designer sets limits to variation in order to reach a definite end, the direction of events is teleological; but if organization and the laws of development exclude some lines of variation and favor others there is certainly nothing supernatural in this, and nothing which is incompatible with natural selection. Natural selection may enter at any stage of orthogenetic variation, preserve and modify in various directions the results over which it may have had no previous control."

How far one is justified in extending the orderly sequence of embryonic development to the sequence shown in evolutionary advance is a large question and will no doubt be settled some day by fuller knowledge. At present our speculations must rest on the evidence at hand, and this evidence, Whitman finds, as stated, in his comparative studies of pigeon coloration, and in a most ingenious experiment of feather plucking.

His studies of domesticated breeds and their wild relatives led him to conclude that the blue wing with two black bars is not the original pattern as Darwin supposes, but rather the checkered wing covered with black spots. Both patterns are found to-day in wild birds, hence these birds can not be appealed to for a decision. But an examination of other species of pigeons shows that the checkered type is widespread and occurs in many varieties; and the young in many groups show a more checkered pattern than do the adults themselves. The Japanese turtle dove comes nearest, in Whitman's opinion, to the original type of wing pattern. The elaborate consideration that Whitman devotes to the subject indicates how important the question appeared to him;

[2] Whitman uses the word "recapitulation" in the sense for which the reviewer argued in 1903 ("Evolution and Adaptation," Chap. III.). As so used it means something essentially different from the word "recapitulation" in the original sense of Darwin and Haeckel, unless the changes in the germ-plasm add stages only to the end of ontogeny as Whitman seems to think is the way in which the process takes place. (See a later footnote.)

for, from it he derives the support of his orthogenesis. Since the same kinds of advances are observed over and over again in different groups, and since no plausible reason can be given why such changes are of benefit to the species, it follows, on Whitman's view, that some internal agency has brought about these parallel advances.

The change at molting that transforms the young plumage into that of the adult is often abrupt, almost like a mutation, yet a simple experiment shows that in the interval the constitution of the bird has been progressively advancing. If feathers are plucked in the intervening stages, the new feathers show an advance over the young feathers still present, an advance in the direction of the feathers that are to come at the next molt. And the nearer to molting time the operation is performed the nearer the approach to the newer feathers. Here then what appears to be a sudden change has in reality been led up to by a continuous series of preparatory stages; so, in Whitman's view, what appear at times to be sudden and great changes in evolution (mutations) are in reality only end stages of continuous advance. The development of the bird repeating the history of the race shows continuous change but the exegesis of molting gives us only the earlier and the later picture. To discuss this theme would take us too far afield, but it is a matter not unfamiliar to the morphologist. It should be pointed out that a change (mutation) in the germ-plasm affecting principally the end stages would be expected to give results that are in no sense incompatible with this picture.

Whitman obtained a few "mutations," *i. e.*, new types of pattern that were transmitted. The mutant change, he points out, is only an extension of a character already faintly present in the birds and present in certain wild species. What is produced is not new but a "continuous" extension of a character already present. Hence such mutations are not, he contends, new unit-characters but extension or diminution of characters already in existence. Such, in fact, are the majority of mutations known to us to-day.

Whitman thinks a very old idea reincarnated in Darwin's theory of pangenesis (that the body characters impress their influence on the germ cells) while nominally rejected survives in more subtle guise in some more modern theories such as de Vries's theory of pangenesis. In this theory the nucleus is looked upon as the seat of the hereditary complex. Its "vital" units are self-perpetuating by division, so that the nucleus in every cell remains the store house of all of the hereditary materials. In the course of embryonic development these vital elements, pangenes or genes, are set free in the surrounding cytoplasm of the cell, where they multiply and determine the fate of the cell. "The myth of transmission was not eliminated; it was only reduced in its field." "Transmission thus became more direct, but its mysteries remained as unfathomable as before. The unit-characters are assumed to preexist in the chromosomes and to stand in need of transportation from the nucleus to the body of the cell in order to develop." But "if an innumerable host of specifically distinct unit-characters are let loose in the cell-plasm, how are they to reach precisely predetermined points in the organism, and at just the time when needed? It is here that the theory breaks down, for the difficulty is not one that further investigation may hope to solve, but one that lands us in hopeless speculation. So long as the primary assumption is that of ready-made unit-characters, specifically distinct and independently variable, whether located in the nucleus or in the cytoplasm, or in both, the problem of development will remain inscrutable."

A perusal of de Vries's pangenesis theory will show that Whitman has put his finger on a weak spot in the speculation, in so far as this view pretends to explain how the specific pangens of the nucleus are supposed to migrate out of the nucleus of each cell at the right time in particular regions of the embryo, but de Vries laid no emphasis on this and was familiar with the absence of evidence for such an interpretation. The same difficulty confronts us to-day, but if I understand the situation rightly no one would be bold enough to claim any such time relations of pangen migration nor does the theory of nuclear influence call for such a hypothesis in any sense. It is ony necessary that nuclear influence should in some way affect the chemical changes that go on in the surrounding cell to cover completely the situation. No time relation is expected or called for, and who to-day will deny, in the face of extensive evidence, that the nucleus does have an important influence on the cell? With this understanding one can agree cordially with Whitman's concluding thrust: "The doctrine of germs laden with independent unit-characters, or pangens, each predestined, so to speak, to flower in its own place and time strikes me as teleological mythology, fine spun, to the verge of absurdity. We have not yet fathomed primordial organization, but it is safe to assume that the germ sets out with a biophysical constitution of a given specific type, within which metabolic, generative and differentiating processes under normal conditions run on in a self-regulating way."

The title of Volume II. epitomizes its contents, "Inheritance, Fertility and the Dominance of Sex and Color in Hybrids of Wild Species of Pigeons." Seven manuscripts of less than one hundred pages, nearly 2,000 pages of breeding records, and two hundred illustrations comprised the original material of this volume of two hundred twenty-three pages. Only a few chapters, viz., I. (1904–05), XII. (1897), XVI. (1898), and XVII. (1906) were left complete. The remaining chapters (containing fragments and sections by Whitman, and his breeding records) consist in large part of analyses and discussions by the editor based on Whitman's data to which have been added many of the later observations and views of the editor. This work of elucidation and summarization has been well done, making the text readable, and guiding the reader through a maze of not completed and intricate data.

One of the outstanding results of the hybridization work, which constitutes the bulk of this volume, is that offspring produced by crossing species of generic or family rank are males. This fact is in conformity with results obtained in other species of birds (see Guyer). The result is however complicated, according to the editor, by a second result, viz., "that, in many crosses of very distinct genera and species, fertility (developmental power) is shown to be highest in the spring and lowest in the autumn, and that male offspring predominate in the season of highest fertility, while females largely predominate in the season of lowest fertility." Several pages attempting to explain the apparent contradiction follow this statement, but since "it may be emphasized that Professor Whitman was by no means inclined to dogmatize as to the interpretation of this sex series," the subject need not be further discussed here.

In certain crosses between checkered and barred domesticated races the results show that checkered birds may throw some barred offspring. That the two may differ by a single factor difference may seem probable, especially in the light of other evidence (Bonhote and Smally, Staples-Browne) not referred to in the text. The relation is mentioned here because it elucidates a point not fully understood by opponents of Mendelian interpretation, viz., that such a relation is not claimed by most Mendelians as showing necessarily that the barred character must have arisen by a single mutation, although it may have done so. There may have been, as Whitman thinks, a long line of more graded intermediate steps between the two; still the barred and the checkered types might be differentiated to-day by a single factor difference provided both contained all other genes in common. In other words the modern checkered and barred birds, as compared with the old checkered type, would be supposed to carry an entire series of gradually acquired factors, and the checkered birds one further factor. Thus one change in the complex that gave the barred type is supposed to have sufficed to suppress all of the new stages. The two checkered birds would differ then in the entire series of gradually acquired factors, and also in the single final factor that caused the apparent back-throw. There are also records, some of them too fragmentary to be significant, bearing on the question of the greater likelihood of the first egg being a male in "pure" species—a question that goes back to Aristotle and has as often been denied as affirmed. A table on page 171 (Table 170) appears to indicate that this is the case in the Streptopelia senegalensis where twelve males came from the first egg, and only two females came from the first egg, while only two males came from the second egg and nine females from the second egg. The evidence that has been advanced in refutation of this relation is due, the editor suggests, to the use of "mongrels, collectively known as domesticated pigeons." More data must be obtained and statistical treatment applied to settle this question. The genetic evidence shows that the female is heterozygous for the sex-chromosome, and if the method of disjunction of the sex-chromosome in the egg is affected by the conditions that prevail when the first egg is set free from the ovary, we may possibly find in this relation an *excuse* for such a result. If this should turn out to be true, the cause of the maleness of the generic hybrids must be sought in some other direction.

The chapter (XIV.) on Heredity contains mainly the more general points of view reached by Whitman in 1907. Coming at a time when Mendel's discoveries had received general notice and had been, even then, confirmed from many sources, the chapter contains results of exceptional interest. The grounds for Whitman's objection to any theory resting on the assumption of unit-characters is contained in the following striking paragraph:

"Every theory founded upon the postulate of unit-characters, or specific determinants stored in the nucleus is necessarily committed to some form of centrifugal distribution during the course of development; and for each element to be distributed it is necessary to assume either that it is passively transported to its destination or that it finds its own way automatically. In either case it would be nothing less than a miracle for a specific pangen to reach a prescribed point in such a complex mosaic field as the organism represents; and, for this to be fulfilled, not only at the predetermined point, but also just at the moment for harmonious development with its immediate neighbors, with symmetrical and correlated groups, with inter- and intra-locking systems constituting a microcosmic whole, incomparably more difficult to grasp than the stellar universe—for all this to be fulfilled is utterly beyond the bounds of scientific credibility. To try to conceive of normal development as thus prepunctuated in all its time and space relations—as proceeding from ready-made elemental characters, automatically distributing themselves or guided by entelechies —is to indulge in ultra-scientific teleology."

The statement imputes apparently, to Mendelism in so far as it deals with unit-factors and unit-characters an implication from de Vries's hypothesis of pangenesis; viz., the migration from the nucleus of "organic bodies" which multiply in the cytoplasm and determine the fate of the cell. There is the further implication that the migration is so timed that it takes place at each critical place in development. With Whitman's criticism most students of heredity will agree, but it should be noted, as I have pointed out above, first that Mendelism makes no such appeal, second that the relation of specific materials in the nucleus need not be supposed to have any such time relations as here stated, and third a careful reading of de Vries's "pangenesis" shows that he does little more than make a passing reference to such an interpretation and to-day, at any rate, it is not an essential part of the doctrine of nuclear action. Whitman's own view makes it evident that he is not inclined to disregard the nucleus as one of the elements in the "organization" that supposedly has some action on "the cell as a unit." Granting that differences may exist in the nucleus of different species, different end products are expected. The evidence that such differences may be related to specific substances in the nucleus is no longer a speculation but rests on the analytical evidence from Mendelian heredity. In what way and at what times the nuclear materials take part in the determination of characters we do not know. The essential point is that we are in no way committed to any interpretation. Stated negatively we might add that there is nothing known at present to preclude the possibility that the influence is a purely chemical process. We find ourselves, therefore, practically in agreement with Whitman's attitude when he says:

"Now while ontogeny is so wonderfully exact that we never cease to be amazed at its performances, we must not forget that germ-cells are subject to slow variation. In fact, it is only germ-variation that has to be considered in phylogeny as in ontogeny. Consequently, when the germ-cell takes a step forward, ontogeny begins with an initial difference that sets the whole series of ontogenetic stages on a diverging line that digresses so little as to be undiscoverable until nearly at the end of development."[3]

Whitman's failure to find "dominance and recessiveness" of character in his pigeon crosses led him to attack the supposed importance of these relations. To-day we know more cases where the hybrid shows in some degree an intermediate development of the contrasted characters than where dominance is complete Obviously the distinction has no importance since the law of segregation is found to hold as well when blending occurs as in cases where the somatic differences are clearly evident. The hybrid pigeons fall, therefore, in this respect into line with familiar phenomena. The failure of "splitting" in subsequent generations is a point that calls to-day for special consideration, but will not be dwelt on here.

In this chapter, and in several that precede it, Whitman and the editor speak rather frequently of what is called "weak" and "strong" germs as having an importance in determining the "strength" to which a character develops, even causing a "reversal of dominance." Curiously enough their effects are supposed to be transmitted so that fertility in the offspring is also affected. Even the occasional mutations found by Whitman are ascribed to this source. Pigeons unquestionably furnish unusual material for the study of this appearance. It is perhaps too soon to attempt to state how much or how little in variation to ascribe to such an influence, aside from the obvious effect in the immediate offspring. No doubt further work along these lines will help us to define more sharply what is to be understood by the somewhat vague attributes "weakness" and "strength."

There are important discoveries recorded in this volume that can only be referred to briefly; the "divisibility" of characters (meaning intermediate conditions) as seen in hybrids, the study of a "dominant" mutant character; the discovery as early as 1896 of sex-linked inheritance (of which a number of cases in other birds are well understood to-day), the cross between the last surviving members of our wild passenger pigeon and the ring dove, the relative influence of egg and sperm on the time of hatching of the hybrid young. Each of these results marks an advance in our understanding of heredity.

The third volume containing Whitman's observations on the "Behavior of Pigeons" is edited by Professor Harvey A. Carr. Thirty-two short manuscripts were left. It appears that Whitman's first period of study in this field was from 1895–98. In a few lectures at Woods Hole in 1897–98 some of his conclusions are given. After a period of five years a renewed interest in these directions recurred and many notes were made. The Woods Hole lecture in 1906 gave an opportunity for further consideration. Despite the very fragmentary remains of this work—fragmentary only in comparison with the extensive observations that Whitman had made, this volume contains many observations of great interest and gives an insight into the character of Whitman's methods, where the most careful and minute observations are interpreted with a breadth of intelligence that is truly remarkable. There are few if any groups of animals

[3] The reviewer would add an important reservation, viz., that a "forward step" in the germ-plasm might affect any stage in the course of development, or in the extreme case every stage in the development. This view is obviously consistent with what Whitman states, but, if emphasized, would to a large extent undermine the value of the evidence from ontogeny in interpreting ancestral stages.

so well suited to studies of this kind as are the pigeons. The elaborate courtship, the fidelity of the individuals to each other, the mating and nesting habits, the part taken by the female and the male in incubation, the feeding instinct of old and young, the weaning and the rythmic sequence of broods offer a fascinating opportunity to the student of animal behavior. Whitman obviously had in view a large program toward the accomplishment of which he had progressed much further that these notes indicate. Some of the lines of work opened up by him have been pursued successfully by his students Professor Craig and Dr. Riddle, but according to their statement his knowledge far outstripped that of any other observer in this field. The many observations here recorded are clearly only the material out of which, in time, he had expected to link up the evolution of instincts with the study of the evolution of structure and color. "If Professor Whitman had completed his work, he would have produced an extensive treatise on the phylogney of the pigeon group. . . . The voices and the behavior of the various species would have been used, like the color patterns, to throw light on the relationships, derivation and method of origin of pigeon species" (Craig and Riddle). According to Carr, Whitman developed "what one may term an orthogenetic conception of instinctive development. Instincts are not novel and unique constructions which spring, without ancestry, into being; rather each new instinct is but a slight modification or organization of tendencies already in existence." When one sees how vital the instincts are for the existence of the species it is probable that however the changes originated the advances would most probably be those involving only slight modifications of intincts already in action.

The Carnegie Institution and equally Dr. Riddle are to be sincerely congratulated on having preserved for American zoologists the last great work of Whitman. The wonderful colored pictures, almost entirely the work of the Japanese artist Hyashi, are marvels of beauty and accuracy, and stand for the minute attention that Whitman demanded at every stage of his work. The same attention to detail is shown in Whitman's early work on cell-lineage, on the leeches of Japan, and on the embryology of fishes, and explains in part his far reaching influence on American zoologists. It is rare to find combined such delicacy in treatment of detail with the sweep of philosophical interpretation of which Whitman was equally master.

Whitman stood at the parting of the ways. We may regret that he did not enter into the new era that even at that time was opening up its far reaching vistas, but this need not blind us to the fine example he set—an example of unworldly devotion and absorption in his work, of self-criticism made possible by simplicity and honesty of character, of fairness that led him to appreciate and to state accurately and kindly the opinions of others with whom he disagreed heartily.

T. H. Morgan
Columbia University

A PALEONTOLOGIC REVIVAL AT YALE UNIVERSITY

Othniel Charles Marsh was appointed professor of paleontology at Yale in 1866, this being the first time such a chair was established at any university He was unquestionably one of America's leading men of science, and in vertebrate paleontology "he stood without a peer." He had collected fossils long before his graduation from Yale in 1860, and after taking the doctorate at Heidelberg, he became deeply interested in the wonderful array of extinct vertebrates that the U. S. Geological and Geographical Survey of the Territories was finding in the "bad lands" of Nebraska. In the meantime, his uncle, George Peabody, had founded at Yale the Peabody Museum of Natural History, though the building was not erected until 1875. Marsh saw the great western wilderness for the first time in 1868, going over the Union Pacific into Nebraska and Wyoming. In 1870 he fitted out the first Yale College Scientific Expedition, and took west with him twelve enthusiastic students. From this time the flood of boxes shipped to the university grew annually greater and greater. In 1899 Professor Beecher said of these collections: Professor Marsh "brought forth in such rapid succession so many astonishing things that the unexpected became the rule. The science of vertebrate paleontology could not assimilate new material so fast. . . . The constant stream of vertebrate riches which, from 1868 to 1899, flowed into the Peabody Museum from the Rocky Mountain region had a similar bewildering effect upon Marsh, for it was impossible for him to do more than seize upon what appealed to him as the most salient. As a collector Marsh was seen at his best, and the collections he amassed during his forty-five years and more of activity in this direction form a lasting monument to his perseverance and foresight."

In Marsh's day, Peabody Museum was a very busy place, with a large staff unearthing and preparing the collections so that the master mind might make the treasures known to science. At least 400 new species and 185 new genera were described in abbreviated form previous to 1896, mainly in the *American Journal of Science*. In 1892 came the first check to his activity, and Marsh had to let go a considerable portion of his staff. He was then sixty-one years of age, but he struggled on, thinking that somehow he could describe the great mass of still unknown animals assembled in the museum, and make them fully known in large monographs Seven years later the Great Reaper took him, with his work still undone.

Professor Charles E. Beecher took up the work after Marsh's death, but he had no one to assist him in unearthing the collections except two preparators. Even under these conditions, however, the public were shown for the first time the skeletons of some of the wonderful animals of the past mounted as they appeared in life. The exhibition collections grew apace, and long before Professor Schuchert succeeded Beecher in 1904, they had outgrown the building. Two years later Professor Lull was added to the staff. Now we have mounted or ready to mount so many of our treasures that we are yearning for the new Peabody Museum, to take the place of the original building which was destroyed in 1917 to make way for the Harkness dormitories.

Professor Marsh left $30,000 "to be expended by the trustees of said Peabody Museum in preparing for publication and publishing the results of my explorations in the West." The trustees have heretofore held that only the income of this fund should be used in this way. However, having only this income to devote to the Marsh Collections, it was but natural that progress should be slow. We have now come to realize this fully, and the recognition has brought use to a new turn in the administration of the collections.

As it was evidently Professor Marsh's wish that both the income and the principal of the "Marsh Publication Fund" should be used in work on his collections, the trustees of the museum have recently decided to spend as much of the fund as will be required to make known the collections. The study of the Marsh material is therefore progressing far more rapidly than it has at any time since the donor's death. We have now on the staff of the museum, working under the guidance of Professor Lull, besides the two preparators, the following research associates: Dr. George F. Eaton and Assistant Professor John P. Buwalda, who give us half their time, and Drs. Edward L. Troxell and Malcolm R. Thorpe, who devote all their time to the Marsh collections.

In unearthing the unknown in science, no one can predict what the results will be, or how quickly they will be forthcoming, but we trust that in this case they will be abundant and timely. In working out the new things, however, we have also to consider the old ones, which, viewed in the light of the knowledge of to-day, were inadequately described. How vast are the treasures that Professor Marsh has left us is not even at this time fully known to the curators, but if it should take from ten to twenty years more to complete the description of the fossil vertebrate material assembled by Professor Marsh, Yale will but be the richer scientifically.

CHARLES SCHUCHERT
YALE UNIVERSITY

WILLIAM GILSON FARLOW[1]

The Botanical Society of America records its appreciation of the great loss sustained by the society, by American science, and by botanical science throughout the world, in the death of Professor William Gilson Farlow.

Educated as a physician, he yielded readily to Asa Gray's suggestion that he broaden the scope of botany at Harvard University by developing there an interest in flowerless plants, which up to that time had scarcely appeared above the horizon of professional botanists in America. In preparation for this he traveled extensively in northern Europe, at a time when extended travel was uncommon, meeting and forming personal relations with the leading authorities on cryptogams; and he had the very unusual privilege of working in De Bary's laboratory at Strasbourg, where he associated intimately with other young men who were to continue the work of this great leader after his own untimely death.

Never overburdened by large numbers of half-interested students, Dr. Farlow communicated his own enthusiasm and industrious habits through long years to a limited number of men who have been counted for a generation among the leaders in American botany, and particularly in that branch of the science which De Bary's classical studies of fungous parasitism laid as the foundation on which the art of phytopathology has been reared of late, particularly in America, with much success and economic benefit.

Though familiar with ferns, and especially with the marine algæ of New England, of which he published an early monograph, Professor Farlow's interest always centered in the fungi, and the larger number of his publications have dealt with these plants.

He served his science particularly well in securing for permanent reference preservation the historic herbarium of Curtiss, one of the pioneers in American mycology, and that of Tuckerman, long the authority on American lichens; and since the death of Asa Gray, in 1887, he has been recognized at home and abroad as the foremost of American botanists.

Among his unpublished manuscripts is the completion of a compendious Bibliographic Index of North American Fungi, one volume of which was printed in 1905, and of which the remainder should be brought to publication promptly now that his work on it is done.

A keen critic, an encouraging teacher, a kindly and sympathetic friend, and a man of the broadest international interest, Professor Farlow is mourned by all who knew him.

[1] Memorial adopted by the Botanical Society of America.

SCIENTIFIC EVENTS

RESEARCH ON RUBBER CULTIVATION

A correspondent writes from Sumatra:

During the last week of August and the first week of September, 1919, Dr. J. J. van Hall, director of the Laboratory of Plant Diseases in Buitenzorg, Java, and Dr. R. D. Rands, botanist in the same laboratory; specially engaged on a study of the brown bast disease of the Hevea rubber, made a journey to Sumatra to study conditions there.

On September 2, 1919, a conference on brown bast disease was held at the A. V. R. O. S. (Algemeene-proefstation voor Rubber-Cultur, Oost-kust van Sumatra) Proefstation. This was attended by Acting Director F. C. van Heurn, of the A. V. R. O. S. Mr. J. C. Maas, and Dr. H. Heuser, also of the A. V. R. O. S., Dr. J. J. van Hall and Dr. R. D. Rands, both of the Laboratory of Plant Disease, Mr. Carl D. La Rue and Mr. P. E. Keuchenius, botanist and mycologist respectively, of the Holland-American Plantations Company, and Dr. J. G. Fol, director of the experiment station of the Cultur Maatschappij Amsterdam.

The cause of the disease was first discussed, Dr. Rands giving recent evidence secured by him pointing to a physiological origin. Mr. Carl D. La Rue stated that results obtained by Professor H. H. Bartlett and himself in 1918, and later by himself alone, indicated that the same bacterium was always present in bark affected with brown bark disease. Mr. Keuchenius stated that he also found bacteria to be constantly present in diseased tissue, and that he had secured positive results from inoculations with these bacteria.

Conditions favorable to attack by the disease were also discussed as well as methods of treatment. All present agreed that the disease is the most serious one known to the rubber industry, that treatment alone was too expensive, and that methods of prevention should be discovered if possible.

Later at a special meeting an experiment was planned by Messrs. Rands, Maas, Keuchenius and La Rue to test more fully whether or not the disease may have a physiological cause. After visiting a number of rubber estates on the east coast of Sumatra and in Atjeh, Drs. van Hall and Rands returned to Java.

The first technical meeting of the personnel of the experiment stations for the rubber culture was held in Buitenzorg, Java, on November 1, 1919. Representatives of the Central Rubber Proefstation, the West-Java Proefstation, the Malang Proefstation, the Besoeki Proefstation, the Laboratorium voor Plantenziekten, and the research department of the Holland Plantations Company.

Among the subjects discussed were brown bast disease, mildew-diseases of leaves, borers, thinning out of trees on estates, and selection. The last topic is only now beginning to be a matter of concern to rubber planters, although experiment station workers have been interested in it for several years.

EXPERIMENT STATIONS OF THE BUREAU OF MINES

In connection with the work of the Bureau of Mines, Department of the Interior, the bureau is now conducting eleven mining experiment stations, located in the various mining centers of the country, and bending their energies toward the special mining problems that are local to their part of the country. So great has been the demand for knowledge concerning the character of the work undertaken at these various mining stations and its general relation to the mining industry, the bureau has issued a bulletin describing the work of the stations. Dr. Van H. Manning, director of the bureau, sketches the work of the different stations as follows:

The station at Columbus, Ohio, situated at a clay-working center is employed mostly on ceramic problems. In this country there are about 4,000 firms manufacturing clay products, including brick, tile, sewer pipe, conduits, hollow blocks, architectural terra cotta, porcelain, earthenware, china and art pottery. The amount invested in these industries is approximately $375,000,000 and the value of the products exceeds $208,000,000 annually.

The station at Bartlesville, Okla., is investigating problems that arise in the proper utilization of oil and gas resources, such as elimination of waste of oil and natural gas, improvements in drilling and casing wells, prevention of water troubles at wells, and of waste in storing and refining petroleum, and the recovery of gasoline from natural gas.

What the Bureau of Mines has done for the great coal-mining industry, chiefly through investigations at the experiment station at Pittsburgh, Pa., has been published in numerous reports issued by the bureau. Some of the more important accomplishments have been the development and introduction of permissible explosives for use in gaseous mines, the training of thousands of coal miners in mine-rescue and first-aid work, and the conducting of combustion investigations, aimed at increased efficiency in the burning of coal and the effective utilization of our vast deposits of lignite and low-grade coal.

The Salt Lake City station has devised novel methods of treating certain low-grade and complex ores of lead and zinc. These methods show a large saving of metal over methods hitherto employed, and have made available ores that other methods could not treat profitably.

The Seattle station is busy with the beneficiation of the low-grade ores of the Northwest, and the mining and utilization of the coals of the Pacific states; the Tucson station is working on the beneficiation of low-grade copper ores; and the Berkeley station has shown how losses may be reduced at quicksilver plants and how methods at those plants can be improved.

In the conduct of these investigations the bureau seeks and is obtaining the cooperation of the mine operators. At more than a dozen mills in the west engineers from the stations are working directly with the mill men on various problems, and the results they already have obtained more than warrant the existence of the stations. Success in solving one problem may easily be worth millions to the country. Mining men are using these stations more and more freely as they realize that the government maintains these stations to help them, and that the difficulties of the operators, both large and small, will receive sympathetic consideration and such aid as the stations can give.

GRANTS FOR RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

At the St. Louis meeting of the association, the council assigned the sum of $4,500 to be expended by the Committee on Grants for

Research during the year 1920. The members of the committe for the current year are: Henry Crew, chairman; W. B. Cannon, R. T. Chamberlin, G. N. Lewis, George T. Moore, G. H. Parker, Robert M. Yerkes, and Joel Stebbins, secretary.

The committee will hold a meeting in Washington in the month of April, when the distribution of the grants will be made. Applications for grants may be made under the general rules given below, which were adopted in 1917; but the committee especially invites suggestions from scientific men who may happen to know of cases where young or poorly supported investigators would be greatly helped by small grants.

1. Applications for grants may be made to the member of the committee representing the science in which the work falls or to the chairman or secretary of the committee. The committee will not depend upon applications, but will make inquiry as to the way in which research funds can be best expended to promote the advancement of science. In such inquiry the committee hopes to have the cooperation of scientific men and especially of the sectional committees of the association.

2. The committee will meet at the time of the annual meeting of the association or on the call of the chairman. Business may be transacted and grants may be made by correspondence. In such cases the rules of procedure formulated by the late Professor Pickering and printed in the issue of Science for May 23, 1913, will be followed.

3. Grants may be made to residents of any country, but preference will be given to residents of America.

4. Grants of sums of $500 or less are favored, but larger appropriations may be made. In some cases appropriations may be guaranteed for several years in advance.

5. Grants, as a rule, will be made for work which could not be done or would be very difficult to do without the grant. A grant will not ordinarily be made to defray living expenses.

6. The committee will not undertake to supervise in any way the work done by those who receive the grants. Unless otherwise provided, any apparatus or materials purchased will be the property of the individual receiving the grant.

7. No restriction is made as to publication, but the recipient of the grant should in the publication of his work acknowledge the aid given by the fund.

8. The recipient of the grant is expected to make to the secretary of the committee a report in December of each year while the work is in progress and a final report when the work is accomplished. Each report should be accompanied by a financial statement of expenditures, with vouchers for the larger items when these can be supplied without difficulty.

9. The purposes for which grants are made and the grounds for making them will be published.

Joel Stebbins,
Secretary

SCIENTIFIC NOTES AND NEWS

Richard C. Maclaurin, president of the Massachusetts Institute of Technology since 1909, died from pneumonia in Boston on January 15. Dr. Maclaurin was born in Scotland in 1870. He was educated at the Universities of New Zealand and Cambridge, and was appointed professor of mathematics in the University of New Zealand in 1898. In 1907 he was appointed professor in mathematics and physics in Columbia University.

Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research, was elected president of the American Society of Naturalists at the recent meeting held in Princeton.

Professor F. B. Loomis, of Amherst College, has been elected president of the Paleontological Society.

Dr. Phoebus A. T. Levene, of the Rockefeller Institute for Medical Research, in New York, was elected associate member of the Société Royale des Sciences Médicales et Naturelles of Brussels, on December 1, 1919.

Mr. J. H. Jeans, of Cambridge, formerly professor of mathematics in Princeton University, has been nominated as secretary of the Royal Society.

Dr. Paul Sabatier (Toulouse), and Dr. Pierre Paul Emile Roux (Paris), have been elected honorary members of the British Royal Institution.

The Swedish Medical Association has awarded its jubilee prize this year to Dr.

Hans Gertz of the physiological laboratory of the Karolinska Institut for his work on the functions of the labyrinth. It was published in the *Nordisk Medicinskt Arkiv* in 1918.

THE president and fellows of Magdalen College of Oxford University on the express recommendation of the General Board of the Faculties decided to award a pension of £450 per annum to Professor Sydney Howard Vines, M.A., F.R.S., F.L.S., fellow of the college, and honorary fellow of Christ's College, Cambridge, who is resigning the Sherardian chair of botany with the fellowship on December 31 next, after a tenure of thirty-one years. This is the first occasion on which the new system of pensions for professors instituted by the college with the approval of the university has been brought into operation.

PROFESSOR EDGAR JAMES SWIFT, head of the department of psychology of Washington University, has been invited to give two lectures before the officers and students of the Post Graduate School of the United States Naval Academy at Annapolis. The subjects of these lectures are "Thinking and Acting" (February 14), and "The Psychology of Handling Men" (April 10).

UNIVERSITY AND EDUCATIONAL NEWS

AT the dinner of the alumni of the Massachusetts Institute of Technology, held in Cambridge on January 10, it was announced that the endowment fund of four million dollars had been obtained by the alumni, thus securing the gift of an equal sum from the hitherto anonymous "Mr. Smith." It was revealed that "Mr. Smith," who has now given eleven million dollars to the Massachusetts Institute of Technology, is Mr. George Eastman, president of the Eastman Kodak Company.

THE trustees of Oberlin College have granted increases of salaries for all in the service of the institution. Early in the fall the faculty of the college appointed a committee under the chairmanship of Professor C. G. Rogers to consider the salary needs of the members of the faculty. The report of the committee, approved by the faculty, was transmitted to the trustees, and findings calling for a fifty per cent. increase in the salaries of all teaching and administrative officers of the college, dating from September 1, 1919, were approved. This action adds about $175,000 to the annual budget of the college.

ANNOUNCEMENT has been made at the University of Pennsylvania of a gift of $50,000 from the estate of William C. Goodell for the establishment of a chair of gynecology in the medical school. The trustees have adopted a resolution providing that as far as possible rooms and facilities for the carrying on of research work be extended to emeritus professors in all departments.

THE pathological buildings of the Johns Hopkins Hospital group, the professional workshop of Dr. William H. Welch, was wrecked by fire, January 12. It is said that none of the valuable specimens was lost, nor were any of the records of research work damaged.

PROFESSOR A. P. COLEMAN, geology, has been elected dean of the faculty of arts of the University of Toronto. Professor J. Playfair McMurrich, anatomy, has been elected chairman of the board of graduate studies, which corresponds with the graduate faculty in many universities.

DR. HAROLD PRINGLE, lecturer on histology and assistant in the department of physiology in the University of Edinburgh, has been appointed professor of physiology in Trinity College, Dublin, in the room of the late Sir Henry Thompson.

DR. F. W. KEEBLE, assistant-secretary of the British Board of Agriculture, has been elected to the Sherardian professorship of botany of Oxford University in succession to Professor S. H. Vines.

DISCUSSION AND CORRESPONDENCE

THE POLYDOGMATA OF THE PHYSICIST

THE mind of the physicist may be said to be somewhat in confusion. But there is no reason to hope that it ever will enjoy the logical perfection of a consistent set of theories. He constructs the electromagnetic theory of light and must needs adhere to it on many occasions, yet with full knowledge that it can not be correct. He rejoices in the existence of the universal constant, h, and the appearance of the quantum, $h\nu$, in resonance and ionization potentials, in photoelectric X-ray phenomena, and in the theory of heat radiation, yet he can not be reconciled to the existence of the quantum in the phenomenon of the passage of light through a vacuum. He builds an atomic structure which will not only provide a clear picture, but will also furnish quantitative results in striking agreement with experiment; and yet he must, in his building, reject certain principles which elsewhere he adopts without hesitancy. He rejoices in the achievement of the general theory of relativity, which, unless proved untenable, gives a logical consistency at present—and probably for many, many years, unattainable by other means; yet in his constructive thinking he sometimes uses the ether which the general theory of relativity ignores, and he lives in his old Euclidean world which the present developments from this theory deny.

In short, the physicist can not be consistent. Moreover, he can not progress unless this inconsistency is a stimulus and not an annoyance. He must live as if in several compartments, enjoying in each one the consistency possible therein, and being not distressed but rather interested and invigorated by the failure to unite these compartments into one consistent whole. If he "believes," he must be inconsistent. If he progresses, he must adopt a set of dogmas in the small compartment in his immediate problem. If he follows with full sympathy modern progress in physics, he must have not one, but many dogmas, and these not wholly consistent with one another.

I refer not merely to the multiple-theory method of attack upon a problem, for the dogmas are not even altogether similar in kind, but more especially to the ability to appreciate thoroughly not only "constructive theories," but also "theories of principle" (quoting from Einstein) It is not merely the approach from a different viewpoint in the same universe, but it is the ability to live in more than one universe.

All of this may be obvious, but yet, in point of fact, now and again there appears evidence that even physicists of note are pained by this rôle. They seem to resist by objections which do not aid in the extension of these compartments, or by a rebellion against the obviously advantageous policy of polydogmata.

G. W. Stewart
State University of Iowa

TOTEM POLES FOR MUSEUMS

Fifty years ago some of the best totem poles of the Haida Indians of Queen Charlotte Islands cost the Indians several thousand dollars each. To-day many of these may be purchased for a dollar and a half or two dollars a foot. That is, an average totem pole can be purchased, crated and put aboard a steamer at Masset for about one hundred dollars.

Many of the Haida totem poles have disappeared. A few have been taken to museums where they are preserved; some have been burned; many have decayed. Several, seen during the past summer, at Yan opposite Masset, have recently been blown over by the wind. In a few years all will have disappeared unless means are taken to save specimens of this art for the future. However the other tribes having totem poles may feel at this date, the Haidas have come to the point of neglecting the poles and being willing to sell them. They are owned by families, and negotiations as with an estate are necessary for properly obtaining them.

This North Pacific art is one of the treasures of Canada and the United States. Examples of it should be preserved in each large city of the continent. It may not be generally known how easily this can be done.

In the summer the Haidas of Masset are busy fishing. In the spring they have less to do and some are in need of money. Mr. Alfred Adams or Mr. Henry Edensaw are trust-worthy Haidas of Masset, B. C., who are capable of corresponding and executing the purchase of a pole or poles, and of engaging other help and superintending the lowering and creating of poles, their transportation across the inlet from Yan to the wharf at Masset and their shipment to destination. The poles are very heavy and the cost of handling will be perhaps equal to the price of the poles. They are soft and their own weight will crush parts of the carvings unless they are properly crated. Some of the poles 50 to 60 feet in length may have to be cut in sections for shipment.

Here is an opportunity. Examples of this unique art now going to decay may be rescued, loaded and started on their way to safe-keeping in our museums at the rate of about one hundred dollars per specimen.

Harlan I. Smith
Geological Survey,
Ottawa, Canada

TO KILL CATS FOR LABORATORY USE

A quick and humane method of killing a cat or other small mammal in the laboratory is to put the animal under an open topped bell jar, *i. e.*, a bell jar which has a small bottle-like neck at the top through which there is an opening. This mouth should be comparatively small, not over a half inch in diameter, and the neck should be at least an inch long. After the animal has been placed under the bell jar, a very small quantity of ether or chloroform is poured through the opening in the top, and it is then corked up. The liquid strikes the sides of the neck and immediately runs down in a thin film over the inner surface of the bell jar and evaporates into the chamber in two or three seconds. The enclosed animal shows its effects almost immediately, and dies in a very short time.

While it is not necessary, it is better to seal up the base of the bell jar because occasionally the animal falls down after it becomes unconscious, and its head comes in close proximity to the crack between the jar and the object on which it is placed, and it thus obtains sufficient air to delay its death. This can be prevented by wrapping a damp towel around the base so as to exclude the air. By placing the bell jar on a glass plate and sealing with vaseline, an airtight chamber can be made, but the advantage thus gained does not make up for the care necessary in order to avoid getting one's clothing in contact with the greased surfaces.

Horace Gunthorp
Washburn College,
Topeka, Kans.

ANTS AND SCIENTISTS

To the Editor of Science: As a result of watching a colony of ants and attending a scientific meeting on the afternoon and evening of the same day, it seemed to me the two teeming hordes of excited workers—the insects and the scientists—had some queer traits in common, as:

1. How they work in ranks and cohorts, mutually attracted by some exciting discovery that a wandering member has stumbled upon, and that awakens the most astounding and intense interest.

2. How they immediately set to work to pull opposite ways, fight valiantly over their treasure, and heroically keep it up after they have amputated some of each others' legs and other appendages.

3. How they take up one thing, drag it about for a time, and then drop it for some other thing.

4. How they often expend enormous labor on something that isn't worth a darn; and here Mark Twain's story of the two ants and the grasshopper leg came to mind.

5. How their splendid industry is generally circular in direction; so that after long struggle, they get the thing back to the exact spot from which it started.

6. How they firmly believe that "they are the people" and refuse to admit or bother over bigger intelligences that are their interested observers and that can and sometimes do sweep them and their hills and runways and stores into oblivion.

7. How, measured by final results, they are nevertheless a wonderful body of workers;

and in tireless energy, patience and talent, stand out preeminent in their respective groups. Albert Mann

QUOTATIONS

THE BRITISH NATURAL HISTORY MUSEUM

We learn that there are at present vacancies in the entomological, zoological and geological departments of the Natural History Museum which have been open for several months, and that more vacancies are expected in the immediate future. The museum is one of the great national instruments for the collection, classification, and preservation of specimens of the animal and plants, the rocks and minerals, of the world. For the adequate performance of its duties, it must have a full staff of able and devoted specialists. It should require no defense on utilitarian grounds, for the advancement of natural knowledge of the kind to which it is devoted is recognized as a privilege by every civilized state. But there are plenty of utilitarian arguments. Take entomology alone: the number of living species of insects is estimated at over 2,000,000. The preserver of insect life on human life is continuous. As household pests, as carriers of disease, as enemies of stores or crops, they are every day being found to have an unexpected economic importance. It is to the experts and the collections of the Natural History Museum that we have to turn for the requisite information, and unless the museum has an adequate staff we turn in vain. The difficulty in filling posts with suitable men is partly financial. The present rate of pay for assistants in the second class is from £150 to £300, and in the first class from £300 to £500 a year, with a temporary war bonus. These salaries—the "despair" of Professor Stanley Gardiner, whose cogent letter we publish in another column—are no longer sufficient to attract or to retain men of the right attainments, unless they happen to have private means. The smallness of the staff and its inevitable division into water-tight compartments makes promotion slow and capricious. These disadvantages are increased by an antique privilege of the principal trustee, who nominates candidates for vacancies instead of advertising for them. It has frequently happened in the past that middle-aged mediocrities have been brought in and placed over the heads of the existing staff because of their acquaintance with a group in which some of the trustees are interested. The fact is that the mode of governance of the Natural History Museum is medieval. It should be separated from Bloomsbury and placed under a body of trustees selected not because they make a hobby of collecting bugs or butterflies, but because they have a wide knowledge of the scientific purposes which it is the business of the museum to subserve.—*The London Times.*

SCIENTIFIC BOOKS

Geodesy, including Astronomic Observations, Gravity Measurements and Method of Least Squares. By George L. Hosmer. John Wiley and Sons. First edition, 1919, 377 pages, 6 × 9, 115 cuts.

This book is especially to be commended for the skill shown in the selection of illustrations, both photographs and drawings, and for the excellence of arrangement and printing of the text and tabular matter. These things contribute substantially to the satisfaction and comfort of the user.

Still more is the book to be commended for its positive qualities, which make it a distinct and valuable addition to that part of the literature of geodesy which serves to carry information and understanding from the extreme specialists who are developing the methods and extending the knowledge in these fields, to the students and the practising engineers who desire to get a well-balanced view of the whole field of geodesy quickly. The old well-known matters are restated well in effective grouping. The ideas, formulæ and tables most needed by the student and the practising engineer are selected from the great mass of available material with rare skill. The recent developments in geodesy are shown in true perspective with respect to old things, to a quite unusual extent for a text-book.

Among the comparative recent developments in geodesy that are especially well stated in the book are (1) the importance of determining the relative strength of different proposed chains of triangulation as fixed by the geometrical relations, and the methods for quickly doing so; (2) the relation between the average length of the lines in a triangulation and the rapidity, economy, and accuracy of that triangulation and its convenience to the user; (3) the advantages of the light and rapidly built towers such as are now used in the Coast and Geodetic Survey; (4) the advantages of the transit micrometer on portable instruments for determining time accurately; (5) the application of the interferometer to determination of the flexure of the support of a pendulum used to determine the relative values of gravity at different points. These things are stated forcefully and with good judgment as to their relation to older ideas and methods.

Though he has looked carefully for errors of omission, the reviewer, who has a background of experience which naturally tends to make him keenly critical, finds only three that are, in his opinion, important.

1. On its best direction theodolites the Coast and Geodetic Survey uses two sets of double parallel lines in the micrometer microscopes with which the horizontal circle is read, the two sets being so placed that the observer moves the micrometer screw only one turn between a forward and the corresponding backward reading, instead of five turns. This is a time-saving convenience which also increases the accuracy, and surely should have been mentioned in the book.

2. The necessity of tracing back the adopted field length of a base measuring tape to the standard meter and the methods of doing so are inadequately treated in the book. The developments of the past twenty years have made it clear that one must concentrate much more keenly on this part of the work than the book indicates.

3. The area method of computing the figure of the earth from geodetic and astronomic observations is barely referred to on page 204 without explanation. In view of the fact that this method gives a much higher degree of accuracy from the same observations than the traditional arc method, it certainly deserves a page of general exposition in the book, even if it is possibly too difficult for the student to grasp in full. The student and the engineer should know that the more accurate method exists, should know its general character, and in a general way why it is more accurate than the arc method.

The author of the book has shown such ability to see with the eye of an expert, and to exercise the judgment of a practicing geodetic engineer, that one may confidently expect that even these three omissions will not occur in a second edition.

JOHN F. HAYFORD

SPECIAL ARTICLES

CONCERNING APPLICATION OF THE PROBABLE ERROR IN CASES OF EXTREMELY ASYMMETRICAL FREQUENCY CURVES

IN a study of the fecal pollution of shellfish, Dr. James Johnstone[1] raises an important question: that of determining the most probable value of a measure from a series whose frequency distribution is highly asymmetrical. In such instances it is evident, although prevailing practise contradicts the statement, that it is illegitimate to apply the probable error in the usual manner. For such application presupposes a symmetrical (Gaussian) distribution, and, since a wide range of biological measurements is characterized by an asymmetrical distribution, the matter merits consideration.

Dr. Johnstone lists the following counts of colonies of bacteria growing on twenty plates, each having been incubated a standard length of time after being inoculated with 1 c.c. of an emulsion, in 250 c.c. of water, of five muscles collected at random from the polluted area: 7, 24, 40, 15, 22, 20, 17, 9, 16, 29, 7, 9, 10, 26, 15, 11, 21, 17, 10, and 41. Dr. Johnstone assumes each count to be an estimate of the number of bacteria per c.c. of the emul-

[1] "The Probable Error of a Bacteriological Analysis," Rept. Lanc. Sea-Fish. Lab., 1919, No. XXVII., p. 64–85.

sion, the variation between the counts being attributed to errors in sampling. He then raises the question as to the most probable number of bacteria present, and, after pointing out that, according to custom, the arithmetic mean of the counts (18.3) would be regarded as the most probable number, proves this to be untrue by showing the frequency distribution to be highly asymmetrical, as follows:

Counts	Frequency
6–10	6
11–15	3
16–20	4
21–25	3
26–30	2
31–35	0
36–40	1
41–45	1

Although Dr. Johnstone discusses this distribution, and, by employing Galton's graphical method, determines certain constants, he fails to answer the question he raises.

In cases of this kind it seems as though the simplest procedure is to find some function of the measurements whose frequency distribution is Gaussian, and apply the probable error to that function. The reason is that an asymmetrical distribution implies that some influence other than "chance" is operative, and substitution of a function whose distribution is Gaussian enables their separation. In the particular case at hand, and it is typical of many within the province of biology, this function is the logarithm. This is easily demonstrated by grouping the logarithms of the counts with respect to a deviation of ± 0.1 from their mean ($=1.2046$) as follows:

Logarithm	Frequency
0.505–0.704	0
0.705–0.904	2
0.905–1.104	5
1.105–1.304	6
1.305–1.504	5
1.505–1.704	2
1.705–1.904	0

The arithmetic mean of the logarithms (1.2046) is the logarithm of the geometric mean of the counts ($=16.02$), the geometric mean, by definition, being the twentieth root of the product of the twenty counts. Accordingly, the Gaussian distribution of the logarithms shows that the counts cluster in approximately constant ratio about their geometric mean, or, to express it otherwise, that variations in the count are compensatory in the geometric mean. This signifies that variation in the count is not primarily attributable to errors in sampling and that each count is not an estimate of the number of bacteria present per c.c. in a homogeneous emulsion, but rather that conditions favoring the propagation of bacteria fluctuated in an "accidental" way either during the period in which the twenty samples were removed from the emulsion, or from place to place within the emulsion, or both. Whether or not this interpretation be correct, the logarithmic frequency distribution demonstrates that something of like nature occurred. In any case the most probable number of bacteria per c.c. corresponding to the most typical condition of the emulsion is the geometric mean of the counts (16.02); and, in the same sense, $250 \times 16.02 = 4{,}005$ is, of course, the most probable number of bacteria in the whole emulsion.

The reliability of this estimate may be approximated by applying the probable error to the logarithms. The standard deviation of the logarithms, σ, is 0.224, the probable error, or, better, the "probable departure" from the logarithm of a single count is $0.6745\ \sigma = \pm 0.1511$ and the probable departure from the logarithmic mean is $0.1511/\sqrt{20} = \pm 0.0337$. It follows from tabulated values of the probability integral that, had the entire 250 c.c. been examined, it is as likely that the logarithmic mean would have been within 1.2046 ± 0.0337 as that it would have been outside these limits, while the odds are about 4.6 to 1 that it would have been within $1.2046 \pm 2(0.0337)$, about 22 to 1 that it would have been within $1.2046 \pm 3(0.0337)$, and nearly 142 to 1 that it would have been within $1.2046 \pm 4(0.0337)$. The numbers corresponding to these logarithms are the limiting values of the estimated number of bacteria per c.c.; that is, the odds are even that this number lay between 14.82 and 17.31, about 4.6 to 1 that it lay between 13.72 and 18.72, about 22 to 1 that it lay between 12.69 and 20.22, and nearly 142 to 1 that it lay between 11.74 and 21.86.

This, I believe, answers Dr. Johnstone's question in so far as the small series of counts permit. The problem is typical of many that have not received due consideration by either biologist or statistician; and conclusions departing widely from the truth are continually being reached through failure to apply any criterion of reliability on the one hand, and through an erroneous application of the probable error on the other hand. It is hoped this brief presentation will stimulate discussion.

Ellis L. Michael

Scripps Institution,
La Jolla

THE AMERICAN MATHEMATICAL SOCIETY

The twenty-sixth annual meeting of the society was held at Columbia University on Tuesday and Wednesday, December 30–31, with the usual morning and afternoon sessions on each day. The attendance included 96 members. President Frank Morley occupied the chair, being relieved at the last session by Professor J. L. Coolidge. The following new members were elected: Dr. H. E. Bray, Rice Institute; Professor I. L. Miller, Carthage College; Dr. Helen B. Owens, Cornell University; Professor E. W. Pehrson, University of Utah. Ten applications for membership were received.

At the annual election the following officers and other members of the council were chosen: vice-presidents, C. N. Haskins and R. G. D. Richardson; secretary, F. N. Cole; treasurer, J. H. Tanner; librarian, D. E. Smith; committee on publication, F. N. Cole, Virgil Snyder, and J. W. Young; members of the council to serve until December, 1922, T. H. Hildebrandt, Edward Kasner, W. A. Manning, H. H. Mitchell.

The total membership of the society is now 733, including 80 life members. The total attendance of members at all meetings, including sectional meetings, during the past year was 393; the number of papers read was 187. The number of members attending at least one meeting during the year was 252. At the annual election 156 votes were cast. The treasurer's report shows a balance of $10,692.23, including the life membership fund of $7,168.87. Sales of the society's publications during the year amounted to $1,811.52. The library now contains 5,690 volumes, excluding some 500 unbound dissertations.

It was decided to proceed with the incorporation of the society under the general law of the state of New York. A committee was appointed to consider plans for the organization and administration of the society after the retirement of the present secretary and librarian from their offices at the close of the present year. A committee was also appointed to consider the formation of an international union of mathematicians. The committee on mathematical requirements presented a report, which was laid over for consideration at the February meeting.

The following resolutions, introduced by Professor R. C. Archibald as chairman of the committee on bibliography, were adopted by the council:

> The council regards the preparation and publication, in America, of a dictionary of mathematical terms as not only most desirable but also entirely feasible, provided that financial aid for the preparation of the manuscript can be secured.
>
> Impressed with possibilities for the more extensive development of pure and applied mathematics in America, and with the importance of such development to the nation, the Council records its conviction that there are undertakings whose active consideration would be highly desirable if adequate financial assistance might be regarded as available. Among such undertakings are: 1. The preparation and publication by societies or individuals of surveys, introductory monographs, translations, memoirs, and treatises, in important fields, including the history of mathematics. 2. The organization of research fellowships. 3. The preparation and publication of an encyclopædia of mathematics in English. 4. The preparation and publication of an annual critical survey, in English, of the mathematical literature of the world. 5. The preparation and publication of a biographical and bibliographical dictionary of mathematicians.

The meeting of the society immediately preceded that of the Mathematical Association of America on January 1–2. A very pleasant occasion was the joint dinner of the two organizations on New Year's eve with an attendance of 114 members and friends.

The following papers were read at the annual meeting:

The sum of the face angles of a polyhedron in space of n dimensions: H. F. MacNeish.

A connected set of points which contains no continuous arc: G. A. Pfeiffer.

Fundamental types of groups of relations of an infinite field: C. J. Keyser.

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Abstracts of the papers will appear in the March issue of the society's *Bulletin.*

The thirteenth western meeting of the society, being a joint meeting of the Chicago and Southwestern Sections, was held at St. Louis on the same days as the meeting in New York. The next regular meeting of the society will be held in New York on February 28.

F. N. Cole,
Secretary

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THE MESSAGE OF THE BIOLOGIST[1]

It is eminently fitting that we biologists, like virile swarm spores, should periodically come together in a holiday spirit of mutual exchange, and after giving and receiving our messages, go back to our life work, reinvigorated and reoriented, to prepare for another brief period of social conjugation.

The messages we send to one another will have little carrying power, and little influence on the receiver, if they are not specific in content, limited in scope, and securely wrapped up in the precise technical terms of our own familiar code.

On the other hand, the biologist would be wholly lacking in social instincts if he failed to recognize that he also has a more comprehensive message for the layman, who is largely dependent on the biologist for his working knowledge of the great domain of nature-life, and by whom the biologist is provided with the necessary means of existence.

This larger message must have a different vehicle. It must first be summarized, digested and metabolized into the vernacular, before it can circulate through the body of social life, reach its terminals, and there accomplish its strengthening and rectifying purpose.

We may well ask ourselves whether we have such a message to give, and if so, what it is, and who, or what, is our authority. And by "we," I now mean all of us, not merely the biologist, but the astronomer, geologist, chemist, physicist and psychologist, for we are what we are to-day because of the underlying community of our methods and purposes, and because, in our concept of evolution, we acknowledge the same mental sovereignty.

This concept, of which we are the trustees,

[1] Address of the vice-president and chairman of Section F, Zoology, American Association for the Advancement of Science, St. Louis, January 31, 1919.

initiated in man a veritable intellectual mutation, which is now rapidly expressing itself in new phases of social action, and in the emergence, like the parts of a growing embryo, of new types of social architecture. It is our duty to interpret this concept, and to see to it that its real significance is understood, and rightly used in social growth.

The social metamorphosis which historians call the renaissance was largely due to organic improvements in the system of educational circulation and the transmission of mental possessions from man to man. Learning was democratized by translating the bible and the classics into the vernacular, and by this betterment in transmission across time and space, the profits of a dead past were made to flow more freely into a living future, making those profits in some measure the mental heritage of the common people, and their enduring germinal possessions for self-constructive purposes.

In this accelerated social growth, the base line for the orientation of human conduct, and for the measurement of right and wrong, good and evil, was the bible, the classics, and the divine right of civic and religious leadership. The power and stability of these external directive agencies was universally acknowledged, the source of their authority unquestioned, and like radiant beams, their trophic influence was formally expressed in the prevailing architectonics of social procedure.

We are now witnessing, incident to a new birth of social vision, a new social convulsion, much more significant than that of the middle ages, in which science, and especially biological science, unconsciously played, and is still playing, a very important part. For when we recognized a new source of authority in lawful nature-action and in evolution, the old base line for the measurements of human conduct vanished, and many of the old bonds of social allegiance were destroyed; and now we are asked: What shall be the new compulsion to constructive social action, and on what authority can we stay the march of anarchy?

And you, as biologists and American men of science, can not shirk the grave responsibilities of social leadership now thrust upon you, for it requires little gift of prophecy to forsee that America is destined quickly to become the world's chief center of biological learning, as she is to-day the center of the broadest sympathy with human life and nature.

Perhaps it may clarify our vision if we first ask, not what biology is, but what science, as a whole, does, and what she tries to do. It will little help us to enumerate all the sciences, or be told there is "pure" science and applied science; science experimental, and descriptive. Behind and beyond all these varied aspects of science there must be common motives, and common purposes in the scientists, if we are rightly to include them as intelligent beings in the same class.

Let us therefore precipitate and remove these adjective purities and impurities, and you will then agree with me, I believe, that there still remain in science several overlapping functions and purposes. First to explore and to chronicle. To that end, she aims to discover what things are contained in nature, where they are, what they do, what the order is, step by step, of their coming in, their growing up, their going out. And then to memorize, to conserve her mental possessions, to register, in convenient and enduring symbols the result of her explorations, for future usage. Second, to compare and explain. To that end, she aims to discover why things are as they are, in what respects they differ, in what they agree, how one thing influences another, constructively, or destructively, and to distinguish the right ways of doing things from wrong ways. Her third function is to do things rightly. In that respect, she is artistic, architectural. To that end, by conforming her ways of doing things to nature's ways, she aims to create, and to conserve, and to use her records and her knowledge of right and wrong profitably.

Thus three qualifying motives pervade science: the acquisitive, the ethical and the moral. She seeks knowledge through experience, wisdom through understanding, and profit through obedience. One purpose is self-constructive, or egotistic, the other, self-giving, or altruistic. Both are cooperative functions; in action, continuous; in rightness, cumulative; in effect, creative.

The renaissance of to-day has its chief creative impulse in the consciousness of evolution. This revelation of modern science, which we all acknowledge as our guiding star, has come to mean world-growth, or the progressive organization and architectural upbuilding of nature. Nature is now the source of our authority, and creative nature-action, as expressed in nature-growth, is the standard of all our values. Science is therefore compelled to express all her measurements in positive and negative constructive terms, which ultimately must be oriented in reference to this gradient base line of nature-progress, called evolution.

In this nature-growth, we fail to discover any gain or loss, either in basic constructive matter, or in energy. But gain there must be, if evolution is a reality. That gain is, in reality, a moral and ethical gain, or a gain in that creative action and constructive rightness which we call organization and directive discipline. There are no better positive and negative terms to express those gains, both relatively and absolutely, than the familiar terms, right and wrong, good and evil.

On this point, therefore, there need be no equivocation in our message. The profit in evolution is in better constructive action. By the conservation of these profits, nature augments her capital in constructive rightness.

But how is this profit made and conserved? That is the really vital question. Until it is answered there can be no underlying intellectual stability in human life, individually, or socially; no basic unity of purpose in human conduct. Here our vision is not so clear. Many of us believe that on this point we have no comprehensive message to give.

The most familiar attempts to explain how evolution takes place are restricted to special aspects of evolution, and are often epitomized in personal names, such as Darwinism, Lamarkism, Weismannism, Mendelism. Among us there are naturalists, morphologists, physiologists, and psychologists; breeders, experimentalists, and bio-chemists. And surrounding us on all sides are the physicists, chemists, geologists, and astronomers, with whom we must reckon, for their domains and their subject matter overlap ours in countless ways.

But unfortunately between all these workers there is little common understanding and much petty criticism.

Are we building out of aimless contributions to science a new Babel's tower of disjointed, slippery words, with nothing to hold them to constructive lines, and preserve the unity of purpose in our social architecture?

Perhaps the most comprehensive terms, although they have little meaning outside the organic world, are "natural selection," the "struggle for existence," and the "survival of the fittest." But granting their validity within the organic world, they have no definite moral significance. They convey no implication as to how man, or anything else, must act in order to exist, to say nothing of surviving. What is the fittest? Why is it fit? Why does it survive? If right combinations happen primarily by chance, why, or how, do they come to happen regularly? How can "right accidents" become cumulative, or lawful, or determinate, unless there is a saving, or more enduring, directive element in that something we call rightness?

When the layman makes his holiday call on his biological menagerie and points his umbrella at us, hoping to receive through that safety-first device a brush discharge of information, we fail to "come across" with illuminating answers to these very pertinent questions. But to conceal our low potential, and preserve our self-respect, we all resort to certain unintelligible sounds, or warning signals, according to the particular pen in which we have been bred and exercised, and which are guaranteed to scare away, or charm into inaction, the most intrepid questioner. One mumbles something about "environment" and "ecology," and crawls back into the bushes. Another wheezes something about "enzymes" and "vitality'" and goes on with his experimenting. Another climbs to the top of his cage and yells "eugenics," while his mate in the corner faintly lisps "euthenics." Some particularly active youngsters jump into a revolving wheel, and every time it makes a complete revolution shout "chromosomes, chromosomes, chromosomes." A few old-moss-backs, a rare variety, mournfully harp on "morphology." And one majestic megatherium comprising all in one, coughs up an "energy complex," followed by a prolonged roar, in several volumes, in which one can distinguish the words "action, reaction, and interaction." The clergymen, senators, and Bolsheviki, with their retinues of lady friends, exclaim "How wonderful, and so true." Life indeed is complex, energetic, and full of actions, reactions, and interactions! And all of them deeply impressed, go back to their deadly work, and act, and believe, if at all, just as they did before.

After they are gone, all the animals agree that no one has any right to bother real, simon-pure scientists with such fool questions. Let them go to—well, Where? To Germany? To Nietsche, Bernhardi, and Treitsche? To the militant philosophy of dominion, to a half-witted selfishness, in politics, commerce, and kultur, frankly upbuilt on the doctrine of the survival of the fittest, the fittest universally acknowledged, by themselves, to be the Germans and their system?

Or to the spiritualists, anthropomorphists, and sentimentalists, who see nothing clearly in the mirror of nature but a distorted image of themselves?

Or to Huxley and his "I don't know" followers, who can discover no ethics or morality in nature-action; neither warning nor invitation, nor directive discipline, but merely a drab, unoriented neutrality of "unmorality," leaving man nothing but himself with which to orient himself; leaving him to create his own system of ethics and morality out of his own inner consciousness?

The biologist has found no evidence for the broad assumptions of these philosophers. In nature, he sees no one-sided dominion of the strong over the weak, or the weak over the strong; no special privileges; and no freedom from obligations. Neither does he see any warrant for puling sentimentality, nor any expectation of an unaggressive neutrality in nature-action.

Nature, so far as we have been able to discover, is an enduring, self-constructive system, gaining and preserving her gains, in a definite way, according to her own system of ethics and morality. In so far as nature-growth is manifest in evolution, we can not deny that at least to that extent her ethics are constructive and her morals saving.

Man's constructive and saving principles can not be otherwise, without severing all his bonds with nature-action in a futile attempt, like that suggested by Huxley, to set up an anarchistic "imperium in imperio," or a Bolshevistic "microcosm within the macrocosm."

I can not believe we have reached that parting of the ways, for man's highest activities are all too clearly but extensions of nature's ways and means of creating and preserving her products, in which man uses whatever intelligence he may have, and the cultural implements he has constructed, as special instruments to attain his ends.

The specific gravity of the western variety of biologists will not let him float in a vacuum of cosmic mysteries with the Hindoo; and he does not care to wallow in a quagmire of metaphysics with the Greek. He gladly plants his substantial mental feet on the first firm substratum he can reach. And even though that substratum be nothing more than the molecular quicksands of physics and chemistry, it safely leads him to the rising shores of hard realities.

But now that we biologists, as evolutionists, feel reasonably safe in our storm-proof shelters of established facts, the spirit of adventure again leads us forth to wider excursions, and we ask ourselves whether it is possible to reduce all the constructive processes of nature to a simple formula, which can be expressed in familiar terms of universal human significance? This is a venture doomed apparently beforehand to defeat, for it takes us back again to the most ancient beaches of human controversy, strewn with the wreckage of all man's early and late attempts to launch a religion, or a philosophy, that will stand the test of experience.

And all these mournful wrecks are jealously guarded by marooned mariners of hope, and their beach-combing followers, who show no mercy to intruders. But modern science, which has wisely built on firmer, though drier ground, must ultimately extend the foundations of all of her out-housings down to the low water mark of this old shore, and while the attempt is fraught with danger, it will ever be an inspiring task for those engaged in the process of social reconstruction that now lies before us. I know of no other engineers whose occupation should better fit them for leadership in this task than the biologists, occupying, as they do, a central strategic position in relation to chemistry and physics, geology and astronomy, sociology and the humanities.

When to this end, we examine, as best we may, the attributes of these basic, chemical elements of nature's substance, we find in them, as in human social atoms, a potential constructive and creative power which becomes clearly manifest in the familiar processes of chemical action. In that process we are compelled to assume, if we are willing to assume anything, that some influence, or effect, we know not what, or how, is exercised by one element on another, the result of which may be the formation of a new unit, or compounded individuality, with a new style of architecture of its own. Coincident with this construction, the former attributes of the constituent parts vanish, and in the new unit a different attribute appears which was not there before.

We may profitably translate this constructive process into the vernacular, without, I trust, seriously offending the properties of the purest scientist, even though the words may savor of morality.

We may say, for example, that when the right chemical elements are in the right relations to one another, or if they are moved into them, or placed there or if these elements themselves find the right relations by chance, or otherwise, cooperative action between them then takes place automatically, or under a compulsion neither can resist, and something new is created. In this cooperative action, each element evidently does something, or gives something to the other, and receives something from the other. It is in fact apparently a clear case of creative action through mutual subjection and mutual service—not necessarily service for each other, because for all we know these elements may be the original anarchists and would much prefer neither to give anything to anybody, nor receive anything from anybody—but for the molecule so created.

In this creative process, the essential factors are, unity, mutual service, mutual discipline, and some sort of constructive rightness. When these conditions are fulfilled, something new is created, and these anarchistic elements then become, perforce, altruistic agents, or accessories, to some ulterior creative act, in which they may or may not be interested. In spite of themselves, by their mere existence, they are compelled to act for something beyond self, and in doing so they cease to be anarchists and become more or less orderly servants in a staid molecular society.

Mr. Molecule, therefore, is created by the mutual services and directive discipline of his constituent atoms, or elements, and by his home surroundings, all acting cooperatively to give him birth. In his creation, he becomes endowed with a sovereign quality of his own, subject to the sovereignty of his outer world. He endures as long as those cooperative services are rightly performed, and the discipline rightly maintained, and no longer. His existence, therefore, is contingent on the performance of these services, and on the existence of some degree of rightness within himself, and outside himself; and that molecule which does survive has preserved within its makeup some measure of that rightness. In that measure of cooperation and rightness lies the fitness of his constituents, and the selective agency in the evolution of the molecule.

But the molecule thus peremptorily set up in business for itself, and without being consulted in any way as to his own wishes in the matter, has his own work in the world to do, subject to his own specific attributes and external compulsions. This new anarchist, by force of circumstances, may be compelled to help in the construction of proteids to be used by some future plant or animal life, even if his anarchistic soul does rebel at the performance of such useless altruistic labor, and at such unwarrantable interference with his freedom of action.

If we now make a momentary excursion toward the other extreme of nature-action, into the domain of the astronomer, we apparently find the same constructive, selective, and saving agencies at work that are manifest in the upbuilding of the molecule, only the system and its component parts are larger, the time and space factors greater, and the unknowable movers have different names.

Here the cooperative agencies are the sovereign cosmos, and the sovereign individualities it contains. These solar systems, with their constituents suns, planets, and satellites, and their subordinate elements, are grouped in partially visible architectural entities, suggesting the wholly invisible molecular entities of physics and chemistry.

The gains in this cosmic action-system are formulated in sidereal architecture, and the continuity of its constructive services is manifest in the stability of its organization. The morphology of the heavens, like that of molecules and living organisms, is not only an index of past and present physiologic action, but an assuring prophecy of future action. Without this forward and backward aspect, along a gradient line of progressive nature-action, science itself could not exist, for there would be no base line for the profitable orientation of intelligent thought or action.

In each of these larger sidereal units, and systems of units, is embodied the summed up profits of past cooperative actions. In this self-construction lies the egoistic phase of these individualities. The ulterior altruistic services to which they are accessories are in some measure apparent in the terrestrial conditions under which, without our consent or approval, we now exist. So let us get back to earth again, where these agencies have made life and constructive thought a possibility, and have rigidly defined its impossibilities, whether we like these invitations, restrictions, and compulsion of nature's discipline, or not.

In the terrestrial world, the most convincing and familiar example of creative unity through cooperative action, is the living organism. But plant and animal life stand on, and in, the altruistic achievements of the physical world. They are pensioners of the past, using both the oldest and newest instruments of nature in their self-construction. The individual plant, or animal, is the product of its cooperating elements, cells and organs, and its environment, and is itself a cooperative agent in that environment. It is subject to its own sovereign attributes, as well as to those of its constituents and its habitat. The individual gain is everywhere contingent on the general. The plant can not long endure without the animal, the male without the female, and neither without their retinues of other servants. They exist, as they do, because of these mutual services, within and without, past and present. Their profit is in service betterments: their working capital, past betterments conserved.

In this phase of nature-action, the cooperative system is formless, elastic, and democratic. Plants and animals are the actor-units, widely separated it may be, in time and space, but everywhere intermingled regardless of high or low degree. And the system now assumes the familiar give and take of predatory life and reproduction, where consumer and consumed, parent and offspring, egoism and altruism, perform reciprocal functions in the universal metabolism of nature-life.

Consider, for example, the nut, the mouse and the cat.

If the mouse destroyed all the nuts, it would destroy itself. Its interests are best served when nuts are encouraged. If it had intelligence, it would cherish and preserve them. If it had the necessary cultural implements, it might profitably spend its spare time and energy in producing more and better nuts. Not even a "nut" could reasonably object to that. On the other hand, the cat is an efficient educator. It teaches the mouse to confine its attention to its own affairs, and both teacher and pupil are the better for that.

And when the mouse is about to die, and is brought to earth, it does not wholly go to waste. A percentage of him goes to make another nut, and a percentage helps to make another cat, which without the one and the other could not exist. And finally nature levies a tax upon the cat, and in due season the cat pays his taxes.

By virtue of this rigorous nature discipline, which prescribes when, and how, and where, the nut, the mouse, and the cat may act, and what they must, and must not do, each in its own way makes a living, as many others like them have done in similar ways before, a sufficient testimonial to the constructive and saving virtue of the system.

But this is only one part of this system of give and take. The plant, the mouse, or the cat, as an individual, not only gets, or receives enough income from all sources to pay his personal running expenses, but on the whole, each in his own way, makes a profit. Part goes into alterations, repairs and additions, or into what we call growth. But there is always a definite limit to individual holdings, or to the growth of every individual system, which is peculiar to itself. When that limit of cohesion is reached, or approached, the surplus overflows into other individualities and becomes their possession.

Much of this surplus of the profiteer, which for him is unusable, is scattered right and left with astounding prodigality, and this unwilling altruism on his part becomes one of the chief sources of income to life at large. But an adequate percentage becomes a special entailed endowment to a new individual, similar to the first, thus setting up a substitute, or a direct lineal descendant in the business of life, giving him a fixed capital in germinal materials, quick assets in germinal food-stuffs, with containers and protective envelopes, all rightly constructed and arranged, and the whole package so located in time and space by the administrators of these estates as to insure for it, in the long run, a new life of adventure among the hazards and inviting opportunities of the outer world.

Thus in this larger spongeoplasmic fabric of nature-life, visible only to the more comprehensive instruments of the mind, kingdoms and classes, races and species, young and old, the physical and organic entities of the living and the dead, are unconscious partners in a common system of cooperative action. In this social metabolism across the larger reaches of time and space, each unit, in the reciprocal egoism and altruism of life and death, plays its respective anabolic and catabolic functions, and thereby gives the system, as a whole, its self-sustaining, vital power.

Through the shifting patterns of this growing fabric, we most clearly see the converging threads of genetic lineage, the long, gradient lines of alternating youthful egoism and parental altruism, on the one hand vanishing in the primordial life that has its issue in the terrestrial loom, and on the other, radiating into the abyss of future possibilities. Everywhere shot through and across these more rigid hereditary lines are those which mark the sinuous course of predatory action, and other actions less discriminating. Thus the whole system is woven into that variegated plexus of success and failure, tragedy and comedy, joys and sorrows, good and evil, which makes up the cooperation functions of life and give it creative unity.

And then man, a new nature-anarchist, the most modern pattern in this moving-picture fabric, makes his appearance on the screen, and surrounded by his satellites of cultural instruments, and with both positive and negative poles of his very material self flaming with the auroras of intelligence, attempts to set this system which gave him birth to rights.

He is little conscious of the source of his own endowments, or that his ethics and morality, as manifest in his sporadic outbursts of social philanthropy and benevolence, are not his own institutions, but the compulsory application of world-old constructive principles to his own peculiar affairs. Nor is he fully conscious that his boasted material inventions and discoveries, his canoes and battleships, his ovens, highways and machinery, his microscopes, telephones, and telescopes, his commerce, literature-science, and art, are but improvements, or enlargements, outside himself, of his own internal organs and functions, and that he must use these cultural instruments if he would use them constructively, in precisely the same ways his vital organs are used in his bodily growth and preservation.

In their functioning, these cultural instruments extend, deeper into time and farther across space, the power of his sense organs to discriminate between good and evil, and increase the range and velocity of the load his muscles, blood vessels, nerves, and other bodily organs can move, or carry. In other words they serve to increase the rate and diversity of the mutually profitable exchange, mental and physical, between the human molecules of social life, and between man and nature. They alone give man's social life its cooperative unity and power, just as the cooperative action of molecules, cells, and organs give unity and power to his body. Their saving and constructive action is contingent on the growth and right usage of intelligence, as the construction and preservation of his body is contingent on the evolution of right reflex actions and instincts.

And now, in this twentieth century of the historian's calendar—when the human blastoderm, for the first time in cosmic evolution, has practically enclosed the terrestrial egg, filling in all the habitable surface of this cosmic yolk-sphere, establishing its capillary network of highways, and its nerve plexus of communication, joining its racial blood-islands and national placodes into one organism—humanity has ceased to be a germinal potentiality, or a mere vision of the prophets. It has become a present and very obvious reality, and the academic flickerings of the philosophic auroras are now sufficiently luminous to be visible, as practical questions, to the politician. Indeed there is still hope that some rays may eventually pass the threshold of senatorial sensibility.

But the man of normal social instincts and average intelligence, in spite of himself, is now compelled to recognize this unity in human life and nature, and the dependence of that unity on the fulfillment of mutual rights, of mutual services, and mutual obligations. In this more humble state of mind, he does not now ask "What will I do?" but "What must we do?" to preserve social life and social structures. What is our protection against the will to destroy? With destructive agencies everywhere now at hand for those who have the will to use them, What shall be the compulsion to constructive action?

The answers to these questions can not be found in precedents, for there are no precedents in the whole history of evolution for man's present social conditions. The solution must be found in the intelligent application of the elementary principles of ethics and morality, principles which have their roots in the biological and physical sciences.

We must not accept Huxley's despairing assertions that "cosmic nature is no school of virtue, but the headquarters of the enemy of ethical nature," and that "the cosmic process has no sort of relation to moral ends." To do so we should have wholly to ignore the manifest creative power in cosmic action. We may surmise, from internal evidence, the irritation that provoked Huxley's brilliant but unconvincing dialectics, and it may be said that his point of view then, and the chief target of his attack, is not ours now.

And surely it is not for us "to fight the cosmic process" even under a fighting Huxley; nor on the other hand need we accept the stoical philosophy of protective mimicry and regard "living according to nature as the whole duty of man"; nor need we be horrified at the thought of ethics as "applied natural history."

Rather is it our duty to understand nature-action and to cooperate with it; to distinguish between the minor tactics of evolution and the grand strategy of evolution, and with our own peculiar instruments be willing and happy agents in its consummation. Man has but his animal organs, his cultural implements, and his intelligence, or his knowledge of right and wrong constructive ways to work with. The more those instruments are augmented, the better he can direct nature's constructive agencies to his own egoistic ends, and in so doing, man himself then unwittingly becomes a new and better altruistic agent in evolution.

We scientists, conscious of our purpose as constructive social agents, have three broad fields of activity open to us, as already indicated in defining the various functions and purposes of science. First, investigation, or the discovery of nature's ways and means of creative action. This is the ethical side of our work. Second, the constructive usage of these ways and means, or their application to the growing demands of social life, and their usage in the regulation of human conduct. This is the moral side. And, third, the conservation of our ethical and moral gains through education. The first two we may now ignore, for their significance is duly appreciated and their future is promising. But the educational side of our work is in a very serious condition, and it may even now be too late to avoid disaster. It little matters how much we may develop either our technique, or the spear-head of our research, if the so-called common people still have the ghost-hunter's paleolithic mental attitude toward natural phenomena, and their leaders a similar attitude toward social problems.

No social life can endure that is not under some common compulsion to united action. With the growth of the spirit of freedom and democracy, and the absence of any commonly recognized dictatorship in church or state, that compulsion can come only through a common understanding of the elemental necessities of social life, and through that sense of personal benefit and personal ownership in social institutions which alone can create the will to cherish and protect them.

The compulsion of elemental intelligence, acting in social unison, can alone provide the enduring directive and cohesive power essential to social cooperation. Man's will to create can be steadfast in purpose only when his intelligence becomes stabilized in its trophic attitudes, and rightly oriented to elemental realities. Man, stumbling in ignorance, must be bandaged with restrictions and propped up with crutches of force. A nation, pricked by the poisoned shafts of a lying propaganda, will dissolve in anarchy, though the armies and navies of the world have failed to break it.

In our education, we continually over-emphasized social rights and individual freedom of action, and ignore the obligations essential to partnership in any social or constructive compact. It is not without significance that ordinary people, like you and me, can discover no specific mandate in the Constitution of the United States. It broadly defines what the state does, or will do, in certain contingencies, and what its citizens may, or may not do, but says nothing about what the citizen must do in return for what the state does for him. The absence in citizenship of a formal and specific contract, defining a common purpose and recognizing mutual liabilities and mutual benefits in its attainment, is in marked contrast with modern business procedure, as well as with almost every other form of intelligent cooperation. It is, therefore, not surprising that an international covenant for the specific purpose of reducing the danger of international wars to a minimum, in which an attempt is made to define national rights and obligations in that undertaking, has a strange and unfamiliar sound.

The absence of this covenant principle is noticeable in almost every phase of modern education. Science, even, does not formally recognize a covenant with nature, although nature virtually says to man "Know me, and serve me, and I will serve you." Much of our biological teaching is like a shop window display of nature's competitive goods, with a varied assortment of human notions thrown in, but with no guarantee as to their significance, or quality, or usefulness. The pedagogical barker, seldom having convictions of his own, proudly displays the impartiality of his "purely scientific" attitude, and leaves the callow purchaser to decide for himself which trinket he will select for his mental adornment.

Perhaps all of us can get together again on common ground by putting our concepts of nature-action into simpler, more comprehensive formulas, universal in application, and somewhat as follows. In so far as we have a right to assume that purposeful action is involved in any constructive functioning whatever, or in anything that has been accomplished, we may assume that the purpose, or grand strategy in nature-action, is evolution, or self-construction, or growth. To that end, serviceable agents must first exist, or be constructed, in which is resident a basic right to receive service, and a basic obligation to give service. As all constructive action is contingent on the fulfilment of these mutual rights and obligations, the categorical imperative to existence is mutual service.

As corollaries to this categorical imperative, the following compulsions are laid upon these constructive agents. In all sustained constructive action there must be: (1) A mutual directive discipline, or mutual adaptation; that is, a mutual subjection, and yielding to one another's influence. (2) An individual freedom of opportunity for self-constructive, or egoistic action, within rigidly circumscribed limitations. (3) Mutual service or cooperative action, in which, soner or later, the profits of egoism must be surrendered, through altruism, to some ulterior creative act. (4) Conservation of these profits as an accumulating capital in constructive rightness, and its endowment to other individualities for usage in further constructive action.

In that phase of cosmic evolution which we call social growth, science and religion are the outstanding cooperative agents. They better serve their ulterior purposes the better their mutual services, and the better their mutual adaptation of thought and act to creative ends.

Science and religion always have asked, and doubtless always will ask, the same fundamental questions. What creates, what preserves, and what destroys the products of nature, and how may man profit thereby? The answers, whatever they may be, must ultimately be expressed by them in essentially equivalent terms, their verification sought in constructive action.

The large element of unpredictable returns resident in all phases of nature-action demands trial; creative turns justify the experiment.

These unsuspected potentialities are revealed in the triumphs of nature's creative art and thus confirm her independence of established laws and precedents. Therein is the source of man's undying hope and faith, his abiding impulse to endeavor.

William Patten

Dartmouth College

ON NIPHER'S "GRAVITATIONAL" EXPERIMENT AND THE ANOMALIES OF THE MOON'S MOTION[1]

From his assumption that matter is entirely electrical, Fessenden concluded[2] that the atoms in the interior of solid bodies are charged electrically, contrary to a common conception that a static charge resides wholly on the surface. Fessenden's assumption has now been completely confirmed by Professor Francis E. Nipher's experiment with an electrified Cavendish apparatus,[3] which shows that when thin electrified shells of metal are substituted for the large leaden spheres, no effect is produced on the inner small suspended spheres, protected by a metal case, when the electricity is applied. This, of course, simply corroborates Faraday's "ice-pail" experiment. But when the large leaden spheres are restored to place and electrified, the electricity gradually soaks in, and after about half an hour this interior charge of the atoms has accumulated sufficiently to produce an electrical repulsion of the small spheres, greater than their original gravitational at-

1 This paper was read at the twenty-second meeting of the American Astronomical Society at Harvard College Observatory, August, 1918.

2 *Electr. Soc.*, Newark, 1890; *Electr. World*, August 8–22, 1891.

3 "Gravitational Repulsion," *Transactions of the Academy of Science of St. Louis*, Vol. XXIII., p. 177, 1917.

traction by the material of the unelectrified large spheres. Professor Nipher calls this a "gravitational repulsion," but this appears to be a misnomer. If the lead had really become *gravitationally* repulsive, it should also repel the earth, and the leaden spheres should rise up and float away. Needless to say, this is not what happens. Contrary to the usual conception of a static charge, *the electric charges have penetrated into the substance of the metal.* Since it is thus shown that a charge of electricity, which in other respects would not be distinguished from a static charge, has in this instance slowly been absorbed by the metal, permeating its substance, the thin metal of the protecting case can be no barrier to the transmission of such a charge as this, and the metal case no longer protects the inner balls of lead from directly receiving a corresponding electric charge of the same sign as that of the large spheres, and thus there is repulsion between the two, no matter whether the electrification be positive or negative. However, since the electric penetration progresses very slowly, the large spheres presumably take more time to charge up than the small spheres. Consequently, if after a preliminary application of one sort of electricity for a sufficient time to produce saturation, the electrification is changed to the opposite sort, we should expect that the electrification of the small spheres would change sign first, and for a while there should be electric attraction, or at least a progressively diminishing repulsion. Now this is exactly what takes place, though sometimes with rather vigorous tremors, as if the interior distribution of the electricity were not quite uniform and as though its unloading were spasmodic; but eventually, if the experiment endures long enough and the electrification is sufficiently powerful the signs of the electric charges become the same in both large and small spheres and the temporary electric attraction changes back to a repulsion. There are some anomalies connected with the orientation of the applied electricity when direct contact of brushes is the method of application, which possibly signify that the lead spheres are not entirely homogeneous for charges communicated in this way.

While the gravitational and electrical forces are intimately related, insomuch that a common entity—the electron—is presumably concerned in both, their modes of action and speeds of transmission appear to be entirely different. The electric phenomena which counterfeit gravitation in the preceding experiment, are irregularly variable and slow. Gravity is constant and its impulses so rapid in their transmission that their speed has never been directly measured. There is no reason to suppose that gravity is conveyed by electro magnetic vibrations with the speed of light, for these uniformly give repulsion, and not attraction; nor is the final action of the penetration of the electric charges other than repulsion, while, in spite of Professor Nipher's title, there is no evidence of any *gravitational repulsion.*

From the result of Nipher's experiment, we may infer that the penetration of electrons, emitted by the sun from time to time and entering into the substance of earth and moon, will produce a variable electric repulsion between these neighboring bodies, and it is conceivable that some of the unaccounted irregularities in the moon's motion may be produced in this way.

The positive electric potential of the atmosphere increases in an upward direction, at first slowly, then more rapidly, though sometimes quite irregularly, often attaining a value of tens of thousands of volts at a height of a few miles. This electrification of the air is the result of the ionization of some of its ingredients through absorption of the sun's rays. The ionization is greatest in the upper air, partly because the incoming rays are there rich in the ultra-violet rays which are the most efficient ionizers, and the upper layers are the ones which first take toll of the radiation before these rays have been depleted; but the electrification is also greater in the upper air partly because these layers are furthest from the surface of the ground and can not lose their charge by conduction to the ground as easily as the lower layers. Although air is a very imperfect conductor, the section of this conductor being equal to the entire surface of the globe is enormous, compared with the distance to be bridged; and thus the minute specific conductivity of the air multiplied by the section and divided by the length of the path is still an appreciable quantity even locally, and a very large one taking the earth as a whole. Moist air conducts better than dry, and the electrification at a given altitude is on the average several times as great in winter as in summer, because the drier air of winter is a better insulator.

The following examples are from U. S. Weather Bureau observations at Drexel, Nebraska, in 1917 (e = mean pressure of aqueous vapor in the air up to the given height, measured in millibars; v = positive electric potential of the upper layer in volts).

Height Above Sea-level, Meters	Jan. 11, P. M.		Jan. 18, A. M.		Jan. 26, A. M.		June 12, A. M.		June 19, A. M.		June 23, A. M.	
	e	v	e	v	e	v	e	v	e	v	e	v
500	1.44	410	2.39	390	2.17	1,130	12.48	0	10.06	0	18.47	0
1,000	1.43	3,420	2.04	2,090	2.14	7,520	10.18	0	8.97	40	15.24	0
1,500	1.62	6,355	1.89	6,160	2.62	17,735	10.46	0	8.40	320	13.27	0
2,000	1.80	9,645	1.67	7,625	2.76	20,775	7.73	315	7.86	870	10.65	310
2,500	1.87	14,650	1.35	12.280	2.79	22,300	7.00	805	7.21	1,245	9.56	490
3,000	1.91	19,850	1.13	16,085	2.71	25,060	6.75	1,295	6.68	1,710	8.74	340
3,500					2.57	26,835	6.46	1,785	6.07	2,405	7.82	480
4,000							6.40	2,270	5.50	3,255	7.24	535
4,500									5.10	4,200	6.70	550

On the given dates in January, which are fairly typical, the average positive electric potential was 20,332 volts at 3,000 meters for e = 1.92 m.b., and in June a potential of 1,375 volts was found at the same height for e = 7.39 m.b. So far as ionization of water vapor is concerned, there should be more of it in June per unit volume of air; but in spite of this, the greater atmospheric conductivity at that time cuts down the potential to a much lower value than the winter one. Evidently there is continual conduction from the air to the ground. This does not neutralize the negative charge of the ground, partly because of the large electric capacity of the latter, but mainly because the prevalent negative charge of the earth as a whole is continually being restored. Except for convective uplifting of local bodies of air temporarily negatively charged by contact with the ground, these conditions of electric distribution in the atmosphere are fairly persistent. The two electricities are continually combining, but are as constantly replenished.

The incoming electrons from the sun may be absorbed by the upper air, but they serve to increase the absolute potential of the earth by a process which is independent of the radiant ionization; and as I have shown that there is conduction between the upper and lower layers of the atmosphere and adjustment of its ever varying charges, the increased absolute potential of the upper air is eventually, and probably pretty rapidly, transferred to the ground. Thus the ground receives its permanent negative charge from the sun; and in spite of all sorts of irregular electric variations in the intervening atmosphere, the permanent negative charge of the ground is maintained with only such minor fluctuations as occur in magnetic storms. In these, the showers of electrons received by the earth from the sun at times of great solar activity certainly penetrate into the earth's solid substance almost immediately, in spite of atmospheric obstruction, and produce electric "earth currents" of considerable magnitude. We must conclude that the absolute potential of the earth is continually varying.

Newcomb's investigations of the inequalities of the moon's motion[4] indicate the existence of unexplained fluctuations in the moon's mean motion—a great fluctuation possibly with a period of between 250 and 300 years,

[4] Monthly Notices of the Royal Astronomical Society, Vol. LXIX., p. 164, January, 1909.

though the change may prove aperiodic, and a lesser one of about 70 years. Professor Newcomb says:[5]

> Taken in connection with the recent exhaustive researches of Brown, which seem to be complete in determining with precision the action of every known mass of matter upon the moon, the present study seems to prove beyond serious doubt the actuality of the large unexplained fluctuations in the moon's mean motion to which I have called attention at various times during the past forty years.

And he concludes, after examining every known cause of motion, that "if we pass to unknown causes and inquire what is the simplest sort of action that would explain all the phenomena, the answer would be—a fluctuation in the attraction between the earth and the moon."[6] This is in line with my present suggestion, but as yet we have no certain knowledge whether there is correspondence between the supposed attractive change and the solar emission of electrons. However, the comparison which Professor E. W. Brown has made between the variation of the moon's mean motion in longitude and the fluctuation in height of the maxima of the sun-spot curve[7] lend considerable confirmation to the view that the 70-year period in the moon's motion is in fact due to a varying electric repulsion between the moon and the earth owing to the larger reception, by both bodies, of negative electrons when sun-spot maxima are highest and when, presumably, solar electronic emission is exceptionally great, with consequent slight reduction of gravitational control and loss of motion owing to electronic repulsion. We might suppose that the electrons thus received by our earth from the sun, form a fluctuating electronic "atmosphere," outside of the denser air, but attached to the planet. Nipher's experiment, however, favors the supposition that there is actual electronic penetration into the solid substance of the outer layers of the earth.

Professor Brown says:[8] "With some change of phase the periods of high and low maxima correspond nearly with the fluctuations above," referring to his curve of the variations of the moon's motion in longitude, where negative values of the moon's motion-variation from the mean follow close after the high sun-spot maxima of 1780 and 1850, while positive lunar values (that is, increased speed from greater total attraction) are equally associated with the low solar maxima of the epochs near 1815 and 1885, or half way between the epochs of high sun-spot maxima. Nevertheless, as the electric hypothesis was then unbroached, Brown considered the connection open to doubt because, as he says, "it is difficult to understand how, under the electron theory of magnetic storms, the motions of moon and planets can be sensibly affected." But this difficulty which was felt when the only hypothesis in sight was that of some sort of *magnetic* effect, disappears in the light of the now known efficacy of electronic penetration. Similar, though much smaller variations, with apparently identical period, are found in the motions of Mercury and the Earth in respect to the sun, but in these there are some discrepancies, and until these are cleared up, the proposed explanation, though plausible and perhaps even probable, can not be considered as certainly established.

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[5] *Op. cit.*, p. 164.

[6] *Op. cit.*, p. 169.

[7] See Report of the Australian meeting of the British Association for the Advancement of Science, *Transactions Sect. A*, pages 311 to 321.

[8] *Op. cit.*, p. 321.

FRANK PERKINS WHITMAN[1]

PROFESSOR WHITMAN was of New England stock. The Whitman (originally Wightman) family came to Massachusetts in 1632. The line of Whitmans has included three clergymen. The father of Frank was William Warren, early in life a lawyer, but later engaged in business, who died in 1902, at the age of eighty-two. Caroline Keith Perkins, the mother of Frank, died at the age of forty-one. She and the mother of President Taylor,

[1] Minute adopted by the Undergraduate Colleges of Western Reserve University.

of Vassar College, were sisters. Her father, Aaron Perkins, served the Baptist church as minister for over seventy years. The Perkins family also settled in Massachusetts early in the seventeenth century.

Professor Whitman was born and spent his boyhood years in Troy, N. Y. After attending a private academy, the high school, and also for a while a private home school in Pittsfield, he entered Brown University and graduated in 1874. He was a member of Alpha Delta Phi, Phi Beta Kappa, a Junior Exhibition speaker and on the commencement list. After graduation he taught in the English and Classical High School of Mowry and Goff for four years, at the same time pursuing graduate studies at Brown University, and received the master's degree in 1877. In the year 1878-9 he studied physics at the Massachusetts Institute of Technology, at the same time making astronomical observations with E. C. Pickering, and working on lenses with Alvan Clark. He spent the following year at the Johns Hopkins University. During this time he was associated with Mr. Newton Anderson, who later founded the University School in Cleveland.

In 1880 Professor Whitman was called to the professorship of physics at Rensselaer Polytechnic Institute at Troy, where he remained until he came to Cleveland. His work in Adelbert College and the College for Women began in 1886, and continued until 1918, when, after a year's leave of absence, he became professor emeritus. He acted as dean of Adelbert College from 1903 to 1906.

He was chairman of the physics section of the American Association for the Advancement of Science, and thus vice-president of the association, in 1898. His vice-presidential address was on the subject color-vision. Two years before he published a paper on the subject of the flicker photometer, an idea not original with him, but he developed its possibilities and it has since been perfected by others. His scientific ability was critical rather than creative. For this critical faculty there developed few opportunities, hence his scientific activities were confined mainly to college halls. He was not a research scholar and never wished to be considered one, but he did have a profound knowledge of the great problems of physics and astronomy, and he kept up with the research work done in these branches. He devoted much of his attention to the possibilities of lecture experiments as a means of instruction. The construction and administration of the physics laboratory naturally received much of his time and interest. He never failed in the mass of executive work which is required in a college, and in this field he showed the greatest capacity and usefulness. In addition to his minor interest in local organizations, he was a member of Sigma Xi, of the American Physical Society, of the American Astronomical Society and of the Illuminating Engineering Society. He received the honorary degree of Sc.D. from Brown University in 1900. He was a trustee of the University School of Cleveland, and took an active interest in its development.

During his long connection with Western Reserve, Professor Whitman endeared himself to his colleagues in an unusual degree by his unfailing courtesy and generosity, the charm of his personality, the wisdom of his counsel, and the absolute integrity of his conduct. A righteous man, whose ear was ever open to the voice of an enlightened conscience, he inspired complete confidence and made himself a trusted leader. He brought honor to his profession, happiness to his friends, a rich service to the university; and in the halls of memory, his figure will long remain a type of perfect faithfulness.

HORATIO C. WOOD

Horatio C. Wood, M.D., LL.D., emeritus professor of materia medica, pharmacy and general therapeutics in the University of Pennsylvania Medical School, died, January 3. The obituary notice in the *Pennsylvania Gazette* states that for three generations members of the Wood family have been on the medical faculty. Dr. George Bacon Wood, one of the founders of the Philadelphia College of Pharmacy, and an uncle of Horatio C. Wood, was professor of materia medica at Pennsylvania from 1835 until 1850, and professor of the theory and practise of medicine until 1860, when he resigned. Dr. Horatio Charles Wood, Jr., is professor of pharmacology and therapeutics, having succeeded to one of the chairs held by his father when he retired. He is survived by these children: James L. Wood, Milford, Pa.; Dr. George B. Wood, Dr. Horatio Charles Wood, Jr., and Miss Sarah K. Wood.

Dr. Wood was born in Philadelphia, January 13, 1841, a son of Horatio Curtis and Elizabeth Head Bacon Wood. His first American ancestor, Richard Wood, emigrated from Bristol, England, in 1682, settling first in Philadelphia and afterwards in New Jersey. Horatio C. Wood was educated at Westtown School and Friends' Select School, and was graduated from the medical department of the University of Pennsylvania in 1862.

In his youth he developed a fondness for natural history and before studying medicine became a worker in the Academy of Natural Sciences, distinguishing himself by his original work. After spending several years in hospitals, Dr. Wood began private practise in 1865, making a specialty of therapeutics and materia medica, meanwhile continuing his natural history studies and publishing numerous papers on this branch of science, especially cell botany. In his early life Dr. Wood also was a student of entomology and published thirteen original memoirs upon the subject. He abandoned these studies after 1873 and devoted his whole attention to medicine.

He was appointed professor of botany in 1866 in the auxiliary faculty of medicine in the university which had been established and endowed by his uncle, Dr. George B. Wood, and held this position ten years. He also made a special study of nervous diseases and upon the organization of the University Hospital in 1874 was appointed clinical lecturer, becoming professor in 1875 and retaining this chair until 1901. He also was professor of materia medica and therapeutics from 1875 until he retired.

Dr. Wood was the author of numerous medical and scientific works including "Thermic Fever or Sunstroke," 1872; "Materia Medica and Therapeutics," 1874; "Brain Work and Overwork," 1880; and "Nervous Diseases and their Diagnosis," 1874. In cooperation with Professors Bennington and Sadtler he revised the United States Dispensatory.

Lafayette College conferred upon him the degree A.M., in 1881 and LL.D. in 1883. He received the degree LL.D. from Yale in 1889 and from the University of Pennsylvania in 1904. He was a member of many learned societies including the National Academy of Sciences, was president of the American Pharmacopœial convention from 1890 until 1910, and was president of the College of Physicians in 1902 and 1903.

SCIENTIFIC EVENTS

WATER-POWER AND DARTMOOR

As similar problems must frequently be solved in the United States, the following may be quoted from *Nature:*

The proposal to develop electrical energy from water-power on Dartmoor has led to a strong protest against interference with the amenity of the moor as appreciated by the lovers of solitary places. Mr. Eden Phillpotts first directed attention to the matter by a letter in the *Times* of December 10, in which he called on the Duchy of Cornwall, the landlords of Dartmoor, to act quickly "and help to create a body of Parliamentary opinion; otherwise the destructive and ill-considered enterprise may receive sanction from an indifferent House of Commons next session." A Plymouth correspondent supplied to the *Times* of December 23 an account of the scope of the proposed scheme, and on later days other writers expressed their strong disapproval of the project from local, engineering, or esthetic points of view.

The scheme of the Dartmoor and District Hydro-electric Supply Company is briefly to utilize the great rainfall and high altitude of Dartmoor in the generation of electricity at several power stations situated on different streams, to convey the current to the neighboring towns and villages for ordinary municipal purposes, and possibly to erect industrial establishments where current might be used for electrolytic or power purposes. It is claimed that this work will furnish needed employment for the population of the district, provide a continuous and economical supply of electricity for lighting, traction and heating, reduce the congestion of railway traffic by diminishing the demand for coal, and generally increase prosperity and confer public benefits more than sufficient to counterbalance any interference with agriculture, fishing rights, or the pleasure of visitors to the Moor.

The general, and especially the local, public is not qualified to weigh the rival claims, and as things now stand Parliament must proceed by the old, cumbrous, and very costly method of hearing eloquent advocates and technical experts on all the points raised.

At present the whole question of the water resources, and especially of the water-power of the British Isles is being investigated by a committee of the Board of Trade, and on this account Parliament may be inclined to postpone the consideration of private bills dealing with water, if not of special urgency, until the committee has reported. There are few areas in England where an unused gathering-ground exists at an altitude allowing of the development of water-power, and it may well be considered inexpedient to allocate them finally before a hydrometric survey has been carried out to enable the available power and its cost to be calculated on a sure basis before work is commenced.

MEDICAL EDUCATION

The Council on Medical Education of the American Medical Association, the Association of American Medical Colleges and the Federation of State Medical Boards of the United States will hold a congress on medical education and licensure at Chicago on March 1, 2 and 3. The program is as follows:

MONDAY, MARCH 1, 1920

Morning Session, 9:30 A.M.

Introductory Remarks by Dr. Arthur Dean Bevan, chairman of the Council on Medical Education, Chicago.

Dr. George Blumer, president of the Association of American Medical Colleges, New Haven, Conn.

Dr. David A. Strickler, president of the Federation of State Medical Boards, Denver, Colo.

"Present status of medical education," Dr. N. P. Colwell, secretary of the Council on Medical Education, Chicago.

Symposium on "The needs and future of medical education," Dr. George E. Vincent, president of the Rockefeller Foundation, New York City.

Dr. Ray Lyman Wilbur, president of Leland Stanford University, Stanford University, Calif.

Dr. Henry S. Pritchett, president, Carnegie Foundation for the Advancement of Teaching, New York City.

Dr. Harry Pratt Judson, president, University of Chicago, Chicago.

Mr. Abraham Flexner, secretary of the General Education Board, New York City.

Monday Afternoon, 2 P.M.

"The larger function of state university medical schools," Dr. Walter A. Jessup, president of the State University of Iowa, Iowa City.

"Full-time teachers in clinical departments," Dr. William Darrach, dean of Columbia University College of Physicians and Surgeons, New York City.

"Research in medical schools, laboratory departments," Dr. Oskar Klotz, professor of pathology, University of Pittsburgh School of Medicine, Pittsburgh.

"Research in medical schools, clinical departments," Dr. G. Canby Robinson, dean, Washington University School of Medicine, St. Louis.

TUESDAY, MARCH 2, 1920

Morning Session, 9:30 A.M.

"Graduate medical instruction in the United States," Dr. Louis B. Wilson, Mayo Clinic, Rochester, Minn.

"Interallied medical relations; qualifying examinations, licensure, examinations, graduate medical instruction," Dr. Walter L. Bierring, secretary of the Federation of State Medical Boards, Des Moines.

"Essential improvements in state medical licensure," Dr. John M. Baldy, president of the Pennsylvania Bureau of Medical Education and Licensure, Philadelphia.

"Interstate relations in medical licensure," Francis W. Shepardson, director of the Department of Education and Registration of the State of Illinois, Springfield.

Tuesday Afternoon, 2 P.M.

Reports on Medical Teaching from the Committee on Medical Pedagogy of the Association of American Medical Colleges.

Remarks by the chairman, Dr. W. S. Carter, dean, University of Texas, department of medicine, Galveston.

Anatomy: Dr. Charles R. Bardeen, dean, University of Wisconsin Medical School, Madison.

Histology and embryology: Dr. F. C. Waite, secretary, Western Reserve University School of Medicine, Cleveland.

Physiology: Dr. E. P. Lyon, dean, University of Minnesota Medical School, Minneapolis.

Biological chemistry: Dr. Otto Folin, professor of biological chemistry, medical school of Harvard University, Boston.

WEDNESDAY, MARCH 3, 1920

Morning Session, 9:30 A.M.

Pharmacology: Dr. C. W. Edmunds, assistant dean, University of Michigan Medical School, Ann Arbor.

Pathology: Dr. James Ewing, professor of pathology, Cornell University Medical School, New York City.

Bacteriology and parasitology: Dr. A. I. Kendall, dean, Northwestern University Medical School, Chicago.

Public health and preventive medicine: Dr. Victor C. Vaughan, dean, University of Michigan Medical School, Ann Arbor.

Wednesday Afternoon, 2 P.M.

Separate business meetings will be held by the Association of American Medical Colleges and the Federation of State Medical Boards.

SCIENTIFIC LECTURES

THE faculty of medicine of Harvard University offers a course of free public lectures, given at the medical school, Longwood Avenue, Boston, on Sunday afternoons, beginning February 1 and ending March 28, 1920. The lectures begin at four o'clock and the doors will be closed at five minutes past the hour. No tickets are required.

February 1. Child welfare. Dr. Richard M. Smith.

February 8. Smallpox and vaccination. Dr. Edwin H. Place.

February 15. Protection against infection in diseases other than smallpox. Dr. Harold C. Ernst.

February 22. Diseases of the teeth in relation to systematic disturbances. Dr. Kurt H. Thoma.

February 29. Pneumonia. Dr. Frederick T. Lord.

March 7. Some aspects of alcohol. Dr. Percy G. Stiles.

March 14. New conceptions of the structure of matter. Dr. William T. Bovie.

March 21. Health and industry. Dr. Cecil K. Drinker.

March 28. Some points of interest to the public in regard to medical education as brought out by the recent war. Dr. Channing Frothingham.

The trustees of the Ropes Memorial announce that the eighth course of lectures on botany is being given in the trustees' room at the Ropes Mansion, 318 Essex Street, Salem, Mass., by Professor M. L. Fernald, of Harvard University, on Thursday afternoons, at 4.15 o'clock, the subject being The Geographic Origin of the Flora of Northeastern America. The lectures are:

January 15. The maritime flora: the flowering plants of sea-margin salt marsh tidal estuaries and strands.

January 22. The coastal plain flora: the plants of sand hills; of Cape Cod; of eastern Newfoundland.

January 29. The deciduous forests: the Alleghenian flora and its history.

February 5. The Canadian forests: similarities and variations of circumpolar forest plants.

February 12. The actic-alpine flora: the contrasting ranges of the floras of the granitic, limestone and serpentine mountains of northern New England, Quebec and Newfoundland.

February 19. The cosmopolitan flora of the future.

The objects of the course are to present in brief outline the more striking features in the history of the floras of the northern hemisphere—their antiquity, probable migrations and wholesale extinctions in geological time; and to make clear why, unless the more sensitive and easily exterminated of our wild flowers are intelligently safeguarded, they are doomed to early extinction.

THE ILLINOIS ACADEMY OF SCIENCES

THE thirteenth annual meeting of the Illinois State Academy of Science will be held at Danville. The preliminary program is as follows:

FRIDAY, FEBRUARY 20

11 A.M. Business session. Reports of officers and committees.

2 P.M. General scientific session for the reading of papers.

5:30 P.M. Delegates and citizens assemble at Elks' Hall.

6 P.M. Academy banquet.

8:15 P.M. Public session of the academy in the Washington school and auditorium. Address by the president, "Alaska and its Riches." (Illustrated by lantern.)

9:30 P.M. Informal reception.

SATURDAY, FEBRUARY 21

9 A.M. General scientific session for the reading of papers.

1:30 P.M. Business session. Election of officers.

The Indiana Academy of Science has been invited to participate and will send a number of delegates as well as contribute to the program. The South American expedition conducted jointly by the University of Indiana and the University of Illinois will be discussed by the director, Dean C. H. Eigenmann, of the University of Indiana.

Amendments to the constitution providing for the affiliation of the academy with the American Association for the Advancement of Science and creating two classes of members, viz., national members and local members, have been unanimously accepted and will come up for final adoption.

GIFT OF THE CARNEGIE CORPORATION TO THE NATIONAL ACADEMY OF SCIENCES AND THE NATIONAL RESEARCH COUNCIL

The Carnegie Corporation of New York has announced its purpose to give $5,000,000 for the use of the National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organizations. The remainder will be placed in the hands of the academy, which enjoys a federal charter, to be used as a permanent endowment for the National Research Council. In announcing this gift the report from the council says:

This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry.

The council is a democratic organization based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent divisions. It is not supported or controlled by the government, differing in this respect from other similar organizations established since the beginning of the war in England, Italy, Japan, Canada and Australia. It intends, if possible to achieve in a democracy and by democratic methods the great scientific results which the Germans achieved by autocratic methods in an autocracy while avoiding the obnoxious features of the autocratic régime.

The council was organized in 1916 as a measure of national preparedness and its efforts during the war were mostly confined to assisting the government in the solution of pressing war-time problems involving scientific investigation. Reorganized since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science. The war afforded a convincing demonstration of the dependence of modern nations upon scientific achievement, and nothing is more certain than that the United States will ultimately fall behind in its competition with the other great peoples of the world unless there be persistent and energetic effort expended to foster scientific discovery.

SCIENTIFIC NOTES AND NEWS

Dr. Burton E. Livingston has been elected permanent secretary of the American Association for the Advancement of Science, to succeed Dr. L. O. Howard, elected president of the asociation. Dr. Livingston will retain the professorship of plant physiology at the Johns Hopkins University, and the office of the association will remain at the Smithsonian Institution.

Dr. W. A. Noyes, head of the department of chemistry of the University of Illinois, has been elected president of the American Chemical Society.

At the Cincinnati meeting of the Federation of Societies for Experimental Biology, presidents of the constituent societies were elected as follows: The American Physiological Society, Professor Warren P. Lombard, of the University of Michigan (reelected); the American Bio-chemical Society, Professor Stanley J. Benedict, of Cornell University;

the Society for Experimental Pathology, Dr. William H. Park, of New York City; the American Pharmacologists' Society, Professor Arthur S. Loevenhart, of the University of Wisconsin.

The presentation of the Perkin Medal to Professor-emeritus Charles F. Chandler, of Columbia University, by Professor Marston T. Bogert, of Columbia University, took place at the meeting of the Society of Chemical Industry, at the Chemists' Club, New York City, on January 16.

At a meeting held on December 1, Professor Thomas B. Osborne, of the Connecticut Agricultural Experiment Station, was elected an associate member of the Société Royale des Sciences Médicales et Naturelles de Bruxelles.

The prize of $100 offered in 1914 for the best paper on the availability of Pearson's formulæ for psychophysics, to be judged by an international committee consisting of Professors W. Brown, E. B. Titchener and F. M. Urban, has been awarded to Dr. Godfrey H. Thomson, of Armstrong College, Newcastle-upon-Tyne, for an essay entitled "On the Application of Pearson's Methods of Curve-Fitting to the Problems of Psychophysics."

At its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations: to Professor Frederick A. Saunders, of the Jefferson Physical Laboratory, one hundred and fifty dollars in addition to a former appropriation in aid of his research on Spectral Lines; to Professor David L. Webster, of the Massachusetts Institute of Technology, three hundred and fifty dollars in addition to a previous appropriation in aid of his research on X-ray spectra.

Mr. Elmer D. Merrill, who has been in charge of botanical work for the Philippine government since 1902, has been appointed director of the Bureau of Science. In addition to his duties as botanist, Bureau of Science, Mr. Merrill was chief of the department of botany, University of the Philippines, from 1912 to 1919, first as associate professor, later as professor of botany. In March, 1919, he resigned from the university in order to devote his whole time to the botanical interests of the Bureau of Science, was made acting director of the bureau in June, and director in December, 1919.

Dean Charles Fuller Baker, of the college of agriculture, University of the Philippines, takes a year's leave during 1920, because of failing health. He plans to spend a large part of this leave in the higher regions of the Philippines. His address will continue to be Los Baños, Philippine Islands.

Mr. R. S. McBride, engineer-chemist of the National Bureau of Standards, resigned on January 15, to become the engineering representative in Washington, D. C., of McGraw-Hill Company of New York City. His first work will be in connection with certain coal and fuel utilization problems of particular interest to *Coal Age*. His address is Colorado Building, Washington, D. C.

Dr. E. Mead Wilcox has resigned as professor of plant pathology in the University of Nebraska and plant pathologist of the Experiment Station, effective April 1, 1920, to accept the directorship of the Agricultural Experiment Station being established at Santo Domingo in the Dominican Republic.

Dr. W. S. Gorton has resigned from the Bureau of Standards, where he has been engaged in work on potential-transformer testing and automotive engine ignition, to accept a research position with the Western Electric Company in New York City.

W. Armstrong Price, paleontologist of the West Virginia Geological Survey, is spending the winter months at Johns Hopkins University, where he is carrying on his work on West Virginia fossils through the courtesy of the geological department of the university.

The list of British new year honors, as reported in *Nature*, includes Sir Bertrand Dawson, physician in ordinary to the king, and dean of the medical faculty of the University of London, to a peerage. Among the new knights are Professor Arthur Schuster; Dr. E. A. Wallis Budge, keeper of Egyptian and

Assyrian antiquities, British Museum; Colonel W. A. Churchman, ministry of munitions explosives department; Dr. J. Court, known by his researches on diseases of miners; Mr. F. C. Danson, chairman of the Liverpool School of Tropical Medicine; Mr. D. E. Hutchins, for his services to forestry; Mr. James Kemnal, for public services in connection with the manufacture of munitions; Mr. F. S. Lister, research bacteriologist, South African Institute for Medical Research; Mr. H. J. Mackinder, M.P., and Dr. F. G. Ogilvie, director of the Science Museum, South Kensington. Professor S. J. Chapman, joint permanent secretary, Board of Trade, and Sir Richard Glazebrook, have been promoted from C.B. to K.C.B. Dr. G. R. Parkin has been promoted to the rank of K.C.M.G., and Mr. H. N. Thompson, chief conservator of forests, Nigeria, has received the honor of C.M.G.

Professor Banti, of Florence, Dr. Van Ermengem, of Ghent, and Dr. Pawinski, of Warsaw, have been elected correspondents of the Paris Academy of Medicine.

Officers of the American Philosophical Society for 1902 have been elected as follows: *President,* William B. Scott; *Vice-presidents,* George Ellery Hale, Arthur A. Noyes, Hampton L. Carson; *Secretaries,* I. Minis Hays, Arthur W. Goodspeed, Harry F. Keller, John A. Miller; *Curators,* William P. Wilson, Leslie W. Miller, Henry H. Donaldson; *Treasurer,* Henry La Barre Jayne.

Officers of the Brooklyn Entomological Society for the year 1920 have been elected as follows:

President: W. T. Davis.

Vice-president: J. R. de la Torre-Bueno.

Treasurer: Rowland F. McElvare.

Recording and Corresponding Secretary: Dr. J. Bequaert.

Librarian: A. C. Weeks.

Curator: Geo. Franck.

Publication Committee: J. R. de la Torre-Bueno, editor, Geo. P. Engelhardt, Dr. J. Bequaert.

Delegate to Council of New York Academy of Sciences: Howard Notman.

Dr. Louis A. Bauer gave an illustrated lecture on "The solar eclipse of May 29, 1919, and the Einstein effect," at Brown University, under the auspices of the Sigma Xi, on January 15. He repeated the lecture at Columbia University, Friday afternoon, January 16. On Friday evening, February 6, he has been invited to address the American Philosophical Society in Philadelphia at the stated meeting, on "Observations in Liberia and elsewhere of the total solar eclipse of May 29, 1919, and their bearing on the Einstein theory." The address will be illustrated by lantern slides of all expeditions showing the fully developed solar corona and remarkable prominences, as well as the deflected star images.

At a meeting of the Society of Medical History of Chicago on January 17, addresses were made by Colonel Casey A. Wood, on "Walter Bailey, the first writer of an Ophthalmic Treatise in English," and by Lieutenant-Colonel Fielding H. Garrison, on "Medical Men and Music," and "Remarks on the Medical History of the War."

Professor George M. Stratton, of the University of California, is giving a series of lectures in San Francisco, during January and February on psychology and health.

UNIVERSITY AND EDUCATIONAL NEWS

The Massachusetts Institute of Technology will be administered by a special committee composed of three members of the faculty, the corporation having decided that it is not advisable to name an acting president in succession to the late Dr. Richard C. Maclaurin. This administrative committee will be composed of Dr. Henry P. Talbot, chairman of the faculty and head of the department of chemistry; Professor Edward P. Miller, head of the department of mechanical engineering, and Dr. William H. Walker, director of the newly instituted division of industrial cooperation and research. Frederick P. Fish, senior member, has been elected chairman of the executive committee of the corporation and a subcommittee, consisting of Everett Morse, Francis R. Hart and Edwin S. Webster, has been chosen to keep in touch with the affairs of the institute and to cooperate with the faculty and officers of administration.

AT the University of California Dr. John C. Merriam, professor of paleontology and historical geology, has been appointed dean of the faculties, and Dr. A. C. Leuschner, professor of astronomy and director of the Students' Observatory, dean of the Graduate Division.

DR. JOHN M. T. FINNEY, associate professor of surgery in the Johns Hopkins Medical School, has been invited to accept the chair of surgery at Harvard University, his alma mater.

DR. HOMER L. DODGE, formerly assistant professor of physics at the State University of Iowa, is now professor and head of the department of physics at the University of Oklahoma, Norman, Okla. He has also been appointed director of the State Bureau of Standards.

MISS CATHERINE BEEKLEY has been appointed as instructor of zoology at the University of Oregon to temporarily fill the place left by Dr. C. H. Edmondson, who has resigned to take up work in the University of Hawaii.

DR. ROGER C. SMITH, of the United States Bureau of Entomology, has resigned to accept the position of assistant professor of entomology in the Kansas State Agricultural College.

DR. W. H. BROWN, formerly associate professor of botany in the University of the Philippines, has been promoted to the full professorship and chief of the department, Mr. Elmer D. Merrill having resigned to utilize his whole time in the interests of the Bureau of Science.

MR. HAROLD BOYD SIFTON, of the Seed Laboratory of the Department of Agriculture, Ottawa, has resigned to accept a position in the botanical laboratories of the University of Toronto.

DISCUSSION AND CORRESPONDENCE

OFFICIAL FIELD CROP INSPECTION

IN a recent number of SCIENCE Professor H. L. Bolley, in an article on this subject, has pointed out that until we have control of seed grain production we will continue to have mixed varieties and the best ones will continue to be lost through carelessness. Bad weeds and diseases will be spread with the seeds.

He states that "the work of each cereal crop improver and public educator on breeding dies with him," and mentions Wellman, Haynes and Saunders as examples. "Seed improvement must last through the life of many men and for this there must be plans based on established law."

I am glad to state that crop improvement associations are springing up in many states. Michigan and Wisconsin have each had an association for about ten years. During the summer (1919) there was a meeting of crop improvement association men at St. Paul, Minn. The states of Michigan, Wisconsin, Minnesota, North Dakota, South Dakota and Kansas had representatives at the meeting, showing that those states were active. Besides this we know that Ohio, Indiana, Illinois, Iowa, Nebraska and Colorado are thinking strongly of organizing crop improvement associations.

Professor Bolley, it seems, does not believe in "cooperative breeders associations." A state-controlled seed inspection under the direction of the agricultural college such as Professor Bolley advocates, will in most cases be preceded by a cooperative seed growers association. It is possible that the North Dakota work is not done by an association, as the North Dakota representatives at the St. Paul meeting were interested in alfalfa seed only, and the pedigreed seed was all sent to Fargo for recleaning. This can't be done when a state is to be supplied with pedigreed seed.

Wisconsin was the first to organize one of these associations, and now they have state aid. Most of us have not reached the stage where the lawmakers have recognized the value of a supply of pure seed, representing the highest yielding pedigreed varieties. Each of the crop improvement associations is fostered by the agricultural college of its state but can not be an organic part of any agricultural college because the crop improvement associations are producing and selling associations.

First, before one of these associations can work, some plant breeder must have spent years purifying old varieties, or breeding up new ones. In either case the varieties to be tested must have originated from a single selected plant where thousands are usually selected and tested. The work of variety testing may continue for several years, and usually does, before a superior variety is located. The next stage is to try the new variety in various parts of the state. If it is generally found superior to local varieties it is time for an association to begin.

Thus before a crop improvement association can work, a superior variety must exist. It may have been produced in the same or another state but must have been found superior by local testing.

To distribute a new variety in small quantities without control, always means that farmers lose it by allowing it to be mixed with local varieties. The agricultural college can, with the aid of county agricultural agents, see to it that a new variety is kept pure until it leaves the farm where it is being increased. But if the grower is to continue to produce pedigreed seed and any considerable number of growers are to be interested, the producer must be able to obtain a higher price for this seed than is paid in the open market. He has seen to it that the land was free from other grains and noxious weeds. He has treated his grain for smut. He has cleaned his drill. He has pulled weeds and gone to considerable extra expense. All this trouble must be paid for. It is true that farmers are glad to grow a high-producing grain, that they may produce more bushels. They are also willing to grow a grain of higher quality if they can obtain a better price. But, as a rule, they are not willing to produce seed for other folks without a profit. They are business men not philanthropists.

To find a market for the new seed grain, there has to be a selling agency of some kind. This agency is taking the form of a crop improvement association. This is a farmers organization in every state where the movement has gone far enough to be of substantial value to the state. Usually the extension specialist in farm crops is the controlling agent. He is often the secretary of the association but not as an officer of the agricultural college. In Michigan he sees to it that the fields of grain are inspected while in head and before harvest. The farmer whose field passes inspection also submits a recleaned sample of the grain to the secretary. If his grain is acceptable the grower receives the shipping tags of the association. The grower certifies on the shipping tag that the seed conforms to the state seed laws and to the sample submitted to the association for inspection. Also if these points are not found true he agrees to refund the purchase price.

To illustrate how pedigreed grains can be taken care of, let me mention some Michigan experience. A bushel of Rosen Rye was sent to Mr. Carlton Horton at Albion in 1912. We now estimate there were 400,000 acres of Rosen Rye in Michigan in 1919. A peck of Red Rock wheat was sown by Mr. John Odell on a half of his garden patch in 1913. Mr. Odell lives about seven miles south of Allegan in Trowbridge Township. He grew 7½ bushels of Red Rock in 1914 and sowed seven acres. He had this seed for sale in 1915, but could not have interested his neighbors if it had not been for the county agricultural agent, the miller and the banker, nor could this seed have continued to be kept pure and sold for seed had it not been for the Michigan Crop Improvement Association. However, I personally inspected over three hundred acres in 1917 that contained less 1 per cent. of other varieties and almost no weeds. All this came from the peck of Red Rock sent to Mr. Odell four years before. In 1919 there were about 60,000 acres of Red Rock in Michigan. Several others of our breeding products have likewise been taken care of.

Frank A. Spragg

Plant Breeder,
Michigan Agricultural College

SCIENCE AND POLITICS

At the St. Louis meeting of the American Association for the Advancement of Science, the council passed the following resolution:

> That sectional officers avoid placing on their programs papers relating to acute political questions on which public opinion is divided.

I know nothing of the circumstances leading to this resolution. If papers offered to the sections were inspired by partisan politics rather than by science, they would deserve condemnation and exclusion. But the resolution does not refer to such papers; it implies that scientific men should not discuss matters relating to acute political questions on which public opinion is divided. To one who believes that in the present chaos of conflicting opinions and purposes the finger of science should point the way to safety, this seems almost incredibly stupid. I am of course aware that a scientific man who tries to throw the light of truth on the field of political discussion is not unlikely to be abused for his pains. He may find honest people doubting his integrity or his intelligence. He himself is only too well aware of his liability to error. But in the face of all this, he must and should persevere, knowing well that his feet are set upon the path of progress.

T. D. A. Cockerell
University of Colorado,
January 14, 1920

QUOTATIONS

THE DUES OF THE AMERICAN ASSOCIATION AND THE SALARIES OF SCIENTIFIC MEN

The revised constitution of the American Association for the Advancement of Science, as presented at the Baltimore meeting, was adopted at St. Louis with only one substantial change—an increase of the annual dues to five dollars. This change had been recommended, after careful consideration, by the committee on policy and the council and was adopted by unanimous vote at the opening general session of the association. The increase in the dues only meets the general situation. All the expenses of the association have increased in some such proportion, except the salaries of the officers, and it would be unfair to them and a bad example to other institutions, to retain nominal salaries paid in depreciated dollars. This has been done in the case of teachers in many institutions of learning and for scientific men in the service of the government, while commensurate with the increased cost of living have been the increases in wages for many of the working classes, and of the earnings of most professional and business men.

Institutions of learning and the scientific bureaus of the government have suffered alarming losses from their staffs. At the present time many men of science are hesitating between loyalty to their institutions and research work, on the one hand, and duty to their families and the attraction of new opportunities, on the other. In one government bureau three men are now holding open offers of twenty to thirty thousand dollars a year to see whether the Congress will increase their salaries to six or eight thousand.

If men are driven away from positions where they are using their ability and their training for the general good, and if those who remain are compelled to use time that should be devoted to research or teaching to earning money from outside sources, the future of science and with it the welfare of the nation will be jeopardized. A generation might pass before there would be recovery from the resulting demoralization. It would be indeed humiliating to conquer Germany in war and then permit it to surpass us in the arts of peace.

It is certainly unfortunate that the American Association should be compelled to increase its dues, as measured in dollars, at a time when all costs are advancing to such an extent that those living on fixed salaries find it extremely difficult to make both ends meet. It would, however, be a still more serious misfortune to permit the work of the association and its publications to be crippled. These are important factors in the advancement of science and in impressing on the general public the place of science in modern civilization and the need of maintaining research work for the national welfare.

The meetings of the association and the

publications going to its members and read by a wide public are forces making for appreciation of the value of science to society and the need of giving adequate support to scientific research and to scientific men. Each member of the association contributes to this end and does his part to improve the situation for others as well as for himself. It is consequently to be hoped that no one will permit his membership to lapse on account of the necessary increase in nominal dues, but, on the contrary, that every member use all possible efforts to increase the membership of the association and to promote its influence and its usefulness.—*The Scientific Monthly.*

SCIENTIFIC BOOKS

The System of the Sciences; Principles of the Theory of Education. By Wilhelm Ostwald. The Rice Institute Pamphlet, Vol. II., No. 3, Nov., 1915.

These two lectures were prepared to be given at the inauguration of Rice Institute but the author was prevented from delivering them in person by the outbreak of the Great War. The purpose of the lectures is ambitious, being no less than to propose a fundamental system or classification for the branches of science and, on the basis of this system, to suggest a system of pedagogy which should replace, in some measure, our present system. The subjects now taught, in our universities, in particular, have grown up in an irregular, hit-or-miss fashion, especially as regards the introduction of new subjects, because "Wherever there is a gifted representative of a new discipline who is an excellent teacher and at the same time scientifically productive, he will be able sooner or later to acquire the means and influence to develop this new discipline into a recognized science." Professor Ostwald wishes to substitute for this accidental development a rational, systematic cultivation of those fields which will be most useful—presumably, though he avoids saying so directly, with the repression and discouragement of the gifted individual who does not properly fall into the scheme which has been laid down. This is scarcely in accord with that "Lehrfreiheit" of which the older Germany was so proud.

The historical method is used, in part, to discover the proper system. "All sciences in the early stages of their development formed one great whole, which, together with all other departments of human activity having to do with mental work and cogitation, was intrusted to the oversight of a single corporation—the priesthood." And so the theological faculty is the oldest—then came law—he might have said, perhaps, the Roman Law, for our modern world—and medicine. All the remaining sciences are united in the fourth, the philosophical faculty. The great technical schools form, practically, a fifth faculty, which is not, however, recognized as such.

The statement on p. 112 that "the pure and abstract sciences grow by degrees out of the applied sciences" seems scarcely consistent with the beginnings of the higher forms of knowledge in the hands of the priesthood. Nor does it agree with the development of science through such great masters as Gallileo, Newton, Boyle and Lavoisier. Applied sciences made very slow progress until men came who were interested to know the secrets of nature rather than to apply their knowledge to practical ends. The same idea is emphasized again on p. 121 in the statement that "all sciences have had their origin in the needs and desires of life." This is a utilitarian point of view which we are scarcely prepared to accept.

The over-emphasis on classical and linguistic studies is traced back to the time of the Renaissance when such studies opened to the world a wealth of material from an old and superior, but half-forgotten civilization. At such a time the exact knowledge of the languages which should bring back the old life and philosophies of the Greeks and Romans was well worth while. But now that we have developed a different and very much better civilization of our own the time devoted to classical studies can not be so well justified. It is possible, however, that the author under-estimates the value of those linguistic studies pursued in his youth that gave to him a power to use language clearly and forcibly which it would have been difficult to acquire in any other way.

In the further discussion of language it is pointed out that the content of words which have grown up in the usual manner, through long use, is often vague. This and other considerations lead the author to advocate the use of an artificial, general language with accurately defined words. Such a point of view overlooks the fact that many of the words of our mother tongue carry in themselves delicate shades of meaning which represent our memory of their use in a great variety of connections. Such words can not be successfully replaced by words of a foreign tongue, still less by the words of an artificial language.

In classifying the sciences the simplest and most general ideas came first. These embrace logic or *relationships,* mathematics, or numbers, order, form and quantity, and the science of time, for which there is no distinctive name. The second division, *energetical sciences.* includes mechanics, physics and chemistry. These use the concepts and principles of the first division while the sciences of the first division are, in an important sense, independent of either of the others. The third division, the *biological sciences,* is divided into physiology, psychology and "culturology."

Thus far the divisions of human knowledge and the pedagogical sequences based upon them may be accepted as useful and there is very much of sound common sense in the discussion. But very many will object to the complete omission of any direct reference to moral and religious education, and to his treatment of the child as merely an "energetical machine" (p. 202). On p. 120 the author says; "We shall renounce in any scientific system the consideration of all supernatural relationships of whatever nature, and, on the other hand, we shall extend our scientific problems to each and every field of human experience." If by "supernatural relationships" is meant some one who interferes occasionally and irregularly and capriciously in human affairs, the large majority of scientific men will agree. But if Professor Ostwald means that there is no "Power not ourselves which makes for righteousness" many of the leaders both in England and in America will dissent most strongly. In remembrance of the bitter controversies of the past, we are wont to be very silent about questions of this kind, but to very many it is simply unthinkable that the orderly universe in which we find ourselves is merely the blind resultant of the interaction of matter and energy without some intelligence which is in and through it all.

Somewhat related to his philosophy is Professor Ostwald's statement (p. 206) of "the most general problem of every human life" as "the attainment of happiness." He recalls his former conclusion that "the most important requisites for happiness are, first, the greatest possible amount of completely transformable free energy, and, secondly, the greatest possible amount of energy transformed voluntarily." It is very interesting to notice the naïveté of the last phrase. Anything done "voluntarily" is either a self-deception or it is in flat contradiction with a materialistic or mechanistic philosophy. But there is no mechanistic philosopher who does not act as though he considers himself, practically, a free agent.

The definition of the conditions of happiness is incomplete in a still more important respect. It overlooks the fact that in matters of happiness "he that saveth his life shall lose it." Happiness is not found best by seeking it *directly.* We condemn and despise the man who makes his own personal happiness or even the personal advantage of his family the supreme object of his life. The great men of the world have risen far above such considerations. The time is coming when the class, or community or nation which considers its own advantage as paramount to that of all others will also be condemned. Indeed, the execration which Germany has brought upon herself from the whole world was chiefly due to her supreme national selfishness. Unfortunately, some of the nations which have condemned her so unsparingly are not free from the same fault.

As so often happens, Professor Ostwald is very much better in his conduct as a man than his philosophy might lead us to expect. In these days of international bitterness and hatred, it is worth while to recall an incident of the St. Louis Congress of Arts and Sciences. Professor van't Hoff gave an address in which he presented a masterful sketch of the historical development of chemistry, especially from the point of view of the atomic and molecular theories. In the course of the address he wrote on the blackboard the names of some of the great leaders in chemistry—such names as Dalton, Dulong and Petit, Pasteur, La Bel, Guldberg and Waage, Curie and others. At the close of the address Professor Bancroft, who was in the chair, called on Professor Ostwald. Those were the days when Ostwald and some others wished to find some way to get on without the atomic theory. He began his talk with a very kindly criticism of the address in which he proposed to substitute "energy" for "atoms" and suggested that at the hands of the Curies atoms had "exploded." Then he picked up a piece of chalk and saying "I have still another correction to make" he wrote in the name of van't Hoff at three different places among the great names on the board and in each case those who were present recognized instantly that van't Hoff, in three widely separated fields, had done work of the same fundamental and far-reaching importance as the work of the other men. It is the kindly, generous spirit shown in this incident which endeared Professor Ostwald to his students and to many others with whom he came in personal contact.

The suggestions with regard to students helping each other with their tasks are novel and striking. "It is considered at present one of the worst offenses for one child to help another solve its task. *Is, then, mutual willingness to help a characteristic so exceedingly general that it must be systematically done away with in school?* Is not, rather, egoism and narrowmindedness a fault under which we suffer severely? I do not hesitate to express the conviction that a considerable amount of this illiberality is imparted to our growing youth in school by the prevalent notions regarding this mutual help and the usual treatment of it." So far, good, and worthy of consideration in our treatment of children and of students. But the corollary is not so good—"others learn at an early age that in their advancement they have need of the assistance of better endowed ones, and, what is the best thing for all of them, they learn subordination and how to work in rank and file"—a picture of a world where some are born to rule and others to be ruled. How different from the democratic ideal, where these same differences still exist and always will exist, but where men should work together, not as superior and subordinate, but each according to his ability, for the common good.

We can not take the space for a more detailed criticism of the addresses. While the author of this review dissents most earnestly from a part of the philosophy which lies at the foundation of the papers, there is very much in them which is sound and worthy of most careful study.

William A. Noyes

SPECIAL ARTICLES

DROUGHT AND THE ROOT-SYSTEM OF EUCALYPTUS

In the fall of 1913 the eucalyptus trees, especially the *Eucalyptus globulus* in the Arboretum of Stanford University, were evidently dying. Various persons questioned the members of the Department of Botany here as to the reason for the grave appearance of these large trees and none of us was able to give an answer satisfying to himself. For this reason we undertook to determine the cause of the trouble.

By permission of the business office we tapped various trees with an auger to the heart and found that the wood and bark were entirely free from disease of any sort. The trouble manifested itself in the change of color of the foliage, the leaves turning brown as if burned or killed by frost, and drying out and presently beginning to fall. The leaves which fell showed no sign of fungus or bacterial infection. We were therefore forced to conclude that the trouble was further down and we were compelled by the condition of the trunk to suspect that the difficulty was either between the trunk and the leaves or below ground. As we had no convenient means of climbing the trees to make any examination of the branches, we concluded to look at the roots first.

By laying bare the more superficial part of the root system with pick and shovel, we found that the large superficial roots had been broken through at various distances from the trunk by the heavy plows which, up to that time, had been used in the spring, for a number of years, to clear the ground under the trees of weeds. The deep ploughing had resulted in the serious injury, the wounding or amputation, of all the roots to a distance of twelve or fourteen inches below the surface. In this way the roots, absorbing moisture from the upper layers of the soil, were either very seriously limited, or absolutely destroyed, as regards their capacity for absorbing water; and the soil water supply of these trees came therefore through the taproot or its deeper branches and from the branches running vertically downward from the underside of the uninjured lateral roots, from distances below the surface, of which we have no means of knowing anything. Whether one half or what other proportion of the absorbing surface of the root was thus destroyed we also have no means of knowing. The condition of the roots led us to suspect that this might be the cause of the condition, deplorable in appearance, of the blue gum trees throughout the Arboretum.

We were confirmed in this suspicion by examining the root system of the Monterey cypress (*Cupressus macrocarpa*) tree growing close to the big eucalyptus tree previously examined. We were interested to find that the horizontal roots of the Monterey cypress grew enough deeper in the soil entirely to escape the heavy plows which had wounded or amputated the roots of the eucalyptus. This Monterey cypress tree presented none of the deplorable features of the eucalyptus trees, for although its foliage was dusty, it was green and far from dying. We therefore concluded that the trouble with the big blue gum trees of our Arboretum was lack of water, due to an impaired root system.

That this suspicion was justified we believe is confirmed by two additional observations. Many of the eucalyptus trees which were evidently dying, as indicated by the brown color of the leaves, were cut down. Those that were cut down early enough, promptly stump sprouted, and have since grown up into promising young trees, borne on the old butts. By thus drastically reducing the evaporating surface, the water absorbed by the roots was conserved and the quantity became immediately adequate to meet the loss. Additional confirmation of our suspicion has been furnished during the last two years.

In the winter of 1917–18 there fell in Palo Alto scarcely more than eight inches of rain. In the following autumn there was no sign of injury among the eucalyptus trees, of which there were still many in the Arboretum. To be sure, many of the larger and finer had been cut five years earlier, but enough were left to show damage if the damage had been present, for the rainfall in the rainy season of 1917–18 was about an inch less than in the fifth year preceding. Furthermore, although the rainfall in Palo Alto in the rainy season of 1918–19 was approximately twenty-three inches, there has been practically no rain since early March until late September; and there is not yet a total of one inch of rain in the immediate vicinity of the Arboretum, though there is no sign of drought among the eucalyptus trees.

The manner of keeping down the weeds in the Arboretum, however, has been changed, since our observation of the injury due to deep ploughing, and the disk harrow or spring tooth harrow are all that are used for cutting down and keeping down the weeds which are necessarily numerous on the floor of an open woods like our Arboretum. The necessity therefore of protecting the superficial parts of the root system, even of a deep-rooted tree like blue gum is perfectly obvious from the foregoing description.

One more conclusion can be drawn from these observations. The Monterey cypress above referred to, was growing at no great distance from the eucalyptus trees but was in no wise impoverished by its more rapidly growing neighbor. There is a general impression, based no doubt on a certain amount of accurate observation, that the eucalyptus is a bad neighbor and that trees, shrubs, and herbaceous plants set too close to eucalyptus trees will suffer for lack of water. The above observation shows that if the plants set near eucalyptus have the habit of sending their roots lower than the superficial part of the root system of the eucalyptus, such results will not follow.

Therefore, it would seem to be possible, notwithstanding general belief to the contrary, to plant trees and shrubs fairly close to eucalyptus providing they can get along with the amount of light which the growing eucalyptus will keep from reaching the surface of the soil. This may make possible the fuller utilization of areas of soil already carrying a certain number of eucalyptus trees.

James McMurphy,
George J. Peirce

Stanford University,
November 1, 1919

THE MATHEMATICAL ASSOCIATION OF AMERICA

The fourth annual meeting of the association was held at Columbia University on Thursday and Friday, January 1 and 2, 1920. A joint dinner with the American Mathematical Society occurred on Wednesday evening. About 150 were in attendance at the various sessions.

The general topic for all sessions was "Mathematics in Relation to the Allied Sciences." The program was as follows:

"Mathematics for the physiologist and physician," Dr. Horatio B. Williams, assistant professor of physiology, College of Physicians and Surgeons.

"The regular solids and the types of crystal symmetry," Dr. Paul L. Saurel, professor of mathematics, College of the City of New York.

"The mathematics of physical chemistry," Professor George B. Pegram, dean of the school of mines, engineering and chemistry, Columbia University.

"The mathematics of biometry," Dr. Lowell J. Reed, associate professor of biometry and vital statistics, Johns Hopkins University.

"An experiment in the conduct of freshman mathematics courses," Dr. F. B. Weley, professor of mathematics, Denison University.

Preliminary report of the National Committee of Mathematical Requirements, Dr. John W. Young, professor of mathematics, Dartmouth College.

"Mathematics for students of physics," Dr. Leigh Page, assistant professor of physics, Yale University.

At the business meeting the election to membership by the council of 73 persons and two institutions was announced. The treasurer's report showed receipts of $4,728 on 1919 business, expenditures (up to December 15, 1919) of $4,317, and an estimated final balance of $2,050 for the end of the year 1919.

The result of the election of officers was as follows:

President: David Eugene Smith, Columbia University.

Vice-presidents: Helen A. Merrill, Wellesley College, and E. J. Wilczynski, University of Chicago.

Additional members of the Council (to serve until January, 1923): R. D. Carmichael, University of Illinois; E. R. Hedrick, University of Missouri; H. E. Slaught, University of Chicago, and J. W. Young, Dartmouth College.

To fill the vacancies caused by the election of Professor Wilczynski to a vice-presidency and the reappointment of Professor Slaught as manager of the *Monthly*, the council appointed as members of the council E. L. Dodd, University of Texas, and Oswald Veblen, Princeton University.

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BOTANICAL ACHIEVEMENT[1]

TWENTY-FIVE years ago The Botanical Society of America imposed on me the task of preparing a presidential address. To-day I meet a similar obligation laid on me by the somewhat more democratized society which continues to bear that name.

For my subject then, I took botanical opportunity—moved, you may say, by the hopefulness of youth which looks forward and plans optimistically. To-day I wish to speak of botanical achievement—moved, you may say, by the observed tendency of age to live in the past. Possibly, later, you may not be sure that in choosing complementary subjects I have not wanted to extract much the same hopeful anticipatory lesson from both.

As one looks back over the past, he sometimes finds it difficult to pick out the significance of individual components of the conglomeration that forms the present superstructure of our science, and its foundations are buried in obscurity. Perhaps the most significant observation that he makes is that a person who is minded to add to it has each year to climb to a greater height before his own work can be commenced—unless he turn his attention to repairing the weaknesses and filling the crevices and pointing-up what has been done by others.

Work of this kind really makes the structure stronger, really keeps it from crumbling at some weak point under the weight that has been added above, and gives it an appearance of finish that must be secured at some time and by some one's labor before it can meet with final approval under critical inspection. Undertaking it may bring to light, even, wholly faulty workmanship or the incorporation of materials that have already begun to

[1] Address of retiring president of the Botanical Society of America, given at the Botanists' dinner, St. Louis, December 31, 1919.

disintegrate, and in this way may lead to replacements at various points and to reenforcement of the very foundations.

In putting up a building, such work is found to delay completion of the enterprise to a surprising extent after it seems to the casual observer to be about finished. Those who do it usually derive their satisfaction as workmen from knowing that they are accomplishing something necessary but which ought always to have been left as they leave it; or their esthetic sense is gratified in the pleasing finish that they give to what they found strong and serviceable but raw; or they know that they are safeguarding the completed structure against the inroads of time: but they do not see it really grow under their hands.

If we understand science to be systematized and formulated knowledge, we may be pardoned for stopping to wonder whether sometimes we may not fail fully to grasp the meaning conveyed by these words. Knowledge in a particular field may appear to be systematized and formulated in itself while it lacks comparable incorporation into the knowledge of other things. It may appear ideally dissociated from useful application: but perhaps it never is so in reality. Segregation of the arts which apply science in the practical affairs of life, perhaps does not really remove the necessity of considering all of these applications in the classification and formulation of that knowledge which science claims as its peculiar field.

The edict of an emperor, the injunction of a priest, the counsel of father to son, in the far-off days when civilization was establishing itself on the Tigris and the Ganges or in China, fails to come within our definition of science. We call such instruction empirical rules. But in doing so we can not fail to recognize that before Aristotle philosophized on the phenomena of life and Theophrastus formulated what he knew of plants—which we call the beginning of the science of botany, men had acquired knowledge in our special field and had classified it obviously to the extent of rejection of what they could not use and of selection of what they made the basis of an agricultural practise which may have been crude and inefficient as measured by the standards of to-day, but which was adequate to their needs and appears very refined in comparison with the earlier dependence for food upon the chase— either on land or water, or gleanings of roots and fruits from the plain, the mountain-side, or the forest. One hesitates, even, to think of these still more primitive practises as carried on independently of a very large amount of knowledge gathered and sifted and winnowed through many preceding generations as men worked their way toward an empirical precursor of what we now agree to call science.

When Liebig, the chemist, disposed of the humus theory of nutrition of ordinary plants he is considered to have been making a contribution to the science of botany. When Gilbert and Lawes in the field, and Winogradsky in the laboratory, put the completing link into the chain of the circulation of nitrogen as an active element, they are considered to have been making the same kind of contribution to the same science. I am wondering if my late and lamented associate Cyril Hopkins, calling himself an agronomist, has been far from the same field of science in teaching farmers in the great corn region of the world how to maintain for their children and their children's children a soil fertility that the first generation of white settlers imperiled, and if the last service of his life—carrying his message to those who now farm the worn-out lands of the Hellespont—must be excluded from the recognition that we accord to the achievements of science. If in considering its achievements I chance now and then to wander too far from standardized or forming definitions of our particular science, I trust that the lapses may be excused as evidence of unclear vision rather than wilful disregard of established boundaries.

The superstructure of botany, broadly defined, looks much the same to the casual observer as it did twenty-five years ago. It has been made more finished in parts, windows have been put in where there were blank walls, some parts have been pointed up or rebuilt, perhaps the gables have begun to take form toward its final closing in; but a snapshot to-day from certain positions looks very like a snapshot taken a quarter-century ago except that what seemed then to be temporary lean-tos are beginning to look as if they belong where we see them or to give unmistakable signs of strengthening as well as amplifying the whole.

Perhaps this is the impression made on the superannuated workmen of a generation ago, and of some of those whose activities have continued from the earlier time up to the present. The idea of many who have come on to the job within the past two decades is very different. Under their own hands they have seen the shaping of the gables and the rising of the wings, and in their eyes these have given to the whole a very different appearance from what it presented when their work began. Indeed, under their guidance, and from viewpoints of their selection, it may scarcely look like the same edifice; and they may even point with pride to a well-finished and symmetrical annex in comparison with ragged parts of the main wall still defaced by temporary scaffolding.

The edifice of our science is less comparable with a modern warehouse like the great supply-base that the army constructed in nine months on the levee at New Orleans, than with a medieval chateau that has been changed from a feudal castle into a modernized home. The first is planned and constructed as a whole, and is consistent throughout. The other has existed through and developed with the centuries until most traces of its original plan—if there ever was one—have become obliterated.

Perhaps in this may be found explanation of an impatience that is manifested sometimes by botanists who do not like to see old symmetry changed, or by others who do not like to see labor wasted on walls that are no longer serviceable or to see these guarded from dismemberment so that their materials may be used for additions. Both kinds of criticism are likely to continue as long as construction continues. It may prove a misfortune for botany if either ceases, because the end of its usefulness will have come if it ever reach a stage in which it can no longer be changed with the changing times; but it will have become a ramshackle unserviceable monument if it ever reach a stage in which it has lost the unification of consistency in its details.

The achievements of botany have been like the achievements of nations in many respects, indeed like human achievements in the aggregate. It is impossible to trace its history without seeing some of the factors which have contributed to or retarded its advancement. Men and incentive have been necessary in the first place, opportunity in the second, and intelligent leadership in the third. Of these, perhaps, it may be said that "the first shall be last, and the last first," without too great deviation from the truth.

Men without leadership, even though they have opportunity and incentive, do not usually accomplish great things: and what unled men have achieved has resulted from their ability to plan for and lead themselves. They have been pioneers whose restless spirit has led them to spy out the land beyond the confines of the known. From the reports or echoes of their experiences has come knowledge that the limits of the knowable lay beyond the limits of the known as they found them; and their individual incursions have been followed ultimately by the invasion of numbers of men under the organization of leaders.

These are the true settlers: their leaders are the apostles of progress. Yet there rarely has been a time when an exodus or a hegira has been complete; and when it has, others less happily circumstanced have found in what was abandoned something to allure them from what they already possessed. Even good leadership, too, may have failed in adequate preliminary knowledge or planning, and more than once the new has proved inferior to the old or has been abandoned under wiser or better-informed guidance, or a generation and more of men have wandered in the wilderness before reaching the promised land; and lesser and transient migrations often have preceded or accompanied a large movement.

The founders of our science were pioneers rather than leaders: men with restless minds, no more satisfied with limitation of their field of action when they could see beyond its arbitrary boundaries than some of us to-day are satisfied with an arbitrary zero-date for the scientific naming of plants when it is evident that scientific nomenclature began in part at a much earlier date.

Without the nature-philosophy of Aristotle there would have been no starting point for the systematization of Theophrastus. Yet without centuries of knowledge accumulated through human experience there would have been no background for either. They were the men who through systematization and coordination made the known understood, and thus opened knowable paths into what for them was the unknown.

It was a little incursion led, after a thousand and more years of mental vegetation, by a few nature-loving men of the Rhineland across the old boundaries. Though their day was that of revolt against theologically restricted thought, these resurrectors of a buried but not yet dead science were free-thinkers rather than protestants when they turned from canonized books to a real examination of nature. They were few in number and at first isolated in action; their excursions did not lead them far from home, but they were joined early by others, and their spirit found an instant echo in the sunny south. Instead of remaining explorers they became leaders of little bands whose small advances and retreats cleared the way for advance after advance of the usually better organized and at times better led army of searchers after the truth who in due time became known as botanists.

Small wonder if this growing army saw its legitimate opportunity less comprehensively and less clearly than we see it nearly five hundred years after the movement started! Without such pioneers, the science of botany might have remained to this day within the bounds that Theophrastus found to encompass it over two thousand years ago. Without other, later, even more venturesome pioneers, what they saw in it might remain to us as its present content.

Back of their activities was the incentive that underlay these, the unquenchable human thirst for knowledge. Through the following centuries this has operated side by side with the equally ineradicable human instinct for leaving well enough alone; and men have progressed dominated and restrained by the massive inertia of conservatism, but breaking free every now and then for a trial of the individual inertia of motion, much as a molecule of evaporating water passes off into freedom—ultimately to be lost in space, to enter into a new cycle, or to return to the bondage from which it made its escape, with far-reaching derangement in any case of the stability of what it left behind or joined.

Effort, when really effective, is purposeful. When the microscope provided means of seeing clearly what living beings consist of, it was not Hooke, who first published its revelations, but Malpighi and Grew, who shortly afterward examined the structure of living things with a view to understanding their vital processes, who laid the foundation for a broader science than their predecessors had conceived. They and their followers, in planning and building on the lines that we now recognize from long habit as being those that characterize botany, did not go far from the procedure that has distinguished successful human effort in general, in which a search after the true and the effective has shaped itself usually into a quest for proof or disproof of some theory of what is true or effective.

Without the guiding line of philosophy, the search might or might not have reached its goal. But with it, the result has depended upon adaptation of the means to the end—an adaptation which in our own day and in the last quarter-century has grown with surprising rapidity and extension of the experimental questioning of nature to which science turns with confidence for the solution of those problems that really lie within its field. Beyond that field still lies the realm of metaphysical speculation, which Lewes, half a century ago, protested against calling philosophy because in this sense he felt constrained to call the restless motion of philosophic speculation rotary in contrast with the linear (perhaps one would rather say dendritic) progress of science. The lure of the pioneer lies in the prospect of novel as well as great return. A few years ago some botanists were discussing present-day opportunity in botany, and the opinion was voiced that it lies in the line of large and special equipment opening fields beyond the reach of the ordinary man. This may really be so. Certainly the first men to use the microscope were privileged beyond their fellows: but as we look back on their work they do not shine with a brilliancy corresponding to the greatness of this privilege. Rather, they profited by it to the extent of their knowledge and talent; made much or little progress according to their possession of these personal gifts; and have been surpassed by men who much after their day were impelled and instructed to look deeper and see further with the same instrument.

The optimism which led me twenty-five years ago to see hopeful opportunity for every man inspired by an all-compelling curious interest in nature and natural phenomena leads me still to see hopeful opportunity ahead of every such man—proportioned to his talent and under everyday environment rather than dependent on the special and novel provision which may fall to the lot of a fortunate individual here and there.

Botany, as a science, grew out of the gradually accumulated knowledge of plants acquired through using and cultivating them. The art of applying this knowledge really underlay the science into which it has been organized and formulated, though to-day it rests upon this, which constitutes a firm foundation in agriculture, medicine and the varied fermentation industries. That its scope should broaden, was as inevitable as that the natural horizon should amplify for a man climbing to a hilltop. That the mere selection of suitable subjects for microscopic study should result in closer observation of all that was looked at was equally natural. That Van Helmont's demonstration that plants are not built up out of earth should have preceded a separate analysis of all possible sources of their substance is self-evident. But discovery of the large part that the atmosphere plays in this organic synthesis, of the marvelous organism that a vegetable cell proves to be, and of the part played in heredity by some of the parts of this unit organism of organisms, is seen to have resulted more from the intelligent ingenious use of means at hand than from restricted privilege.

If one were to lapse into momentary pessimism in an optimistic review, the slip would come from recognition of the instinctive conservatism that inclines most of us to see only a form of some well known plant in a specimen that the inspired discoverer knows and even describes as hitherto unknown; or that leads us to ignore as "dirt" or artefacts the seemingly uncharacteristic parts of our preparations—as Löhnis believes that the most eminent bacteriologists have done; or that leads to a wish that experiments on living things were not so apt to turn out differently from the predicted result. We may destroy puzzling intermediates, throw away disappointing preparations, or exclude unsuccessful experiments from our calculations: but we do not explain them in doing this—we merely evade the truth that they mutely offer for our apprehension. It is the exceptional man who, even if he lay them aside for the time, as Haeckel, in his youth, did the "bad" species of his herbarium, can not rest until he understands them.

This is the true pioneer type, not content with what is believed to be the known nor satisfied with little excursions beyond its border, but boldly, in season and out of season, pushing out into the unknown. Such incursions, guided by the compass of correct methods and starting from the direction of acquired knowledge, have been, are and seem likely to continue to be, the epoch-making first moves in scientific progress.

Men who lead in such progress sometimes set off with general approval and good wishes. They follow the bent of their less enterprising fellows. Even rumors of their achievements are received at par and passed on at a premium. Fortunate, then, for science, if the log of their journey come back for verification, for our average human tendency is to believe what we want to believe, and those of us who do not travel to the pole care for little more than to be told that it has been reached by an enterprising explorer when we confidently expected such an explorer to get there.

Quite as often, the pioneers set off in a direction that is uninteresting to the rest of us. They go and come, and we hear with passing attention if at all what they have been doing.

Sometimes they do a good deal of talking about the inadequacy of what is accepted currently; they are regarded as heretics or at best as destructive critics. We complacently await the calamity that we believe them to court, and are incredulous if not really disappointed when they do not disappear for good but return and ask for an impartial examination of what they claim to have brought back.

Each of these types has been represented over and again in our science, which has profited by the good of each; and in the long run it can not suffer through the bad, because time inexorably eliminates this. But there have been quite enough instances of mistakes and delays and discouragements on the one hand, and of spurts of stimulated effort on the other, following the activities of men blessed with the gift of originality and at the same time favored or hampered by its human concomitant of radicalism or conservatism, of sanguine credulity or of phlegmatic incredulity.

Starting from isolated springs of impulse, progress has settled into a continuous flow of constantly increasing volume and rather fixed direction, over and over again, until a new touch of genius or a new revolt against the established order has opened new channels that have broadened and deepened with the years without causing the main course to run dry.

Sometimes change has come through the talent of coordination, as when Linnæus brought chaos into order in the arrangement of flowering plants, or Saccardo in laboriously assembling the fungi. Sometimes it has come from an attempt to dam the main channel as a means of diverting a part of the flow in a new direction, as when Schleiden fought the systematists. Sometimes broad epitomization has caused the change, as when Sachs revivified the science by giving it coherence as a whole. Sometimes an epoch-making improvement in technique is to be seen, as when Strasburger showed how the most transient inner processes of the dividing cell may be preserved for comparative study extending over months or years. Sometimes a device accurately recording for later study every phase of a passing physiological process has shown what was unseen before. Sometimes, and perhaps more often, the result has been achieved through the purposeful untiring straightforward work of a man possessed at once of the plodding industry of the laborer, the genius of the designer, and the perspicacity of the philosopher: such men were von Mohl, Hofmeister and De Bary.

Whatever its type, work that has left its mark indelibly on the science has been done by men endowed with an infectious enthusiasm. These men may have lived to see their own discoveries set aside as incomplete or even faulty, like Schleiden; or they may have discarded their own forceful convictions, like Sachs; or they may have known that in doing a serviceable work effectively, they were as effectively placing a barrier before the greater work that they foresaw ahead, as did Linnæus when he substituted an artificial key for the real taxonomy that he could not develop. But, however far it may have been from perfection, what these men did appealed to the understanding; what they said obtained a hearing; and, above all, their consuming interest was communicated to others and yet others. They proved leaders as well as workers.

The personnel of botany forms a roster of men sometimes working alone, unstimulated and without following, sometimes founding schools, sometimes following in the footprints of masters. The suggestive thought is that these masters for a considerable part have been self made: that their followers who have become masters have broken for themselves new paths; and that one and all they have been workers fitting their work on to that of others, systematizing all, and enlisting eager hands to do the work that they saw ahead waiting to be done. They may not always have had what we call a proper veneration for the antique, or a good sense of perspective, but they have left their mark on the edifice.

Two somewhat paradoxical if not antithetic achievements in botany stand out conspicuously in the last quarter-century or so: increasing assimilation of the science itself with cognate sciences into the broader science of life—biology; and an increasing tendency for its own members, differentiating into organs, to segregate into offsets and strike root for themselves.

To-day we rarely hear any one talk of the food of plants being inorganic, and that of animals, organic; we hear, rather, of green plants as the food makers of the world. Even the word assimilation has fallen into disuse or become hyphenated as applied to this process. Digestion, metabolism, nutrition, have become subjects of parallel investigation in the two branches into which the tree of life has evolved.

The incipient stage of cell division, with qualitative bipartition in its somatic stages and qualitative segregation in the formation of gametes in all but the very lowermost of protista, has become so largely known as to make it hard to think of any bit of existing protoplasm as other than a fragment of one primordial protoplast, or to think of a protoplast of today as not genetically related to every other protoplast past or present.

The chemico-physical activities of plant and animal no longer claim attention as separate problems; absorption, selection and rejection of material, ionization, diffusion, osmosis—all have become biological rather than zoological or botanical questions, as they pertain to living things; but botanists are doing their full share toward answering them.

That botanical investigation should have demonstrated Mendel's law two generations ago or exhumed it two decades ago, places this discovery among the achievements of botany; but on it has been founded the biological superstructure of genetics—as valued an adjunct of the stockbreeder as of the breeder of plants. That a botanist differentiated between fluctuations and mutations and so simplified the understanding of natural selection has not prevented that differentiation penetrating into every branch of evolutionary investigation.

That toxins became known when the activities of bacteria were studied, has not prevented the student of animal physiology from carrying the same study of excreta into the relations of animal parasites and their hosts, or from developing from it the theory of auto-intoxication. Enzymes, hormones and vitamines—whatever either may be, now lie in the common field of biology, but some of the best work on them is done by botanists.

Out of the harmonies and disharmonies of plants with the manifold kinds of environment that the world offers, has developed a line of ecological observation, experimentation, and speculation that not only has brought the microscopic algæ of the world-plankton into recognition as the first fruits and the foundation of all aquatic life, past and present, but points as unmistakably to the individual birth, adolescence, mature life and senescence of a flora as the experience of agronomy does for a plant or recorded history does for a community of men: it has passed forever from the kodak-census stage.

Incursions into the no-man's-land confronting science are increasingly paralleling the phenomena that ecology deals with. The rapid invasion of an army of men, or a swarm of locusts such as I have seen blackening the sky in Central America, carries its own suggestion of impending conquest or devastation. The trickling of a thin thread of water through the dike, the exploration of a few pioneers or the settling of a few families beyond the front, may escape notice as significant; and the army may be driven back or the grasshoppers stopped by attention to their breeding places. The most-heralded advances sometimes prove the least important, and the humblest, the most significant, in retrospect.

Who but a croaking pessimist would have dreamed that an unknown fungus spore dropped on the Emerald Isle would lead to famine and starvation affecting a large population of men; that a rather uninteresting imperfect fungus added to the local flora of New York would cause the magnificent chestnut forest to disappear from our seaboard; that the cultivation of a water plant would choke the streams of England or render those of Florida unnavigable? The like is going on all of the time without such results, and even the man who knows speaks often to an unhearing audience when he ventures to proclaim that an immigrant can do what the leopard moth has done to the elms of New England or the boll-weevil to the sea-island cotton: but the lesson is being learned, bit by bit, and applied with quite as much zeal as wisdom.

In much this way, science has reached its achievements: sometimes annexing large fields that have proved less profitable than they were advertised to be; sometimes finding itself in possession of most fruitful territory that it did not know it was invading. That the mountains of conquest sometimes prove barren and the drained plains of slow sedimentation sometimes prove of inestimable productivity may well lead us to embark in future on the most lauded enterprise with reasonable caution, and to foster in every wise way the experimental prosecution of even the least obviously promising of minor undertakings.

Among newer lines of botanical activity none stand out with more significant distinctness than those directed toward getting conclusive demonstration of the active causes of organic variation and of organic function through a direct questioning of nature. To such experimentation, the shifting theory and complicated phenomena of physical chemistry are fundamental; to it, the deftest and best controlled manipulation is essential; to it, recognition and successive elimination of the many interwoven conditioning factors are indispensable. From it, the subtle change that converts living into dead matter is not capable of separation.

Biometry, laborious to the last degree, is the scale by which some of its results are to be made evident and coordinated. Biochemistry has taken assured place as one of its most necessary tools. Even the physical intricacies of behavior in colloids that never figure in vital phenomena are being pressed into daily use as furnishing analogies for if not demonstrations of the workings of that substance, protoplasm, which alone lives, alone responds to stimulus in the sense of the physiologist, and alone increases its substance through nutrition.

This entire line of advance is very new: some of its progress is startling: but its final results do not appear to promise to be those of metamorphosis but rather of cumulative mutations, perhaps mostly small. In it, above all other lines of progress, caution, conservatism and avoidance of too free generalization and haste in announcing and applying results appear to be desirable.

It is natural that a science concerning itself with the prime makers of human food—and for that matter of all food, and of the healing agents and poisons of the world, should have gleaned its very first results from the usefulness or noxiousness of the materials of its study, and that its achievements should have acquired great economic importance. Too much stress can not be laid on the fact that this is so, and within reason too much can not be expected from its future activities.

This science works within the bounds of what we still regard as natural law, and will continue to be so limited however these boundaries may be defined and extended. Nevertheless because of its discoveries the unpalatable has been made palatable and the unwholesome made wholesome in food; two blades of grass and two grains of wheat really have been made to grow where but one grew before; it has unraveled the mystery of the epidemic scourges of farm and barnyard, has pointed the way to prophylaxis and breeding of hardier races, and at the worst, has shown where therapy is futile. It certainly will make known and understood the critical periods in crop growth, and enable the agronomist to foster and protect his crops with profit at these periods; and it is not unlikely to enable the man who knows to judge and score the growing crop as the growing herd is judged and scored. It has founded a practise of self-sustaining fertility of the soil, and it points a way to restoration of impoverished soils.

These achievements have not come by leaps and bounds of either discovery or application:

they represent gradual accomplishment in both directions. Nevertheless such practical results have been reached within the memory of men now living—many of them indeed through men now with us. The methods of our science are analytical, its application is educational: both require time, and the applications of its teachings tend to pass its results from the questioning realm of science into the formulated empiricism of an art.

The world stress that we are passing through has caused attention to be turned, as never before, toward science; and science and its methods have received a utilitarian recognition never before accorded them. If botany and its dependent arts have met practical expectation as chemistry and physics and their dependent arts have, its hopeful activities are assured quantitatively and qualitatively for generations to come: if it has shown an inherent lack of the liability of these sciences, in which application is almost synchronous with discovery, an understanding of its slower but none-the-less certain methods will secure for it opportunity for equally honorable and useful future advance; and if we think it has been slow in response we must recognize that like the plants with which it deals it requires a period of tilth and growth between seeding and harvest.

Useful though it may be, until it shall have become a finished work, fit companion for those arts and achievements now kept from oblivion through the kind offices of the museum, it will be a sorry day for this or any other science when its prosecution proves to be dependent upon the evident and immediate usefulness of its discoveries.

When the inspiration of the greatest of modern botanists, Sachs, gave to botany something of the meaning that it now has, its place in the educational world changed. Though biological science from its more complex nature fails to give the promise of unmistakable and predictable answer to experiment that the physical sciences pledge and furnish, it took place quickly and without question as one of the foundation stones of the educational idea which recognizes experimentation and observation as of fundamental value in training the human mind.

Perhaps it was put to this use in the best possible way and for the best possible reasons. Its achievements for two generations show that large results have come because of or despite its incorporation into the curriculum of even the secondary schools: the methods of using it, at any rate, have been largely those believed best calculated to make investigators of the pupils who studied it.

To some people, it has seemed from the first that all who study a science can scarcely be expected to become specialists in it. There is no reason for surprise in the patent fact that few of the myriads of students of botany during the last half-century have become professional botanists: investigators are born rather than manufactured. There may be just ground even for a growing feeling that in its application to education, botany should appear in a different guise and with different accents from the same science as the investigator knows it.

If we are wise and alert who wish to see botany or even biology at large continue—as we all must believe that it should—an element of popular instruction, we must see that in the school it regains that simple understandable everyday relation with everyday life that its vastly simpler precursor possessed; that in the college its more complex present-day relations with life are made part of the equipment of all of those who are to teach it in the schools and to follow it into the university; and that in the university its study is characterized by a breadth of understanding and a scope of vision commensurate with that refined specialization which marks the successful delver after facts.

This is a suggestive gathering. It is a session of The Botanical Society of America, but there are present many members of the Phytopathological Society, of the American Society of Naturalists, of organizations of ecologists and geneticists, of fern students and of moss students. Such organizations are meeting in affiliation with the American Association for the Advancement of Science, and members of the botanical and agricultural sections of that great Association are of our number. Pomologists and men devoting themselves broadly to horticultural science are with us. I should not be surprised if there were present also men who call themselves bacteriologists, foresters, or pharmacognosists, though the immediate affiliation of their special national societies has been shaped otherwise. We are here at the present moment as botanists, viewing botany from the various sides of its many specializations and applications. To-morrow we shall be pressing its subdivisions and segregations intensively in specialized sessions. Let us not forget when we do this that in union lies strength and that in division of labor lies efficiency; nor that efficiency usually reaches its maximum in the connected correlated organs of an organism, each taking and giving for the common good.

I would not urge the tyro among us to become less a cytologist, less a bryologist, less a physiologist, less a bio-chemist, than his greatest inspiration prompts: but I would urge him earnestly to be more a botanist, more a naturalist, more a disciple of a broad science which in strength and effectiveness and symmetry combines all that is good of its many and diversified component parts.

Horticulturists talk of graftage. They know that their art can produce more effective creatures than nature has evolved; but stock as well as scion is selected for its inherent worth, and both are essential to the whole that is built up from them.

The great world upheaval has severed many a scientific union that seemed destined to last interminably. Some of the disjointed parts may never reunite: some unquestionably require careful handling. It appears to be our plain and paramount duty now to see that, if worth it, the parts of the old tree be given a chance to establish themselves anew, either on their own roots or on a better footing—not thinking for a moment that the tree of science is limited in time or space or components, but remembering always the old maxim that the whole is equal to the sum of all its parts and greater than any of its parts.

Out of the world dismemberment has come opportunity for cooperative world reorganization and reconstruction which can be made more effective in science than anything that has preceded it. The opportunity is ours. If we make the most of it, we shall attain the greatest of the achievements of science. Even if we fail, we need not miss the lesson that accomplishment in our field is of necessity never final but proves always to be the opening of new fields, fresher and larger, to those who understand the real nature of achievement—out of which opportunity continually develops.

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THE BIOCHEMIST ON THE HOSPITAL STAFF

DURING the past few years there has been gradually evolving in the general mind, and particularly the medical mind, the idea that the chemist is actually something more than a druggist or a detector of arsenic. The present records of the efforts directed towards an elucidation of the reactions of the human organism in health and disease, along the lines of chemical investigation, are an achievement that by their very import, if not their voluminousness, have forcibly directed the attention of the medical profession to the possibility that here is a line of attack worthy of notice. The rapid progress being made is adding so much to the fundamental knowledge of how the organism carries on its activities, that the solution of the many problems being brought to light is most turbid in the minds of the chemical physician and he is turning to the biochemist for clarification. Scientific medicine to-day acknowledges the fundamental value of chemistry in the fight for the prevention and cure of disease; it recognizes now, as never before, the need of ascertaining the basic facts concerned in body reactions and that the satisfying of that need rests in the intensive application of biochemical methods to the study of the human organism. Outside of diabetes there is a general lack of definite information concerning the intricate processes going on, giving rise to, or accompanying pathological conditions, and there is opening up a larger opportunity for acquisition of this information through the open-hearted cooperation between physician and scientist that is now becoming evident.

In view of these facts and since there is an increasing number of hospitals that are coming to realize that the optimum treatment for their patients depends not only in having at hand the means of attaining all possible data, but also that the hospital should be the center for investigation, and are adding to their staffs men specially trained in biochemistry, it seems apropos to discuss briefly some of the points these new alliances are bringing up.

The average physician dumps all chemists into one class, leaving the biochemists undifferentiated, considers them analysts and mentally determines their status on the hospital staff as one a little lower than the plant engineer, but somewhat better than a nurse, although lacking even a nurse's conception of medicine.

Somewhere, though just where I do not recollect, I have read a discussion in which the distinction was drawn between the types of workers in chemistry. It was there brought out that whereas a chemist is always an analyst, an analyst need not necessarily be a chemist, since a chemist is inherently a thinker in chemistry. On the hospital staff it is the chemist that is needed and it is the chemical specialist, the biochemist, for just as in the medical profession there are specialists devoted to certain types of disorders, so have we of the chemical profession divided ourselves according as our inclinations and training have fitted us to pursue certain more or less well defined lines of endeavor. The efficient biochemist, however, must be not only well founded in information and ability to think in terms of all branches of chemistry, but he must also be familiarly acquainted with the principles of physics and general biology. This is merely the groundwork and foundation, on it there must be erected the superstructure of a knowledge of morphology, physiology, bacteriology, pathology and the phenomena of normal and disturbed body functions. Only one with such training can be of maximum service in the field of hospital activities. To a man so equipped the opportunities for usefulness are large, and the full utilization of his services can not but resut in benefit to patients and science.

The question of what and how much routine analytical work should be placed on the shoulders of the biochemist is one of importance, and by routine analytical work is meant the regular and systematic chemical examination of every hospital patient. Routine work, it is true, must and should be done, for from such analyses it is possible to follow the progress of disease and the response to treatment. Moreover, it is from the accumulated mass data carefully correlated that the conclusions can be drawn leading to the understanding of fundamentals, but routine blood and urine analyses can be made by any skilled technician while it requires the cooperative efforts of the clinician and the medically trained biochemist to interpret the results. Now the biochemist being primarily trained for and adapted to research should not have his time so taken up with routine that he can give but meager attention to the outlining and carrying on of investigations. In fact I do not believe that this work should be a part of the duties of the biochemist, except in so far as the results are directly applicable to a certain specific problem, but that it should be done by a technician, leaving the biochemist's time for the investigatory cooperation essential for progress.

The fundamental purpose of the hospital is the cure or relief of the patient, and it should be the aim of the biochemist as an integral part of the institution to plan his work to that end. He has two points of view that are synchronous as to ultimate effect but different in immediacy. The one line is intended to throw light on the present condition and progress of the patient under treatment; it is individual. Correlated with this is the group study of specific disturbance in various individuals with the aim of acquiring information as to the general processes occurring in the disorder. These are the immediate objects of study. In addition, he should have in mind and as an object of his attention investigations along the lines of basic phenomena not connected with any individual or specific pathological condition, but more with the point of view of contributing information as to fundamental functioning. The immediate proposition looms the larger because it is the more pressing. But who will say which is the more important? Logical planning will result in such an intimate dove-tailing of both the immediate and the basic lines of effort that the perspective of time will afford a well founded understanding of the causes contributing to disease, which understanding will lay the path for cure and prevention.

This can not be done nor can full development be obtained without a close cooperation of the other members of the hospital staff with the biochemist. And it almost goes without saying that this cooperation can not be effected unless the biochemist is equipped to understand the point of view of the clinician and is capable of giving to the clinician assistance in the working out of his problems. Progress can not be expected when the biochemist either by preference, or lack of opportunity to do otherwise, remains cooped up with his test-tubes and beakers knowing nothing of the patients save as numbered bottles of urine on which he makes his little tests. Consultations should be held at which the general outlines and progress of investigation should be discussed and opportunity afforded for the examination of any particular case necessitating a biochemical interpretation or study.

Complete independence should be allowed the biochemist in the outlining of his methods of procedure and the problems for investigation, always, however, seeking assistance and ready to give help when his specialized training fits him to be of service. His administrative duties should be confined to his own lines of activity and general laboratory supervision or directorship since it is in that field his capabilities have been developed. The instruction of nurses in the principles of physiological chemistry by the biochemist should be encouraged since the proper collection of specimens depends upon their intelligence. They can not be expected to have an appreciation of the precautions necessary in collecting the material if they are set to do it as automatons and with no knowledge of the purposes involved.

In these days of ours the question of compensation is extraordinarily vital. The scientific specialist is such because he can not help it. His mental make-up forces him to spend his life in giving, not in getting. He is rarely a success in self-directed commercial enterprise. He has no inclination to enter such work unless driven by necessity, and then it is with repugnance, that he competes with his fellow-men in the accumulation of dollars. Rather does he live a life largely deprived of the creature comforts accorded those mentalities whose urge is acquisitional. But whose is the greater service is obvious. Why should not such workers be given compensation sufficient to allow them to have homes and more than bare necessities? Why should they be forced to derive their major joie de vivre in intellectual introspection? Is it because the work is of low value or is it because of sluggish appreciation and lack of self-advertising? Whatever the causes it is not right, but no matter how wrong it is we have men, and will continue to have men who will gladly devote themselves to science whatever the compensation. Nevertheless measures should be taken by properly organized associations, to so educate those necessary of education that future generations of scientists, if not this one, may receive an adequate income in recognition of their continued contributions to human welfare.

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CHARLES BUCKMAN GORING

Few of the readers of Science will be familiar with even the name of Charles Goring.[1] His time was largely spent as a

[1] Goring was born in 1870 and died in 1919. He was a student and later a fellow of University College, London. He served on a hospital ship during the Boer War. At the time of his death—met at his post combating the influenza epidemic—he was Medical Officer in Chief at Strangeways

prison medical officer. His one monumental work, which may perhaps best be described as *the biology of the convict,* is still unfamiliar to all but a limited circle.

Goring's work[2] was based on thousands of data and is stringently biometric in form, but he was no mere measurer, card shuffler and constant computer. He knew his convicts as the trained student of animal behavior knows his organisms—and better, for he had not merely their physical measurements and an intimate personal knowledge and evaluation of their mental characteristics but knew much of their ancestry and family associations. To Goring, measurements were inviolate—not to be juggled with, modified or discarded because they did not substantiate a popular theory. Better proof of this could not be found than the fact that the raw data for his book were set up before the calculations were well under way. Goring as a thoroughgoing biometrician believed that in many fields of research valid conclusions must rest upon the mathematical analysis of large masses of data. But in his research each constant was critically weighed against his own broad and intimate personal experience of the individual instances which constitute the mass.

I find it difficult to decide just what characteristic of Goring impressed me most when we were working together at the Biometric Laboratory ten years ago. Sometimes it was the steadfast scientific purpose which had supported the years of painstaking detail upon which his great book rests—detail scrupulously executed notwithstanding the fact that there was at times little prospect of its ever serving as a basis for constants and generalizations. Sometimes it was the breadth of interests, knowledge and sympathies of one whose work lay in a field seemingly so circumscribed. Sometimes it was the entire freedom from both callousness and sentimentality of a man who had spent a decade, more or less, with the inmates of the British prisons.

One sentence tells much of the man. One day I asked, "Why is this to be *The English Convict* instead of *The English Criminal?*" He replied instantly, "Perhaps some of them are not criminals, only convicts."

J. Arthur Harris

Prison, Manchester. Those who desire may find a portrait and a more adequate appreciation in *Biometrika,* Vol. XII., pp. 297–307, pl. 1, 1919.

[2] Goring, C. B., "The English Convict; A Statistical Study." 444 pp. London, 1913. Abridged edition, Wyman and Co., 1915. The statistical work on this volume was carried out at the Biometric Laboratory with the cooperation of H. E. Soper and with the helpful suggestion and criticism of Professor Pearson.

SCIENTIFIC EVENTS

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH OF GREAT BRITAIN

The following is a list of research associations which have been approved by the department as complying with the conditions laid down in the government scheme for the encouragement of industrial research and have received licenses from the Board of Trade under Section 20 of the Companies' (Consolidated) Act of 1908:

British Boot, Shoe and Allied Trades Research Association,
Technical School, Abington Square, Northampton.
Secretary—Mr. John Blakeman, M.A., M.Sc.

British Cotton Industry Research Association,
108, Deansgate, Manchester.
Secretary—Miss B. Thomas.

British Empire Sugar Research Association,
Evelyn House, 62, Oxford Street, London, W.1.
Secretary—Mr. W. H. Giffard.

British Iron Manufacturers Research Association,
Atlantic Chambers, Brazennose Street, Manchester.
Secretary—Mr. H. S. Knowles.

British Motor and Allied Manufacturers Research Association,
39, St. James's Street, London, S.W.1.
Secretary—Mr. Horace Wyatt.

British Photographic Research Association,
Sicilian House, Southampton Row, London, W.C.1.
Secretary—Mr. Arthur C. Brookes.

British Portland Cement Research Association,
6, Lloyd's Avenue, London, E.C.3.
Secretary—Mr. S. G. S. Panisset, A.C.G.I., F.C.S.

British Research Association for the Woollen and Worsted Industries,
Bond Place Chambers, Leeds.
Secretary—Mr. Arnold Frobisher, B.Sc.
British Scientific Instrument Research Association,
26, Russell Square, W.C.1.
Secretary—Mr. J. W. Williamson, B.Sc.
British Rubber and Tyre Manufacturers Research Association,
c/o Messrs. W. B. Peat & Co., 11, Ironmonger Lane, E.C.2.
The Linen Industry Research Association,
3, Bedford Street, Belfast.
Secretary—Miss M. K. E. Allen.
Glass Research Association,
7, Seamore Place, W.1.
Secretary—Mr. E. Quine, B.Sc.
British Cocoa, Chocolate, Sugar Confectionery, and Jam Trades Research Association,
9, Queen Street Place, E.C.4.
Secretary—Mr. R. M. Leonard.

Schemes for the establishment of Research Associations in the following industries have reached an advanced state of development.

RESEARCH ASSOCIATIONS APPROVED BY THE DEPARTMENT BUT NOT YET LICENSED BY THE BOARD OF TRADE

British Music Industries Research Association.

British Refractory Materials Research Association.

British Non-Ferrous Metals Research Association.

Scottish Shale Oil Research Association.

PROPOSED RESEARCH ASSOCIATIONS WHOSE MEMORANDUM AND ARTICLES OF ASSOCIATION ARE UNDER CONIDERATION

British Launderers Research Association.

British Electrical and Allied Industries Research Association.

British Aircraft Research Association.

INDUSTRIES ORGANIZATIONS ENGAGED IN PREPARING MEMORANDUM AND ARTICLES OF ASSOCIATION

Silk Manufacturers.

Leather Trades.

Master Bakers and Confectioners.

In addition to the industries included above, certain others are engaged in the preliminary consideration for forming Research Associations.

NATURAL GAS CONFERENCE

Secretary Lane, of the Department of the Interior, announces that the following appointments have been made for the committee of ten authorized by the resolution at the Natural Gas Conference, held under Secretary Lane's invitation at Washington, January 15, 1920: Van H. Manning, director, Bureau of Mines, chairman; John B. Corrin, The Reserve Gas Company, Pittsburgh, Pennsylvania; L. B. Denning, The Ohio Fuel Company, Pittsburgh, Pennsylvania; J. C. McDowell, Witchita Natural Gas Company, Pittsburgh, Pennsylvania; W. L. McCloy, The Philadelphia Company, Pittsburgh, Pennsylvania; John S. Rilling, Public Service Commission of Pennsylvania, Harrisburg, Pennsylvania; Miss Edna N. White, American Home Economics Association, Detroit, Michigan; Art L. Walker, Chairman, Corporation Committee, Oklahoma City Oklahoma; F. W. Wozencraft, Mayor, Dallas, Texas; Samuel S. Wyer, Consulting National Gas Engineer, Columbus, Ohio; and Dr. I. C. White, state geologist of West Virginia, Morgantown, West Virginia.

The functions of this committee will be to consider the wastes now going on in natural gas and the relations between the natural gas companies and the consuming public. The committee has been carefully selected from a number of nominations with a view to representing equally the interests of the public and the natural gas companies. Dr. Manning writes:

> The development and utilization of the most ideal fuel known to man—natural gas—has been accompanied by almost inconceivable wastes. Although these wastes have been greatly reduced during recent years, they have by no means been eliminated and the country to-day is paying the penalty of its sins by the depletion and even exhaustion of many of the formerly prolific gas supplies. These wastes have occurred in the fields where the gas is produced; in the lines through which the gas is transported; and from the cooking stoves, furnaces, boiler plants, etc., where the gas is ultimately consumed.

Through the knowledge and experience which has been gained in the natural gas industry, it is now known how these wastes can be practically eliminated, but the main obstacles now to be overcome before these economies can be put into effect are economic rather than technical; that is modern engineering can control these wastes, but it is necessary that the saving be made worth while. There must be a thorough consideration of the broad, underlying economics of the gas business and its relations to the conservation and better utilization of natural gas. There is a necessity that the public more thoroughly understand the economics and technique of the gas business to the end that machinery be devised and put into operation whereby the interests of the public and the gas companies can be brought together in such a manner that the gas now being wasted can be saved and used.

It is the purpose of this committee to consider these broader questions of the relations between the consuming public and the gas companies, that a program may be drawn up looking forward to the application of those engineering principles which it is known minimize the waste of natural gas now taking place and prolong the supply of gas to the consumer.

THE STEINHART AQUARIUM

The erection of an up-to-date aquarium in Golden Gate Park, San Francisco, is an event of some significance in the scientific world and the fact that it is to be under the direction and management of the California Academy of Sciences and supervised by Dr. Barton Warren Evermann, the ichthyologist, will insure it fulfilling its purpose of quickening interest in the fauna of the Pacific Ocean and the inland waters of the Pacific coast area.

Funds for the building of the aquarium amounting to $250,000 have been provided through the munificence of the late Ignatz Steinhart who stipulated in his will that the management should vest in the California Academy of Sciences. By an amendment to the city charter the city of San Francisco has undertaken the maintenance of the aquarium. The aquarium will be built adjoining the Academy's Museum building and will be equipped with a full complement of glass exhibition tanks. Outdoor pools for the exhibition of aquatic mammals form an essential part of the building scheme.

Dr. Evermann is now in the East and will visit the aquariums of Boston, New York, Detroit, Philadelphia and Washington to study carefully the most approved methods of installation.

RESIGNATION OF DEAN BAKER OF THE NEW YORK STATE COLLEGE OF FORESTRY

An appeal for better salaries for educators, particularly those in New York State and in the New York State College of Forestry, at Syracuse marks the letter of resignation filed by Dean Hugh P. Baker, who has resigned after eight years of service, to accept twice the salary he is rated as receiving at the State College of Forestry, by becoming secretary of the American Paper and Pulp Association.

Although he receives a big increase in pay, his letter of retirement specifies that the inducement which caused him to leave the College of Forestry was not the salary, but the opportunity to carry the profession of forestry into a great industry, that of paper manufacturing. His letter discloses that last year he refused an offer of $7,500 to enter a business career, but that the trustees increased his salary from $5,000 to $6,000 to remain, and he declined the offer. Owing to the rigidity of the New York state budget system, however, even this raise would not take effect until July, 1920, and only then if approved by the legislature. In his letter of resignation, he says this of the salaries of teachers: "The public is apathetic, to say the least, as to the needs of education, with the result that our public schools and colleges and universities throughout the country are suffering for the lack of the right kind of men and women in the teaching profession."

Dean Baker's last work at the College of Forestry will include an effort to secure adequate salaries for the educators in the college, some of whom are paid smaller than men in the same relative positions at other state educational institutions.

SCIENTIFIC NOTES AND NEWS

Dr. David F. Houston, formerly president of Washington University, secretary of agriculture, has been nominated by President Wilson to succeed Senator Carter Glass as secretary of the treasury. E. T. Meredith, of Iowa, publisher of *Successful Farming,* a director of the Chicago Federal Reserve Bank and democratic candidate for senator from Iowa in 1914, will succeed Mr. Houston as secretary of agriculture.

Dr. Hugh S. Cummings, of Hampton, Va., has been selected to succeed Dr. Rupert Blue as surgeon general of the Public Health Service. General Blue has served two terms as surgeon general. He was first appointed during the administration of President Taft and was reappointed by President Wilson. Dr. Blue will remain in the Public Health Service engaged in research work.

Dr. Herman M. Biggs, New York state commissioner of health, was reappointed by the governor for a term of six years, on January 12, and the appointment was unanimously confirmed by the senate on the same day.

Professor Graham Lusk, of the Cornell University Medical College, has been elected associate member of the Société Royale des Sciences Médicales et Naturelles de Bruxelles.

Dr. W. F. Rudd, of the department of chemistry of the Medical College of Virginia, Richmond, has been elected president of the American Conference of Pharmaceutical Faculties.

The council of the Geological Society of London has made the following awards: Wollaston medal to Professor Baron Gerard Jakob de Geer (Stockholm); Murchison medal to Mrs. (Dr.) E. M. Shakespear; Lyell medal to Mr. E. Greenly; Wollaston fund to Mr. W. B. R. King; Murchison fund to Dr. D. Woolacott, and Lyell fund to Dr. J. D. Falconer and Mr. E. S. Pinfold.

At the recent meeting of the American Psychological Association at Harvard University, a committee was appointed to formulate standards for the qualifications and certification of practising psychologists for the United States. The committee consists of Professor Bird T. Baldwin, State University of Iowa, chairman; Professor Walter F. Dearborn, Harvard University; Professor Leta S. Hollingworth, Columbia University; Dr. Helen T. Wooley, Vocational Bureau, Cincinnati, and Dr. Beardsley Ruml, The Scott Company, Philadelphia. State departments of education contemplating the certification of psychologists should consult with a member of the committee. New York, Wisconsin, New Jersey and California recently legalized practising psychologists.

Professor Heber W. Youngken, head of the department of botany and pharmacognosy of the Philadelphia College of Pharmacy, has accepted the invitation of the board of control of *Botanical Abstracts* to become editor for the section of pharmaceutical botany and pharmacognosy of this journal.

Dr. R. E. Rindfusz, formerly an assistant in the chemistry department of Oberlin College, is now chief chemist in charge of research for the American Writing Paper Co., Holyoke, Mass.

Professor Thomas L. Hankinson has been named ichthyologist of the Roosevelt Wild Life Experiment Station of the New York State College of Forestry, at Syracuse University. For the past seventeen years Professor Hankinson has been engaged in the study of fish in Michigan and Illinois, and for five years has been cooperating with Dr. Adams in the study of the fish in Oneida Lake and the Palisades Interstate Park region; since 1902 he has been teaching biological sciences in the Eastern Illinois Normal School, Charleston, Illinois.

Word has been received that the well-known Swedish geologist, Professor Gerard De Geer, of Stockholm, expects to visit America in the autumn of 1920, in order to study the glacial geology in the northeastern part of the United States and Canada.

Dr. Wilfred H. Osgood, of the Field Museum of Natural History, accompanied by M. H. B. Conover, of Chicago, sailed January 28 for Venezuela where they will make general zoological collections and distributional studies in the Maracaibo Basin and the Sierra de Merida.

In the latter part of October, 1919, Carl D. La Rue, botanist for the Hollandsch-Amerikaansche Plantage Maatschappij, returned to the laboratory at Kisaran, Asahan, Sumatra, after a five-weeks stay in Java, where he represented the research department of his company at the First Scientific Congress of the Netherlands East Indies, and at the First Technical Meeting of the Personnel of the Experiment Stations for the Rubber Culture.

We learn from *Nature* that Mr. Willoughby Lowe has recently started on a mission to the west coast of Africa for the purpose of collecting specimens for the South Kensington Natural History Museum. Captain Hubert Lynes, R.N., has just left England on an expedition to Darfur, where he intends to make a special survey of the avifauna of the Jeb-Maria Mountains for the bird department.

Mr. D. Franklin Fisher, formerly connected with the Bureau of Chemistry, U. S. Department of Agriculture, New York, N. Y., in the capacity of food and drug inspector, has recently resigned from that position to become research chemist in the laboratories of the Van Camp Packing Co., Indianapolis, Ind.

The annual Darwin Lecture at New York University will be given on Friday, February 13, at 4 P.M., in the auditorium at University Heights by Robert Cushman Murphy, curator of natural science at the Brooklyn Museum. Mr. Murphy sailed for Peru last August to conduct the Brooklyn Museum Peruvian Littoral Expedition. He has made a comprehensive study of the avian marine fauna of the Humboldt Current and of the Coastal Islands. He has been successful in taking hundreds of pictures—still and moving—of birds and other animals.

Dr. William J. Humphreys, of the U. S. Weather Bureau, gave the address of the retiring president before the Philosophical Society of Washington on January 31, on "A bundle of meteorological paradoxes."

Dr. S. W. Stratton delivered an address on the "Advantages of the general adoption of the metric system in Easton, Pa.," on January 16, under the auspices of the Lehigh Valley Section of the American Metric Association. Under the same auspices Dr. Harrison E. Howe lectured on December 12, on the work of the National Research Council.

On the alumni lectureship in chemistry, Oberlin College has had Colonel W. D. Bancroft, chairman of the division of chemistry, National Research Council, lecturing on "Colloid chemistry," and Mr. Marsh, of the Hercules Powder Co., lecturing on "High explosives."

At the meeting of the Royal Society on February 5, by the council, the program consisted of a discussion on "The theory of relativity," opened by Mr. Jeans and continued by Professor Eddington, the Astronomer Royal, and others.

We learn from *Nature* that active steps are now being taken in the government to establish a memorial to Lord Lister in Edinburgh. The university and the Royal Colleges of Physicians and Surgeons in Edinburgh, under the control of which the memorial will be established, have determined to provide an institute for research and teaching in medicine. A site has been secured, and a committee is now being formed to make an appeal to the public for a sum of £250,000. Mr. Balfour, chancellor of the university will be president of the committee.

There has been established at Case School of Applied Science, in memory of the late Professor Sabine, of Harvard University, the Wallace Clement Sabine Research Fellowship in Acoustics. Its purpose is the encouragement of investigation in the science of acoustics. The holder of the fellowship will pursue his studies and carry on original investigation under the direction of Professor Dayton C. Miller. The facilities afforded by his laboratory for research in any part of acoustics are unusual, and this is particularly true as regards the analysis and synthesis of sound. A candidate for this fellowship must be a college graduate and should have had at least one year of advanced study in physics. The stipend is $1,000 a year.

Rear Admiral John Elliott Pillsbury, U. S. N., retired, president of the National Geographical Society, distinguished for his contributions to science, especially on the Gulf Stream, as well as for his services as an officer in the navy, has died at the age of seventy-three years.

Richard Bliss, who died at Newport on January 7, was at one time an assistant in the Museum of Comparative Zoology, Cambridge, and bibliographer of the United States Geological Survey and the Northern Trans-continental Survey. For thirty-one years, until his retirement in 1914, he was librarian of the Redwood Library at Newport.

Dr. S. Mackay, professor of chemistry at Dalhousie University since 1896, died from pneumonia in Halifax, N. S., on January 6. Dr. Mackay was born in Nova Scotia in 1864. He was educated at Dalhousie and the Johns Hopkins Universities.

The Senate has passed a joint resolution appropriating $500,000 to be used by the Public Health Service in combating influenza. The resolution directs the Public Health Service to investigate influenza and allied diseases in order to discover their causes and prevent their spread. It requires the allotment of money to universities, colleges and other research institutions for scientific investigation. The Public Health Service is accorded the privilege of making selection of such institutions.

A meeting of surgeons, representing the surgical staffs of all the great teaching hospitals of Britain, assembled in the theater of the Royal College of Surgeons of England on January 8, as we learn from *Nature,* under the chairmanship of Sir Rickman J. Godlee, and resolved to form an "Association of Surgeons of Great Britain and Ireland." British surgeons have thus followed the precedent set by their colleagues the physicians, who formed a similar association a number of years ago. The object of the newly formed association is to permit surgeons as the staffs of the hospitals to meet together from time to time at various centers in order to exchange observations and compare results. The association will stand as the representative body for British surgeons, and in that capacity will represent British interests at international surgical congresses. Sir John Bland-Sutton was elected president of the new association.

There has been formed recently in Chicago a Scientific Laboratory Workers' Union, No. 16,986, American Federation of Labor. This includes fifteen members, physicians, chemists and bacteriologists of the Bureau of Laboratories of the Chicago Department of Health.

At the annual general meeting of the Inventors Union, held in London, the provisions of the Patents and Designs Bill were warmly discussed in view of the inadequate protection the bill provides to British inventors. A resolution was carried to the effect that the government should be approached to consider the creation of an all-empire patent to replace the present system which entailed an initial outlay of several hundred pounds to secure protection in Great Britain and the dominions and colonies for the simplest invention.

UNIVERSITY AND EDUCATIONAL NEWS

The corporation of Yale University having requested Dr. Fred T. Murphy to make a survey and report as to the school of medicine and Dr. Murphy having presented his views and recommendations, the committee on educational policy unanimously recommended the following minutes which were adopted by the corporation:

1. That there is a clear and definite opportunity and obligation of the university to medical education.

2. That the Yale School of Medicine has a valuable nucleus of men and material and sound traditions, which richly justify the development of an institution for medical education of the highest type.

3. That the corporation accept as a policy the development of a medical school of the highest type to include the pre-clinical and clinical years of instruction upon such principles of medical education as may be approved by the corporation, after conference with the medical faculty.

4. That every effort be made to obtain at the earliest possible date the necessary funds with which to expand and develop the buildings, the

equipment, the instruction, and the research, and the service, in accordance with the best ideals of modern medical education—as an essential unit of our university plan for development.

Professor W. H. Dalrymple has resigned the editorship of the *Journal* of the American Veterinary Association because of his appointment to the deanship of the college of agriculture of the Louisiana State University. The nominees for the governorship and the legislature have pledged themselves the support of the movement for a greater university, in which movement it is proposed to raise three million dollars for the college of agriculture.

Dr. Allen E. Stern, of the department of chemistry at the University of Illinois, took charge of the division of physical chemistry at the University of West Virginia, beginning in February.

Dr. Henry C. Tracy, of the Marquette Medical School, has been appointed professor of anatomy at the University of Kansas.

Dr. C. H. Edmundson, professor of zoology at the University of Oregon, resigned at the close of the fall term to accept the position as head of the department of zoology and director of the research laboratories at the College of Hawaii, Honolulu.

Professor Clarence Moore has resigned the chair of biology in Dalhousie University, Halifax, N. S., and has been succeeded by Professor Dowell Young, of Cornell University.

DISCUSSION AND CORRESPONDENCE

UNRELIABLE EXPERIMENTAL METHODS OF DETERMINING THE TOXICITY OF ALKALI SALTS

A method frequently used by investigators of the toxicity of alkali salts is to add certain percentages of salts to soils, plant them to crops and estimate the toxicity by the depression of the crop growth. They assume that if sodium carbonate or other salt is added to a pot of soil, that it remains in solution in the soil and that its toxicity can be measured by subsequent crop growth. Very elaborate and expensive experiments have been performed based upon this assumption.

Now it has been shown by various investigators that soils absorb a part, at least, of the salts added, and that the crop growth in these treated soils is much more closely related to the proportion of alkali salts recoverable from the soils than to the proportion of salts which have been added. In other words, the toxicity of salts is not so accurately measured by the amount added to the soil as by the salts recoverable by analysis after the treatments have been made.

Two papers have been published in the *Journal of Agricultural Research* which illustrate the erroneous conclusions that may be reached when toxicity is determined by the per cent. of salts added, viz., "Effect of alkali salts in soils on the germination and growth of crops," by Frank S. Harris, and "Soil factors affecting the toxicity of alkali," by F. S. Harris and D. W. Pittman. In both these investigations the attempt was made to measure the toxicity by correlating crop growth with the amount of salts added. In the first-named paper Mr. Harris reaches the following conclusions which are not in accordance with results obtained by other investigators. The questionable results quoted below would almost certainly not have been secured had the more accurate method been followed of measuring toxicity by correlating crop growth with the soluble salts found in the soil after the various additions had been made.

The conclusions which appear to the writer to be unjustified are:

1. "Only about half as much alkali is required to prohibit the growth of crops in sand as in loam."

Since no analyses were made Mr. Harris did not know how much alkali was contained in the soil solution in either sand or loam and the conclusion is therefore unjustifiable.

2. "Results obtained in solution cultures for the toxicity of alkali salts do not always hold when salts are applied to the soil."

This statement may be true but his experiments do not warrant the drawing of such a conclusion for here again the author did not determine the concentrations of the soil solutions and he therefore has no basis for comparing the toxicity of salts in solution cultures with the same concentrations in soil solutions.

3. "The toxicity of soluble salts in the soil was found to be in the following order: sodium chlorid, calcium chlorid, potassium chlorid, sodium nitrate, magnesium chlorid, potassium nitrate, magnesium nitrate, sodium carbonate, potassium carbonate, sodium sulfate, potassium sulfate, and magnesium sulfate."

Since the author did not determine and did not know how much of these salts were actually in the soil solution he could not very well indicate their relative toxicities. It will be noted that sodium carbonate is placed near the bottom of the list as a relatively harmless salt, whereas, as a matter of fact, it is one of the most toxic salts occurring in the alkali soils of the west.

4. "Land containing more than the following percentages of soluble salts are probably not suited without reclamation to produce ordinary crops: In loam, chlorids 0.3 per cent.; nitrates, 0.4 per cent.; carbonates, 0.5 per cent.; sulfates, above 1.0 per cent. In coarse sands, chlorids, 0.2 per cent.; nitrates, 0.3 per cent; carbonates, 0.3 per cent. and sulfates, 0.6 per cent."

Here again the author draws conclusions without having accurate data on which to base them. If the above percentages were to be adopted by chemists in determining the suitability of alkali soils in the field for crop growth, the results would be misleading in the extreme. The results are not in accord with those obtained by determining toxic limits in field studies, nor with laboratory experiments in which toxicity is related to the alkali actually in the soil solution instead of to that which was put in.

In the paper by Harris and Pittman, published in November, 1918, the authors have adopted the same erroneous method but they are more careful in drawing conclusions as the absorption of the salts added is apparently recognized but is not determined and related to crop growth. The conclusion, however, that "Loam soils and soils with a high water-holding capacity may be successfully farmed at a higher alkali content than others" may possibly be true but there is no data given in the paper which justifies the conclusion, for the per cent, of alkali salts recoverable from the two kinds of soil was not correlated with crop growth.

It is also suggested that the results obtained by Brown and Hitchcock published under the title "The effects of alkali salts on nitrification" (*Soil Science,* Vol. IV., No. 3) and by Singh on the "Toxicity of alkali salts" (*Soil Science,* Vol. IV., No. 6) would have been more valuable had they been correlated with the recoverable salts rather than with the salts added to the soils with which they were working.

F. B. HEADLEY

NEWLANDS EXPERIMENT FARM,
FALLON, NEVADA

ON HIGH-ALTITUDE RESEARCH

I AM beginning to appreciate the difficulty of making one's self understood in a statement where matters are suggested rather than explained in detail, and where a critical attitude is urged until a result is actually verified by experiment, even when one feels perfectly confident beforehand what the result will be. The present statement is written for the purpose of correcting any misconceptions that may have arisen from my recent press statement.

First, the time necessary for a preliminary exploration of the atmosphere will be required chiefly for the preparation. It is not like an exploration of "darkest Africa," for, with the proper rocket apparatus and instruments, each flight will occupy but a short time; and not many will be needed to obtain a very considerable amount of information, such as an accurate knowledge of densities, that would be needed for any further developments.

The expense also will be chiefly that for preparation; namely, for machine construction and tests. A final form of apparatus, designed for reaching any particular altitude, should not be expensive. This is, of course, true of any product that requires machine development.

Incidentally, the object of these experiments is by no means restricted to the taking of photographs in the earth's atmosphere, although this application may have more uses than were at first suspected.

Regarding the ultimate developments of the method, I do not wish to leave the impression that these will be restricted to researches in or near the earth's atmosphere. On the contrary, every one of the matters so far proposed is, as I have already maintained, based upon sound physical principles, and can therefore be realized. Further, there are additional principles, the application of which is certain to lead to results of even greater interest and importance. All these results will be realized, however, not by argument and discussion, but by the application of real research methods to the problems that are waiting to be solved.

Robert H. Goddard
Clark College,
Worcester, Massachusetts

SCIENTIFIC BOOKS

Studies on the Variation, Distribution, and Evolution of the Genus Partula. The Species Inhabiting Tahiti. By Henry Edward Crampton. 313 pp., 34 plates, 252 tables, 7 text figures. Publication No. 228 of the Carnegie Institution of Washington, January, 1917.

Interest having been diverted from pure science by the war, no adequate review has appeared of this monumental and fundamentally important work which represents the results of four journeys of exploration made by its author in Polynesia; in the course of which more than 75,000 adult snails were collected together with over 7,000 adolescent individuals; more than 200 of the valleys of the Society Islands having been visited for this purpose.

The present volume deals with snails from Tahiti alone, and the thorough, scholarly, and conservative treatment given the subject renders this work of paramount value to all future students of the variations of *Partula.*

Not alone were variations and distribution of the adult snails studied, but the young contained in the brood pouches of the adults were dissected out, thus throwing light upon the fecundity of each variety, and the ratio of elimination of the young before they can reach maturity.

Crampton shows that these snails are not found in the dry low-lands along the shore, nor do they occur in the cold regions of the high peaks of the interior, for a temperature of 55°–60° F., stops their activity. The snails are therefore restricted to the relatively moist deeply wooded troughs of the intermediate regions of the valleys where they are commonly found during the day-time on the undersides of the leaves of the banana, wild plantain, caladium, turmeric, wild ginger and dracæna.

The ridges between valleys are generally dry, and thus the snail population of each valley is more or less isolated. Crampton finds that these snails descend from the trees and bushes and feed during the night, or on moist days, upon decaying vegetation. The young and adolescent being more active in this feeding reaction than are the adults.

It has long been known from Garrett's studies that the Tahitian species of *Partula* like the *Achatinella* of Oahu varied from valley to valley, some forms ranging over a wide area while others are restricted to a single valley, or even to a limited region within a valley.

In general moreover the farther apart two valleys the wider the diversity between their snails, although this is not always the case. Crampton's work has the merit of giving precision to our hitherto more or less vague knowledge of the distribution of the 8 species of *Partula* found in Tahiti. He shows conclusively that great changes have occurred since Garrett studied the snails, in 1861–1884, and that in some cases the species have spread over wider areas, and in the interval have produced some new sub-species or varieties. Thus the fascinating picture of a race in active process of evolution is presented. The details of this process are rendered clear by the excellent photographs of relief maps, and the numerous diagrams which accompany the text.

In a brief review such as the present it is not possible to do justice even to some of the more important details of Crampton's masterly work, but it is interesting to see that according to Garrett, *Partula clara* was rare and found only in a sector of valleys comprising about 1/4 the area of Tahiti, while Crampton found it to be very common and to range over 4/5 of the whole island, this dispersal having been accomplished by migration from the former restricted habitat of the species. There are now 7 subspecies, and mutation has occurred not only in some of the new valleys the snail has occupied since Garrett's time but also in the area in which it was found by Garrett.

Partula nodosa which in 1861 was confined to Punaruu valley has now migrated into 6 other valleys, and 3 new varieties have arisen in the area into which it has traveled, as Crampton illustrates in his text-figure 6 on page III.

Nearly one half of Crampton's volume is devoted to an analysis of the group species *Partula otaheitana* with its 8 subspecies and varieties of primary, secondary, and tertiary degree, thus constituting the most complex of the known species of *Partula*.

Crampton collected more than 20,000 adult and 6,000 adolescent snails of this form in practically every habitable area of Tahiti.

In Fautaua valley these snails form an extremely complex colony which stands in parental relation to the diverse colonies of other valleys; for in any one of the latter the shells exhibit one combination or another of the so-called unit characters displayed by the Fautaua group as a whole. In this snail Crampton finds some evidence that in the variety *rubescens* red and yellow colorations bear a Mendelian relation to one another, red being dominant. On the other hand in the variety affinis plain color seems to be dominant over the banded pattern in Mendelian inheritance.

Partula hyalina is peculiar in not being confined to Tahiti for it is found also in Mangaia, and Moki of the Cook Group and Rurutu and Tubuai of the Austral Islands, and in marked contrast to this wide dispersal *Partula, filosa,* is found only in Pirai, and *P. producta* in Faarahi valley and have not migrated from these valleys since Garrett's time.

Crampton concludes that in the production of new varieties the originative influence of environment seems to be little or nothing, and isolation is a mere condition and not a factor in the differentiation of new forms. This is in accord with the studies of Bartsch upon *Cerion,* for he found that no new varieties were produced in any of the numerous colonies of Bahama Cerions which he established upon the Florida Keys from Ragged Keys near Miami to Tortugas. When however, these Cerions of Bahaman ancestry crossed with the native Florida from the second generation of the hybrids gave rise to a large number of variations both in form and color.

This observation indicates that similar experiments should be conducted upon *Partula,* for it seems possible that new species may result from the breeding of mutations with the parent stock, or of species with species producing fertile hybrids unlike either of the parent stocks.

The editorial work upon Crampton's volume reflects the greatest credit upon Mr. William Barnum the well known editor of all publications of the Carnegie Institution of Washington. The 15 colored plates lithographed by Hoen are faithful reproductions of the colors and appearance of these snails, and the fact that the book is published upon the best of paper is fortunate for it will be even more interesting to students a hundred years hence than it is at present.

Crampton's work is of such wide interest and importance, and in the light of Bartsch's observations so suggestive of future experimental research that it is hoped these studies may be pursued continuously under the auspices of the Carnegie Institution until final conclusions have been reached through breeding experiments conducted in the field.

A. G. M.

GRAVITY AND AEROSTATIC PRESSURE ON FAST SHIPS AND AIRPLANES

The latest issue of the Meteorological Office Circular, No. 42, December 1, 1919, contains an interesting note on the Behavior of Marine Barometers on board fast ships. The views expressed are based on certain experiments made by Professor Duffield upon the value of gravity at sea. In his work it became necessary to study carefully the variations of pressure recorded by a mercury barometer of the new type under different conditions of ship motion.

It has been suspected for a long time that on fast ships and in strong winds, pressure readings might be considerably influenced by eddy action.

The experiments in this case were carried out on H.M.S. *Plucky,* a destroyer. Steaming at 22 knots against a head wind of about 12 m/s., the barometer showed a fall of 1.2 kilobars compared with the reading when going with the wind. This is an aspiration effect and will vary with the location of the instrument aboard the ship. Three barometers were used and the change in the cabins was only 0.4 kb. The fall is sudden and unless the navigating officer is posted might be taken as an indication of impending change in weather. It is stated that opening or closing doors and ports did not materially affect the readings but this we are disposed to question since it has long been known that very noticeable aerostatic pressure variations occur during high winds on opening or shutting doors and windows. At Blue Hill Observatory using large and sensitive barographs with fast moving record sheets we have obtained variations of from 3 to 5 kbs. The location of the opening determines the character of the change; windward openings cause a rise, leeward ones, a fall.

This brings home the necessity of correcting the records of fast ships and it would be especially interesting if our Hydrographic Office would furnish open scale barographs to fast ships and analyze the variations in aerostatic pressure when such vessels were encountering high winds ahead or astern. If our ships and planes could also carry pressure tube anemometers of the Dines's pattern or the modified form provided for the Navy, records showing to a nicety gustiness and relation of speed to pressure would be available.

The next interesting feature of these experiments is the deduction that a ship moving east and therefore travelling *with* the earth's rotation experiences a consequent increase in the centrifugal tendency, resulting in a slight decrease in the value of gravity as indicated by a mercurial barometer. A west-bound ship, on the other hand, would show an apparent increase. This was put to test on the *Plucky* and it was found that

> on a west course the mercury barometer when compared with an aneroid stood relatively higher than when on an east course, indicating that the mercury weighs less because a longer column is needed to give the same pressure. For a speed of 22 knots the difference amounted to approximately 0.2 kb.
>
> Since bodies travelling east are lighter than when they are travelling west, we expect to find (other things being equal) a west wind above an east wind, a shell fired east with a longer range than when fired west, and an airship going east with a larger carrying capacity than when flying west. H. M. S. *Plucky* weighed about 4 cwt. less on an east course than when steaming west.

Professor Edward V. Huntington in Science, January 9, 1920, p. 45, shows that a body moving westward at high speed requires an increase in the supporting force.

Dr. Carl Herring in the same issue discusses the possibility of moving a mass so rapidly that the net weight would be zero.

Aerographers of course are familiar with the equation on which the above reasoning for gravity rests, namely $2\omega v \cos\phi \sin\alpha$. In this, ω is the angular velocity of the earth's rotation, that is $2\pi/86164$ seconds or .00007292 radians per second; v, the velocity of the ship in meters per second, ϕ, the latitude and α the deviation from true north or south, of the ship's course. Dr. Duffield gives this value for latitude 50° N. as .005 kb. per knot.

Another matter under discussion is the effect of the ship's vibration due to engines upon the sensitiveness of the barograph record. At present it can be said that on a vibrating ship the lag of the instrument is much reduced.

All of the above applies with even more force to airships. Deflective influence will modify the course not only in a horizontal but also in a vertical plane. Professor Marvin has shown that when a machine is climbing with given power, the ascent will be more rapid if made clockwise than when counterclockwise; this of course for the northern hemisphere, and conversely in the southern. So the aviator must watch his barometer not less than his compass. With him it is all important that true static pressures be recorded; and at least he should be keenly alive to the importance of the corrections to be applied, most of them functions of speed. When an aneroid is moving at 45 m/s (100 miles an hour) not an unusual speed, he may be called upon to add to or subtract from his proper speed, the air speed, say 25 m/s., also the earths angular velocity.

The exposure of the barograph *is* important. The containing box must have an opening either facing the wind or away from it: if the former, the pressure shown is aerostatic plus aerodynamic. Zahm and others have discussed pressure distribution around a steamlike body and J. G. Coffin has actually designed and used a container that rotates periodically. He found that when the aperture was 45° either side of the head-on position the observed pressure was normal or true static.

From all the above, it is evident that hereafter in the charting and discussion of storm centers at sea, as based on pressure readings, we must know *whether the ships were headed east or west, the angle of inclination of the ship to the wind, the speed of the ship and the speed, direction and gustiness of the wind.*

ALEXANDER MCADIE

BLUE HILL OBSERVATORY,
January 20, 1920

STATE REWARDS FOR MEDICAL DISCOVERIES

A REPORT has been issued by a joint committee of the British Medical Association and of the British Science Guild, which has been considering the question of awards for medical discoveries. According to the abstract in the *Journal* of the American Medical Association the committee defines medical discoveries as being: (1) the ascertainment of new facts or theorems bearing on the human body in health and on the nature, prevention, cure or mitigation of injuries and diseases; (2) the invention of new methods or instruments for the improvement of sanitary, medical and surgical practise, or of scientific and pathologic work. The reasons given for rewarding medical discoveries are the encouragement of medical investigation and the discharge of a moral obligation incurred by the public for its use of private effort. The various public types of rewards are cited as: titles and honors given by the state, by universities and other public bodies; prizes and medals; patents; promotion and appointments; pecuniary rewards by the state. Concerning the general principle of assessment, the committee hold that, in the interests of the public, all medical discoveries should if possible receive some kind of acknowledgment or recompense. But in view of the variable conditions, nature and effects of particular investigations, it will often be difficult to assess the kind of recompense suitable. In the first place, a distinction should be drawn between compensation and reward. By compensation is meant an act of justice done to reimburse losses; by reward an act of grace in appreciation of services. The following different cases should be considered: A. Discoveries involving pecuniary or other loss either by direct monetary sacrifice or by expenditure of time, or by diminution of professional practise, without corresponding pecuniary gains. An example is that of Jenner, who occupied himself so closely with the investigation of vaccination that he lost most of his medical practise and also a considerable sum in expenses. This was fully acknowledge by Parliament, which granted him $150,000. B. Discoveries that have increased the professional emoluments of the investigator by enhanced practise or other means.

Such are frequently improvements in surgical operations or medical treatment, which leads to increased practise. Another case is that of serums, etc., which may have been protected and put on the market. Here compensation can not be demanded, and pecuniary rewards are generally unnecessary. On the other hand, honors are often and justly bestowed for such work. C. Discoveries that involve neither gain nor loss to the investigator. This class includes most of the good and sometimes great clinical, pathologic and sanitary discoveries. Here also compensation can scarcely be demanded, and honors are already often given, but pecuniary awards should sometimes be bestowed as an act of grace when the value of a discovery greatly exceeds the emoluments of the investigator. This principle should hold even for men who are directly paid for undertaking the research, especially when such payment is (as usual) small and the discovery great. Special attention is drawn to: (1) men who have refused lucrative posts to complete researches; (2) men who have refused to protect their work for fear of limiting its application, and (3) men who have carried out investigations for governments for little or no payment, on patriotic grounds.

In the public interest, the committee insists on these principles: (1) No medical discovery should be allowed to entail financial loss on him who has made it. (2) Compensation or reward should be assessed as equal to the difference between the emoluments actually received and those which a successful clinician might have received in the same time. Additional reasons for this are that few medical discoveries are patentable, and they seldom give good grounds for promotion or for administrative appointments in the public services. Whether a particular discovery shall receive large or small assessment will depend, in addition, on these considerations: (1) Width of application. For example, the work of many of the older anatomists, physiologists, and parasitologists, of Pasteur and of investigators of immunity, have affected most recent discoveries. Discoveries on widespread diseases, such as the work of Lister, Laveran or Koch, are often more important that those on more limited maladies. (2) Difficulty of the work done. The solution of a difficult problem requires more study and also more time and cost, and therefore deserves more recompense than a chance observation. (3) Immediate practical utility. A strong plea can be made for state remuneration in cases of this kind unless they come under Class B. Curiously, they never receive it, and academic recognition is also often not forthcoming. (4) Scientific importance. Discoveries not of practical utility may become so at any moment and should be included in the scheme if sound and of wide application.

During the last few years, the British government has disbursed an annual grant of about $300,000, under the Medical Research Committee, for subsidizing investigations authorized by the committee and carried on by workers selected by it. This grant does not remunerate discoveries already made, but proceeds on the principle of payment for prospective benefits.

SPECIAL ARTICLES

A POCONO BRACHIOPOD FAUNA

The Pocono formation of the Appalachian Mississippian measures is known to contain marine fossils in places but little has been published on the subject and the information is scattered and difficult to assemble. The writer has recently found two beds of sandstone in the Pocono Series on Laurel Mountain in Tucker county, West Virginia, which contain branchiopod impressions and has assembled the following list of occurrences of fossils in strata which are considered to be of Pocono age. Since the present note is written in the field, full descriptions of these localities and complete citations to the literature are not given.

POCONO FAUNAL LOCALITIES

1. At Altamont, Maryland, on the western limb of the Georges Creek-Potomac Syn-

cline, noted by G. C. Martin, 1903, Maryland Geological Survey, (Report on) Garrett county, pp. 91 and 92; marine invertebrate fauna noted in the Pocono but not described.

2. In the Broad Top Coal Field of Southern Pennsylvania a Pocono fauna has been collected from a black shale by Messrs. David White and G. H. Girty. They have been studied by Dr. Girty and described in manuscript. The fauna consists of only a few genera and species, only three or four species being found at any single locality. In order of abundance the forms noted were: *Chonetes, Camarotœchia, Rhipidomella, discinoids,* and the pelecypod *Cypricardinia* (oral communication from Dr. Girty).
3. At the Beaverhole (ford and limestone quarries) on Cheat River in Preston county, West Virginia, 8 miles east of Morgantown, brachiopoda were found some years ago by Professor S. B. Brown in a dark shale near the base of the Pocono. A small collection consisting of a very few species of brachiopoda was obtained by the writer several years ago, but no list of the forms is at present available.
4. On Laurel Mountain, in Tucker county, West Virginia, brachiopoda have been found in two sandstone beds lying approximately 30 and 90 feet, respectively, below the top of the Pocono. The lower of the two faunal members rests upon a shale which becomes deep red in color a few feet below its top and seems to be the highest red bed at this point below the top of the Pocono. A small assemblage of forms, which are, however, abundantly represented by individuals, was noted. The upper fauna consists of the following forms as noted in the field, given in the order of relative abundance: *Chonetes, Schizophoria, Spirifer* (coarse-ribbed), a gastropod (*cf. Pleurotomaria*), a pelecypod (*cf. Cypricardinia or Grammysia*). The lower fauna contains the following: *Spirifer* (fine-ribbed), abundant, and *Camarotoechia.*
5. On Limestone Mountain in Tucker county, West Virginia, in talus accumulation from the Pocono were found impressions of *Schizophoria* in sandstone.
6. In the Price (Pocono?) Sandstone of Southwestern Virginia brachiopoda have been collected from at least two localities by G. W. Stose, (oral communication), and their presence noted in Bulletin 530 of the U. S. Geological Survey, p. 251.

The study of the Maryland and West Virginia collections is contemplated by the writer and he would be glad to receive through these columns or otherwise additional information concerning Pocono faunas.

W. ARMSTRONG PRICE
WEST VIRGINIA GEOLOGICAL SURVEY,
MORGANTOWN, W. VA.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION F—ZOOLOGY

THE Convocation Week meetings of Section F (Zoology) of the American Association for the Advancement of Science were held in conjunction with those of the American Society of Zoologists at Saint Louis, Missouri, December 29, 30 and 31, 1919.

At the business meeting of the section, Professor Caswell Grave was elected secretary pro tem.; Professor George Lefevre, of the University of Missouri, was elected member of the council; Professor B. H. Ransom, of Northwestern University, was chosen member of the general committee; Professor H. B. Ward, of the University of Illinois, was elected member of the sectional committee for five years.

The sectional committee nominated Professor John Sterling Kingsley, of the University of Illinois, as vice-president of the section for the ensuing year.

The address of the retiring vice-president of Section F, Professor William Patten, of Dartmouth College, upon "The message of the biologist" was delivered at the annual dinner of the American Society of Zoologists at Hotel Statler, Wednesday evening, December 31, and is printed in the issue of SCIENCE for January 30.

H. V. NEAL,
Secretary

THE PALEONTOLOGICAL SOCIETY OF AMERICA

The eleventh annual meeting of the Paleontological Society was held at Boston, Mass., in the Rogers Building of the Massachusetts Institute of Technology, December 30 and 31, 1919, in affiliation with the Geological Society of America. The meeting was the best attended in a number of years, and numerous papers on the various branches of paleontology and stratigraphy were presented. An important item on the program was the symposium on the teaching of paleontology which was combined with a similar symposium on the teaching of geology delivered before the joint membership of the Paleontological and Geological Societies. The result of the ballot of officers for 1920 was as follows:

President: F. B. Loomis, Amherst, Massachusetts.

First Vice-president: E. C. Case, Ann Arbor, Michigan.

Second Vice-president: Ralph Arnold, Los Angeles California.

Third Vice-president: E. M. Kindle, Ottawa, Canada.

Secretary: R. S. Bassler, Washington, D. C.

Treasurer: Richard S. Lull, New Haven, Connecticut.

Editor: W. D. Matthew, New York City.

The address of the retiring president, Dr. R. T. Jackson, was on the subject "Studies in variation and a proposed classification of variants."

Following is a list of papers presented.

Recent restorations of fossil invertebrates: John M. Clarke.

The "good use" of the term "fossil": Richard M. Field.

The presence of Upper Silurian sandstone in Essex County, northeastern Massachusetts: A. F. Foerste.

Paleontological collections in the vicinity of Boston: Percy E. Raymond.

The value of Foraminifera in stratigraphic correlation: Joseph A. Cushman.

The intercalation of thecal plates in Holocystites in connection with the criteria upon which species can be distinguished: A. F. Foerste.

A revision of the anticosti section: W. H. Twenhofel.

The hydrozoan affinities of Serpulites Sowerby: W. Armstrong Price.

The Paleozoic section of the lower Mackenzie River valley: E. M. Kindle.

Echinoderms of the Iowa Devonian: A. O. Thomas.

Cambrian formations and faunas of the upper Mississippi valley: E. O. Ulrich.

Bibliographic studies of the Cambrian: Charles E. Resser.

Correlation of the middle Cambrian of Newfoundland and Great Britain: B. F. Howell.

The Trilobites as ancestors: Percy E. Raymond.

The foraminiferal fauna of the Byram Marl: Joseph A. Cushman.

Study of the life processes in fossils: R. S. Bassler.

The method of appearance of additional arms on increasing age in Caryocrinites: A. F. Foerste.

Origin of the "Beach Rock" (Coquina) at Loggerhead Key: Richard M. Field.

Notes on the teaching of paleobotany: Marian D. Martin.

Further discussion of the ecological composition of the Eagle Creek flora: Ralph W. Chaney.

New mounts in the Princeton Geological Museum: Wm. J. Sinclair.

A study of the entelodonts: Edward L. Troxell.

A mounted skeleton of Moschops capensis Broom: William K. Gregory.

Small mammals in the Marsh collection: Edward L. Troxell.

A new method of restoration for fossil vertebrates: Richard S. Lull.

The Oligocene Equidæ in the Marsh collection of Peabody Museum, Yale University: John P. Buwalda.

The Pawnee creek beds of Colorado: F. B. Loomis.

Nothrotherium Shastense, a Pleistocene ground sloth of North America, with remarks on the Megalonychidæ: Chester Stock.

The present status of the Paleocene: W. D. Matthew.

A mounted skeleton of Pteranodon: W. D. Matthew.

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COOPERATION IN RESEARCH[1]

No one can survey the part played by science in the war without reflecting on the ultimate influence of the war on science. Able investigators have been killed or incapacitated, and with them a host of men who might have taken high places in research. Sources of revenue have been cut off, and the heavy financial burdens permanently imposed upon individuals, institutions, and governments must tend to reduce the funds available for the advancement of science. On the other hand, the usefulness of science is appreciated as it never has been before, and some newly enlightened governments have already recognized that large appropriations for research will bring manifold benefits to the state. The leaders of industry have also been quick to appreciate the increased returns that research renders possible, and industrial laboratories are multiplying at an unprecedented rate. The death of available investigators, and the higher salary scale of the industrial world, have seriously affected educational institutions, members of whose scientific staffs, inadequately paid and tempted by offers of powerful instrumental equipment, have been drawn into the industries. On the other hand, industrial leaders have repeatedly emphasized the fundamental importance of scientific researches made solely for the advancement of knowledge, and the necessity of basing all great industrial advances on the results of such investigations. Thus they may be expected to contribute even more liberally than before to the development of laboratories organized for work of this nature. Educational institutions are also likely to recognize that science should play a larger part in their curriculum, and that men skilled in research should be developed

[1] Address given before the Royal Canadian Institute, Toronto, April 9, 1919.

in greatly increased numbers. The enlarged appreciation of science by the public, the demand for investigators in the industries, and the attitude of industrial leaders of wide vision toward fundamental science, should facilitate attempts to secure the added endowments and equipment required.

On the whole, the outlook in America seems most encouraging. But the great advance in science that thus appears to be within reach can not be attained without organized effort and much hard work. On the one hand, the present interest of the public in science must be developed and utilized to the full and on the other, the spirit of cooperation that played so large a part during the war must be applied to the lasting advantage of science and research. Fortunately enough, this spirit has not been confined within national boundaries. The harmony of purpose and unity of effort displayed by the nations of the Entente in the prosecution of the war have also drawn them more closely together in science and research, with consequences that are bound to prove fruitful in coming years.

The Honorable Elihu Root, who combines the wide vision of a great statesman with a keen appreciation of the importance and methods of scientific research, has recently expressed himself as follows:

> Science has been arranging, classifying, methodizing, simplifying everything except itself. It has made possible the tremendous modern development of the power of organization which has so multiplied the effective power of human effort as to make the differences from the past seem to be of kind rather than of degree. It has organized itself very imperfectly. Scientific men are only recently realizing that the principles which apply to success on a large scale in transportation and manufacture and general staff work apply to them, that the difference between a mob and an army does not depend upon occupation or purpose but upon human nature; that the effective power of a great number of scientific men may be increased by organization just as the effective power of a great number of laborers may be increased by military discipline.

The emphasis laid by Mr. Root on the importance of organization in science must not be misinterpreted. For many years he has been president of the board of trustees of the Carnegie Institution of Washington, and an active member of its executive committee. Thus kept in close touch with scientific research, he is well aware of the vital importance of individual initiative and the necessity of encouraging the independent efforts of the original thinker. Thus he goes on to say:

> This attitude follows naturally from the demand of true scientific work for individual concentration and isolation. The sequence, however, is not necessary or laudable. Your isolated and concentrated scientist must know what has gone before, or he will waste his life in doing what has already been done, or in repeating past failures. He must know something about what his contemporaries are trying to do, or he will waste his life in duplicating effort. The history of science is so vast and contemporary effort is so active that if he undertakes to acquire this knowledge by himself alone his life is largely wasted in doing that; his initiative and creative power are gone before he is ready to use them. Occasionally a man appears who has the instinct to reject the negligible. A very great mind goes directly to the decisive fact, the determining symptom, and can afford not to burden itself with a great mass of unimportant facts; but there are few such minds even among those capable of real scientific work. All other minds need to be guided away from the useless and towards the useful. That can be done only by the application of scientific method to science itself through the purely scientific process of organizing effort.

It is plain that if we are to have effective organization in science, it must be adapted to the needs of the individual worker, stimulating him to larger conceptions, emphasizing the value of original effort, and encouraging independence of action, while at the same time securing the advantages of wide cooperation and division of labor, reducing *unnecessary* duplication[2] of work and providing the means of facilitating research and promoting discovery and progress.

A casual view of the problem of effecting such organization of science might lead to the conclusion that the aims just enumerated are mutually incompatible. It can be shown

[2] Some duplication is frequently desirable.

by actual examples, however, that this is not the case, and that an important advance, in harmony with Mr. Root's conception, is entirely possible.

It goes without saying that no scheme of organization, effected by lesser men, can ever duplicate the epoch-making discoveries of the Faradays, the Darwins, the Pasteurs, and the Rayleighs, who have worked largely unaided, and who will continue to open up the chief pathways of science. Even for such men, however, organization can accomplish much, not by seeking to plan their researches or control their methods, but by securing cooperation, if and when it is needed, and by rendering unnecessary some of the routine work they are now forced to perform.

Let us now turn to some examples of organized research, beginning with a familiar case drawn from the field of astronomy, where the wide expanse of the heavens and the natural limitations of single observers, and even of the largest observatories, led long ago to cooperative effort.

In the words of the late Sir David Gill, then Astronomer Royal at the Cape of Good Hope, the great comet of 1882 showed "an astonishing brilliancy as it rose behind the mountains on the east of Table Bay, and seemed in no way diminished in brightness when the sun rose a few minutes afterward. It was only necessary to shade the eye from direct sunlight with a hand at arm's length, to see the comet, with its brilliant white nucleus and dense white, sharply bordered tail of quite half a degree in length." This extraordinary phenomenon more brilliant than any comet since 1843 marked the beginning of celestial photography at the Cape of Good Hope. No special photographic telescope was available, but Sir David enlisted the aid of a local photographer, whose camera, strapped to an equatorial telescope, immediately yielded pictures of exceptional value. But even more striking than the image of the comet itself was the dense background of stars simultaneously registered upon these plates. Stellar photographs had been taken before, but they had shown only a few of the brighter stars, and no such demonstration of the boundless possibilities of astronomical photography had ever been encountered. Always alive to new opportunities and keen in the appreciation of new methods, Sir David adopted similar means for the mapping of more than 450,000 stars, whose positions were determined through the cooperation of Professor Kapteyn, of Groningen, who measured their images on the photographs.

Stimulated by this success, the Henry brothers soon adapted photographic methods for star charting at the Paris Observatory, and in 1887 an International Congress, called at Sir David's suggestion, met in Paris to arrange for a general survey of the entire heavens by photography. Fifty-six delegates of seventeen different nationalities resolved to construct a photographic chart of the whole sky, comprising stars down to the fourteenth magnitude, estimated to be twenty millions in number. A standard form of photographic telescope was adopted for use at eighteen observatories scattered over the globe, with results which have appeared in many volumes. These contain the measured positions of the stars, and are supplemented by heliogravure enlargements from the plates, estimated, when complete for the entire atlas of the sky, to form a pile thirty feet high and two tons in weight.

The great cooperative undertaking just described is one that involves dealing with a task that is too large for a single institution, and therefore calls for a division of labor among a number of participants. It should be remembered, however, that a very different mode of attacking such a problem may be employed. In fact, although the difference between the two methods may seem on first examination to be slight, it nevertheless involves a fundamental question of principle, so important that it calls for special emphasis to any discussion of cooperative research.

One of the great problems of astronomy is the determination of the structure of the sidereal universe. Its complete solution would involve countless observations. Nevertheless, Professor Kapteyn, the eminent Dutch astronomer, resolved many years ago to make a serious effort to deal with the question. In order to do so, as he had no telescope or other observational means of his own, he enlisted the cooperation of astronomers scattered over the whole world.

In organizing his attack, he recognized that the inclusion of only the brighter stars, or even of all those contained in the International Chart of the Heavens, would not nearly suffice for his purpose. He must penetrate as far as possible into the depths of space, and therefore hundreds of millions of stars are of direct importance in his studies. Moreover, it is evident that if he were to confine his attention to some limited region of the sky, he could form no conclusions regarding the distribution of stars in other directions in space or such common motions as might be shown, for example, by immense streams of stars circling about the center of the visible universe.

As the measurement of the positions, the motions, the brightness, and the distance of all the stars within the reach of the most powerful telescopes would be a truly Utopian task, Professor Kapteyn wisely limited his efforts, and at the same time provided a means of obtaining the uniformly distributed observations essential to the discussion of his great problem. His simple plan was to divide the entire sky into a series of 206 selected areas, thus providing sample regions, uniformly spaced and regularly distributed over the entire sphere. Conclusions based upon the observation of stars in these areas are almost as reliable, so far as large general questions of structure and motion are concerned, as though data were available for all the stars of the visible sidereal universe.

As already remarked, Professor Kapteyn depends entirely upon the volunteer efforts of cooperating astronomers in various parts of the world. One of these astronomers assumes such a task as the determination of the brightness of the stars, of a certain range of magnitude, in the selected areas. Another deals with their positions and motions, another with their velocities measured with the spectroscope, etc. Each observer is able to take a large number of selected areas, covering so much of the sky that he may separately discuss the bearing of his results on some important problem, such as the distribution of the stars of each magnitude with reference to the plane of the Galaxy, the motions in space of stars of different spectral types, the velocity and direction of the sun's motion in space, the dependence of a star's velocity upon its mass. Moreover, each observer is free to use his utmost ingenuity in devising and applying new methods and instruments, in increasing the accuracy of his measures, and in adopting improved means of reducing and discussing his observations. He also enjoys the advantage of observing stars for which many data, necessary for his own purposes, have been obtained by other members of the cooperating group. Outside the selected areas, such data are usually lacking, because so small a proportion of the total number of stars has been accurately observed.

In physics, as well as in astronomy, there are innumerable opportunities for cooperative research. A good illustration is afforded by the determination of the exact wave-lengths of lines in the spectra of various elements, for use as standards in measuring the relative positions of lines in the spectra of celestial and terrestrial light-sources. This work was initiated in 1904 by the International Union for Cooperation in Solar Research, and is now being continued by the International Astronomical Union. The spectrum of iron contains thousands of lines, many of which are well adapted for use as standards. The work of determining their positions was undertaken by the members of an international committee, in accordance with certain specifications formulated by the Solar Union. But those who took part in the investigation were not bound by any rigid rule. On the contrary, they were encouraged to make every possible innovation in the manner of attack, in order that obscure sources of error might be discovered and the highest possible accuracy in the final results attained. The outcome demonstrates most conclusively that organized effort and freedom of initiative are by no means incompatible. Important instrumental improvements of many kinds were effected, sources of error previously unsuspected were brought to light, and means of eliminating them were devised. A by-product of the investigation, of great fundamental interest, was the discovery that the peculiar displacements of certain lines in the spectrum of the electric arc, which are greatest near the negative pole, are due to the influence of the electric field. These displacements, previously unsuspected, are sufficient to render such lines wholly unsuitable for use as standards unless rigorous precautions are observed. The international committee, in the light of the new information thus rendered available, will now have no difficulty in completing its task of determining the positions of standard lines with an accuracy formerly unattainable.

The variation of latitude is another subject in which international cooperation has yielded important results. It was found some years ago by astronomical observations that the earth's axis does not maintain a fixed direction in space, but moves in such a way as to cause the earth's pole to describe a small but complicated curve around a mean position. The change in the direction of the axis is so slight, however, that the most accurate observations made simultaneously at different points on the earth, are required to reveal it. These were undertaken at several stations widely distributed in longitude, in Italy, Japan, and the United States. A new photographic method has recently been devised which will probably render unnecessary the use of more than two stations in future work.

An extensive cooperative investigation planned by the Division of Geology and Geography of the National Research Council involves the joint effort of geologists and chemists in the study of sediments and sedimentary deposits. This is of great importance in connection with many aspects of geological history, and also because of its bearing on economic problems, such as the origin and identification of deposits or accumulations of coal, oil, gas, phosphates, sodium nitrate, clay, iron, manganese, etc.

The essential requirements are sufficient information on (1) modern sediments and deposits and (2) changes in sediments after deposition and the causes of such changes.

In the study of sediments now in process of formation it is important to learn the mechanical state and shapes of particles of different sizes, their mineralogical and chemical composition, the arrangement of the material composing the deposit, the source of the material, the transporting agencies, and the cause of precipitation. Modern deposits must be studied in the scores of forms in which they are laid down: in deserts and arid regions and in humid climates, in the beds of great lakes, in the track of glaciers, and in marine beds off the coast, in deltas and bays, or on submarine plateaus, in lagoons, and on reefs in subtropical and tropical waters.

In much of this work chemical investigations are essential, especially on the composition of the waters flowing into the ocean, yielding data on the chemical degradation of the continent and the amount of soluble material discharged into the sea.

In undertaking this extensive investigation, which would include the studies just cited and others on ancient deposits, the following procedure is proposed: (1) To make a more complete survey than has yet been made of the investigations that are at present under way in the United States and Canada. (2) To prepare, in the light of present geological knowledge, a program for the investigations needed to supply an adequate basis for interpreting sediments. As knowledge advances, the program will have to be modified. (3) To canvass the field for existing agencies that are suitable in prosecuting such investigations. (4) To assign problems to those institutions or individuals prepared properly to prosecute researches of the kind needed. (5) To provide additional agencies for the study of problems of sedimentation and thereby make possible investigations for which there are either no provisions or only inadequate provisions at present.

It is easy to see how an investigator choosing to deal with some aspect of this large general problem would be assisted by information regarding related work planned or in progress, and how readily, as a member of the group, he could render his own researches more widely useful and significant.

Another interesting piece of cooperative research, which involves the joint activities of geographers, physicists, zoologists, and practical fishermen, is centered largely at the Marine Biological Laboratory at La Jolla, California. Systematic measurements of the temperature of the Pacific near the coast show occasional upwelling of cold water. Simultaneous biological studies reveal a change in the distribution of microscopic organisms with the temperature of the water. This has an immediate practical bearing, because the distribution of the organisms is a dominant factor in the distribution of certain food fishes. The source of the temperature changes and their influence on meteorological phenomena, are other interesting aspects of this work.

In the field of engineering, the possibilities of cooperative research are unlimited. The fatigue phenomena of metals have been chosen by the Engineering Division of the National Research Council, acting in conjunction with the Engineering Foundation, as the subject of one of many cooperative investigations. Metals and alloys which are subjected to long-repeated stresses frequently break down, especially in aircraft, where the weight of the parts must be reduced to a minimum. The elastic limit and, to a lesser degree, the ultimate strength of steel can be raised by working it cold, provided that a period of rest ensues after cold-working. The tests indicate, however, that increased static strength due to cold working does not necessarily indicate increased resistance to fatigue under repeated stress. In the case of cold-stretched steel, for low stresses the fatigue strength is actually less than for the same steel before stretching.

These phenomena, and others that illustrate the complexity of this problem, afford abundant opportunity for further research. The membership of the committee includes representatives of educational institutions, the Bureau of Standards, and several large industrial establishments. The work was divided among the members, two dealing with its metallographic features, two with machines for testing, two with mechanics of the materials involved, and one with a survey of the subject from the standpoint of the steel manufacturer. The results already obtained promise much for the future success of this undertaking.

Scores of other illustrations of effective cooperation in research might be given, especially in astronomy, where each of the 32 committees of the International Astronomical Union is constituted for the purpose of organizing cooperative investigations. In spite of the length of this list of committees, it can not be said that astronomy offers any unique possibilities of joint action. The division of the sky among widely separated observers is only a single means of cooperation, which may be paralleled in geology, paleontology, geography, botany, zoology, meteorology, geodesy, terrestrial magnetism and other branches of geophysics, and in many other departments of science. Most of the larger problems of physics and chemistry, though open to study in any laboratory, could be attacked to advantage by cooperating groups. In fact, it may be doubted whether research in any field of science or its applications would not benefit greatly by some form of cooperative attack.

As for the fear of central control, and of interference with personal liberty and individual initiative, which has been entertained by some men of science, it certainly is not warranted by the facts. Cooperative research should always be purely voluntary, and the development of improved methods of observation and novel modes of procedure, not foreseen in preparing the original scheme, should invariably be encouraged. They may occasionally upset some adopted plan of action, but if the cooperating investigators are following the wrong path, or neglecting easily available means of improving their results, the sooner this is discovered the better for all concerned.

Canada and the United States, enjoying similar natural advantages, and lying in such close proximity as to permit the greatest freedom of intercourse, are most favorably situated to profit by cooperation in research. In both countries national movements for the promotion of research are in progress and important advances are being made. The example set by the Canadian government in establishing the Honorary Advisory Council for Scientific and Industrial Research and that of the Royal Canadian Institute in organizing this series of addresses on research and its applications, have stimulated and encouraged us in the United States. The friendly bonds that have joined the two countries in the past have been greatly strengthened by the war, and I am sure that our men of science will welcome every opportunity to cooperate with yours in common efforts to advance science and research.

George Ellery Hale

GENERAL CHEMISTRY AND ITS RELATION TO THE DISTRIBUTION OF STUDENTS' SUPPLIES IN THE LABORATORY

The object of the general chemistry laboratory is, I take it, to teach chemistry. Its mechanical aspect is clearly a business on a par with any other undertaking that has a special object in view. True, the methods will differ somewhat from other endeavors, but the main idea of striving "to put across" a definite proposition puts the laboratory side of teaching chemistry on a straight business basis, and subject to the ordinary rules of business. Now a business firm no matter what the character of its work, knows that if they are to compete with others, they must avail themselves of every method, scheme or device that will cheapen production, facilitate transportation, add to the efficiency of their employees, or in any other way make better goods at a lower price than the competing firm. They are ever on the watch for a new idea and many dollars' worth of machinery are often scrapped to give place to a newer and more efficient machine. Many firms employ efficiency experts constantly seeking to improve or save anywhere and everywhere throughout the works. No progressive firm ever stands still, but is ever changing its methods for better ones. This does not seem to be true always in the conducting of a chemical laboratory. What "Bunsen did" many years ago is good enough now, and the old song, "the old time religion is good enough for me" seems to apply very appropriately to the management of many laboratories.

Such a state of affairs should not be, and these laboratories with unchanging methods will go to the wall as surely as will a business house run on similar ideas.

A recent questionnaire sent to a large number of institutions in all parts of this country reveals the fact that general chemistry is regarded as the most important and vital course in the department. The grade of work done in all other courses is determined by the nature of this course. If it is poorly given, all other courses are built on a poor foundation, and a poorly trained chemist is the result. The importance of this course is further brought out by this questionnaire, when we note that the number of laboratory hours in general chemistry varies from six to eight per week, for one year. In some cases this is in addition to a year of physics and chemistry in the high school. This, in many cases means that a student before he can take qualitative analysis in college has had in the high school one year of chemistry of say five hours a week for forty weeks, which makes a total of two hundred hours. In college, he has two laboratory afternoons of three hours each and three or four recitation hours a week for a year of thirty weeks, which amounts to 270 hours as a minimum. In other words, the student has had 200 hours in high school and 200 hours in college, or a total of 470 hours, exclusive of all home study both in high school and college. A few years ago these same institutions gave only five hours a week to general chemistry, but the growth of chemistry in this country has demanded a correspondingly increased preparation of students (on the part of institutions) and a very generous response has been given all over America. This increased preparation has been made possible by putting into the students earlier and basic training the best the institution had, in quality of instruction, equipment, largely increased laboratory time, and a universal recognition that the important course to the department, as a whole, is general chemistry. It might be said, and some progressive administrators and teachers *do* say, that a chemistry department can be rated in terms of its general chemistry. We can almost say that there is no department of chemistry in this country that can be classed as a great or strong department whose general chemistry is not the best course that the department can secure by having experienced teachers to handle the work, having excellent equipment, modern laboratories, and a sufficient number of laboratory hours to do the work required. Unfortunately some few large institutions still have not changed their general chemistry to meet the new conditions. One has only 4½ hours a week for one year without a year of high school chemistry as a prerequisite; another has had its hours reduced by the board of trustees from five hours a week for a year to four (without a year of high-school chemistry as a prerequisite); this despite the strong protest of the administrative head and the entire teaching staff. This is certainly a mistake, a short-sighted policy, and a backward step by the board. Why should a body of business men who are not experts in this line, determine the policy of a department and neglect the advice of those who do know and have the good of the department at heart?

The greatest confirmatory proof of the statement made that a department of chemistry is great in proportion to the quality of its general chemistry is found by making a list of those institutions, which rank highest in this country from the point of view of research and of the training of its students, and comparing the effort expended in making general chemistry the very best. It will be found that the institutions of the highest rank have a first class course in general chemistry with six hours a week or more in laboratory work for one year. Those who do not take this ever-growing and modern point of view will surely become decadent departments.

The ever-growing importance of chemistry will demand an ever increasing efficiency. I predict that the time is not far distant when an investigation carried on by such an organization as the Carnegie Foundation similar to that done in the medical schools[1] of this country and Canada, will be instituted, and a result similar to that of this report on low grade medical schools, viz., an elimination of those institutions who do not do so good chemistry work. When such a report is published, those low grade institutions will cease to teach chemistry, because the students, knowing the true state of affairs will either not elect chemistry, or if interested, will go elsewhere where the subject is properly taught.

Before taking up the working of the "Freas System"[2] in the general chemistry laboratory, we wish to review briefly the existing methods now in use.

First, the old side-shelf reagent system which is very common, in fact now exists in most college laboratories in this country. Nothing can be said in favor of this system, as it has no virtues, and possesses innumerable evils. It is wasteful, expensive, untidy; almost impossible to prevent contamination of chemicals and is one of the main sources for wasting students' time and encouraging petty theft. In a chemical laboratory of one of the oldest universities in this country, where the side-shelf reagent scheme is used, a student needs one particular chemical five times during the course. For this one chemical alone he has to walk five hundred feet during the term. One hundred and forty chemicals are used, and it can readily be seen that a large amount of time will be wasted if he makes but one trip for each chemical. One trip to the side shelf for these chemicals means a walk of thirteen miles, while a double trip, which is most common, would amount to a twenty-six mile walk or equal to two or more laboratory weeks work. The director of this department told me that while

[1] Published in a report to the Carnegie Foundation on Medical Education in the United States and Canada by Abraham Flexner, Bulletin Number 4, 1910.

[2] Science, May 30, 1919.

taking these laboratory walks to the side shelf the student was deep in chemical thought and therefore it was a good thing. My observation of students in this laboratory and elsewhere leads me to believe that this director seldom enters the chemical laboratory, and therefore does not know the true state of affairs, nevertheless he regards himself eminently qualified to pass on such matters.

One of the most serious objections to this system is not cost, or waste of students' time, but the slovenly habits which a student of a necessity acquires.

In going to a 2-kilogram bottle of potassium iodide, for example, to get 2 grams of that salt the neat and quantitative idea of general chemistry is absolutely lost, although he may be assigned to some general quantitative experiments during the course. Thus, the orderly habits which are so necessary to a good chemist, are not formed when they should be formed, viz., during the early days of his chemical training.

I can not pass without referring to a common sight a few years ago in another large laboratory in this country. Large bottles of chemicals were put on side tables for student use. A cheap porcelain pan balance and a box of weights stood nearby. Suppose a student needs 5 grams of potassium bromide, should it be a bit lumpy, a rusty ring stand served to break up the lumps. A handful of the expensive chemical was then placed on one pan of the scale and the old and corroded 5 gram weight on the other pan. The student brushed the excess chemical from the pan to the floor till he had remaining approximately 5 grams. In the morning I have seen the cleaners sweep up dust pan after dust pan full of valuable chemicals from the floor near this side table. There was seldom any supervision on the part of the instructor in charge when the students were getting their chemicals or conditions would probably not have been so bad. This institution of course was not famous for turning out great chemists and a sudden change in administration alone would save its life. To-day this same laboratory is one of the most up-to-date and progressive laboratories in this country. Few of the former teaching staff now remain, as they were too firmly fixed in the old ways to make reform possible.

The next step in the evolution of the handling of students' chemicals and supplies was to give him a kit of apparatus and place on his bench in the laboratory all the chemicals needed for the day or week. If two men worked on opposite sides of a bench this one set was sufficient for them both, *e. g.*, in a laboratory which holds 28 students at a time 14 such kits are used. This was a very great advance over the side-shelf reagent plan, as it eliminated a great deal of walking on the part of the student, thus enabling him to do much more work. One institution made this change and at the same time enormously increased the amount of assigned laboratory work per afternoon. While this scheme is a great improvement, it has still serious drawbacks. Chemicals are still bound to be mixed up and contaminated no matter how watchful the instructor may be. Certain chemicals are always running short, as some student will take more than his share even though a cheap balance is provided for every two men, so that weighing out approximate amounts is an easy and rapid matter.

Theft of chemicals is still possible, as no instructor can watch 25 students all at one time, and even if he could do so, he can not determine whether chemicals placed in a test tube were for laboratory or home use; this method while cheaper than the first is still expensive, because the students are bound to waste chemicals when they are handy and do not cost them anything; the bottles are always getting mixed up and out of place; and finally it entails enormous amount of work on the stock system or for the instructor, out of laboratory hours, as well as a certain amount of the same kind of stock work during the laboratory period.

In one institution[3] where this plan has been in operation for the past five years a special

[3] Professor C. D. Carpenter's laboratory at Teachers' College, Columbia University.

staff of women is employed to make up sets of common chemicals, place them on the students' desks and on completion of this set of experiments, refill the bottles and place them away for the next time needed. One equipping a week generally suffices for a laboratory with several fillings of certain bottles. This plan relieves the instructor of stock duties, but is still open to the objections named above.

In another large institution with nearly 1,000 students in general chemistry, the change was made from the side-shelf plan to the method of supplying a student chemicals at his bench. Here again the amount of laboratory work was nearly doubled per afternoon, because of the more efficient handling of supplies and a corresponding saving of students' time. Unfortunately in this institution no provision was made for the putting up of sets of chemicals by the stock division and the entire teaching staff in this division became stock keepers and more energy was expended in filling bottles than in giving instruction. This overload was at once observed in a decreased efficiency of work on the part of the instructor, and strenuous appeals have been made to the administrative head to relieve a most intolerable condition. Much cheaper and less highly trained people can and should be secured to fill bottles and do this kind of work, and a director of a chemistry department is short-sighted indeed who insists on his teaching staff spending most of their time doing the work of a ten-dollar-a-week boy. It can be clearly seen that the efforts to improve the work in general chemistry in this particular institution are not appreciated, or conditions will be improved at once and the teacher given a chance to perfect himself in his chosen profession and give the students the benefit of his experience. The failure of an executive to encourage and aid progressive teachers in the development of new ideas along this line is not only a very great injury to the teacher concerned, and to the institution as well, but is professional suicide to the administrator himself. It has been shown that the second scheme is an improvement over the first, but is still open to objections, and while it possesses considerable merit, it has many fatal defects.

The third plan, viz., the Freas System in the general chemistry laboratory has all the virtues of the second plan and none of its defects. In fact, when this plan is properly installed and carried out, it leaves little to be desired for both student and instructor.

The plan in brief is to give the student on his first day all the apparatus and chemicals he will need for that course. The student after the payment of all fees and deposits reports to his instructor and is assigned in writing to a bench in the laboratory. He takes this assignment to the stock room and receives his apparatus and chemicals in heavy cardboard or metal boxes and takes them to his bench. This kit he arranges in his desk as stated in his directions If he has properly arranged his material he can quickly find any special chemical or piece of apparatus and is ready for work within two hours of starting. He puts his own padlock on his bench and he alone is responsible for its contents till his course is completed at the end of the term. He has received just enough of each chemical to perform the experiment plus a slight excess to offset any possible unavoid able accident. Should he be careless and not perform his experiment properly he must go to the store room and sign for more chemicals which of course are charged to his account, and later deducted from his advance breakage and "excess chemicals" deposit. Right here it should be stated for clearness that the student is charged for all apparatus and chemicals, but is given as a free allowance the average value of the chemicals used by his class. If he has a modern bench, with a hod in front of him, all walking about has been eliminated, and the amount of laboratory work that he can do per afternoon can be nearly tripled over that possible under the side-shelf reagent scheme.

Contamination of chemicals is impossible under this plan, as each container is plainly labelled and is under the personal care of the student interested.

The factor of expense has been reduced to the minimum, as there can be no waste from the department's point of view and the student has received as a free allowance, sufficient chemicals for his needs, providing he is the average student and exercises moderate care. The possibility of theft is withdrawn absolutely, as the kit belongs to the student, to do with as he wishes, and no student will or can steal his own things. The prices on his list are selected from the most recent catalogue of the largest apparatus house in his vicinity, so he has no temptation to take things home because he saves by so doing. In fact in many cases an apparatus house will sell him things somewhat cheaper. Theoretically the student can if he wishes get all his kit elsewhere, and this is encouraged, as it will save the department the trouble of furnishing it, but the student would much rather take the department kit which is all ready made up and easy to procure, and is just exactly what he needs in his course.

This system takes out of the hands of the teaching staff all cares in regard to apparatus and chemicals, as this side of the work is handled by a trained body of men and women who soon learn to do the bottling of chemicals and the assembling of the same into kits, with the greatest speed and accuracy. In rush times, student help makes possible the doing of a great deal of work in a short time and is a benefit to both the department and the student.

The Freas System is just as helpful and as easily installed in a high school as in a technical school, college or university laboratory.

Of course each student must have the average size bench, viz., about 8,000 cubic inches, in order to hold this kit. Many laboratories give the student more space than this, but if one takes the measurement of a student bench in high schools and colleges all over this country, the figure 8,000 cubic inches is about the average. Unfortunately in a few good institutions circumstances over which the departmental authorities had no control, forced a reduction of students' bench space. More students were crowded into the laboratories than the benches were able to accommodate, and it seemed at that time wise to begin to reduce the size of the student bench. In one case this went on until a student finally had but one drawer of about 400 cubic inches. In such a space only the most meager equipment can be placed, and the student of course suffers through lack of apparatus and an enforced walking to the storeroom and back for every little thing he may need. The pendulum has started to swing back, and I have no doubt that before long this department will restore the normal 8,000 cubic inches.

Some may say that the cost of installing this system is prohibitive. This is not so, as can be shown by actual figures in institutions using it. Others may wish to know where this scheme has been tried out for a sufficient length of time as to insure it being out of the experimental stage. The department of chemistry of Columbia University in New York City has been using this system for the past eight years with an ever-increasing satisfaction to all concerned, in all divisions of the department.

There is no question but that the Freas System is the cheapest, everything considered, most efficient, and up-to-date method of handling students' supplies yet devised. If a chemical department wishes quality of work above everything else, then this system will be an enormous aid to both student and instructor; but if quantity is the object to be obtained, then it does not matter so much, as quality of work is probably given but little thought. If a department must handle large numbers of students and wishes quality of work as well, then there is no question but that the quicker the authorities investigate the Freas System the better. No unprejudiced man can see this system in operation without feeling that he will not be satisfied till it is as speedily as possible installed in his own department.

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HERBERT SPENCER WOODS

Herbert Spencer Woods, assistant professor in the department of physiology, pharmacology and biochemistry, died on January 4, 1920, in Dallas, Texas, following an operation.

Professor Woods was born and raised a Missourian and descended from Virginia and Kentucky stock.

He received the A.B. and A.M. degrees from the University of Missouri. While pursuing work for the Master's degree he came under the influence of the late Waldemar Koch with whom he conducted fundamental research on the distribution of the lecithins.

Later work and study were had at the Universities of Illinois, Wisconsin, and California and at the Ohio Agricultural Experiment Station. His earliest teaching experiences were enjoyed at the Universities of Illinois and Wisconsin and later on in a high school of California.

Professor Woods's first teaching in Texas was at the Texas Christian University, at Fort Worth, and a little later at the Grubbs Vocational College, an institution connected with the Agricultural and Mechanical College of Texas.

Those who gained an intimate acquaintance with Professor Woods found him to be a man possessed of extraordinary ability. His habits were simple and abstemious, his temperament sensitive and impetuous, very often not sanguine and serene enough for steady happiness.

As a man of science he was essentially clean, candid and a devout lover and seeker of the truth.

When he died he was thirty-six years of age, a period in life when most begin to live in enjoyment of the progression of science. He was a fellow of the American Association for the Advancement of Science.

Lewis William Fetzer

SCIENTIFIC EVENTS

THE LISTER MEMORIAL INSTITUTE IN EDINBURGH

As has been noted in Science, the project originated before the war, for the establishment in Edinburgh of a permanent memorial to the late Lord Lister, has been revived. The *British Medical Journal* states that the University of Edinburgh, the Royal College of Physicians and the Royal College of Surgeons of Edinburgh have come to the conclusion that the most suitable form for such a memorial will be an institute in which the scientific investigation of disease in any of its forms can be undertaken, and in which the principal sciences concerned can be adequately taught. It was in Edinburgh that Lister elaborated and consolidated his system, and it is appropriate that the scientific spirit which animated him and the methods of research he developed should be commemorated and continued in that city. Lister's work in the wards of the Royal Infirmary would have been fruitless—could not indeed have been carried out—had he not first tested his theories in the laboratory. It was in and through research that his system of treatment came to fruition. Research was the keynote of his work, and it is to research and the teaching of the results of research that the proposed memorial is to be dedicated. The need for such a centralized teaching and research institute in Edinburgh, it is said, is pressing. At the present time the burden of such work is borne by the university department of pathology and the laboratory of the Royal College of Physicians. Of these, the former, built and equipped thirty-five years ago, is now inadequate, and the resources of the latter, particularly as regards the accommodation of the workers, are entirely insufficient, even for present needs. There is as yet no permanent memorial to Lister in Edinburgh, and it is felt that the rapid development of pathology, of bacteriology, of clinical pathology, of pathological chemistry, and of other cognate branches of knowledge has widened the field to such an extent as to render it necessary that the building erected to his memory shall be modern in design and equipment, and sufficiently large to house all the departments enumerated. The proposed new institute will be managed by a board on which the university and the two Royal Colleges will be represented.

A committee has been formed to make an appeal for £250,000 to pay for the site, to erect and equip the necessary buildings, and to provide for maintenance, apart from remuneration to research workers. A site, described as extensive and extremely suitable, has been secured close to the Edinburgh Royal Infirmary and the medical school of the university at a cost of over £50,000. The president of the committee is the Right Hon. A. J. Balfour, M.P., chancellor of the university, and vice-presidents are the Duke of Atholl, the Earl of Rosebery, Earl Beatty, Lord Glenconner, Lord Leverhulme, and Sir J. Lorne MacLeod. An appeal has been issued, signed by Sir J. A. Ewing, principal of the university, Sir R. W. Philip, president of the Royal College of Physicians of Edinburgh, and George Mackay, president of the Royal College of Surgeons of Edinburgh. The university has given £10,000, the college of physicians £10,000, and the college of surgeons £5,000.

A JOURNAL OF ECOLOGY

Cooperation in science doubles the value of each man's knowledge and efforts. The Ecological Society of America, comprising zoologists, botanists, foresters, agricultural investigators, climatologists and geographers, is a link in the cooperative chain which will bind the natural sciences together. The society has long felt the need of having its own journal, and at its St. Louis meeting last December voted to start a serial publication to present original papers of an ecological character.

The enterprise is made possible by the generous action of the owners of *Plant World*, who are giving this magazine to the Ecological Society to continue as its official organ. The new serial will begin as an illustrated quarterly of about 200 to 300 pages per year, known as *Ecology*. The Brooklyn Botanic Garden is undertaking the publication of this journal in cooperation with the Ecological Society under an agreement substantially like that under which the *American Journal of Botany* is now being published. The *Plant World* will complete the present volume, number 22, and *Ecology* will begin with the number for March, 1920. Barrington Moore, now serving his second term as president of the Ecological Society, has been elected editor-in-chief.

PUBLIC LECTURES OF THE CALIFORNIA ACADEMY OF SCIENCES

The California Academy of Sciences, under the direction of Dr. Barton Warren Evermann, maintains a Sunday afternoon lecture course devoted to popular science topics in its Museum in Golden Gate Park. This course is steadily gaining in popularity and serves a useful purpose in bringing into closer relations the research man and the public. The lecturers are largely drawn from the research departments of the University of California and Stanford University. Following is the schedule for February and March:

February 1. "The ocean as an abode of life." Dr. W. K. Fisher, director of the Hopkins Marine Station of Stanford University.

February 7. "Life of the deep sea." J. O. Snyder, associate professor of zoology, Stanford University. Illustrated.

February 15. "The ocean meadows, or the microscopic life of the open sea." Dr. C. A. Kofoid, professor of zoology, University of California. Illustrated.

February 22. "Fishes of the California coast." E. C. Starks, assistant professor of zoology, Stanford University. Illustrated.

February 29. "Marine mammals." Dr. Harold Heath, professor of zoology, Stanford University. Illustrated.

March 7. "The fur seals of the Pribilof Islands." Dr. Barton Warren Evermann, director of the Museum, California Academy of Sciences. Illustrated.

March 14. "Life between tides." Dr. W. K. Fisher, director of the Hopkins Marine Station of Stanford University. Illustrated.

March 21. "Oceans of the Past." Dr. J. P. Smith, professor of paleontology, Stanford University.

March 28. "Systematic and economic phases of California marine algæ." Dr. N. L. Gardner, assistant professor of botany, University of California.

DEATHS FROM INFLUENZA AND PNEUMONIA

The Bureau of the Census has issued a bulletin containing records of deaths in larger cities from influenza and pneumonia which are as follows:

	Influenza, Week Ending January					Pneumonia, Week Ending January				
	3	10	17	24	31	3	10	17	24	31
Albany	2	1	0	0	3	4	2	2	3	11
Atlanta					1	6	17	10	10	
Baltimore	1	0	1	0	14	29	20	34	24	45
Birmingham	2			2	4	9	11	8	14	10
Boston	0	1	0	2	25	24	27	28	43	
Buffalo	0	0	0	2	8	13	10	7	17	9
Cambridge	0	0	0	0	2	4	8	7	8	12
Chicago	6	13	21	200	586	92	94	132	272	523
Cincinnati	3	2	1	1	1	15	12	11	16	24
Cleveland	2	2	1	4	16	26	19	24	22	25
Columbus	0	3	0	2	5	5	12	9	6	17
Dayton	0	0	0	5	10	7	4	7	8	
Denver	0	1	0	1	19	15	20	18	23	
Fall River	1	0	0	0	0	2	7	10	5	3
Grand Rapids	0	0	0	0		3	1	4	2	
Indianapolis		2		1		3	16	16	20	
Jersey City	0	0	2	5		12	14	12	19	
Kansas City	0	0	2	45	73	12	13	27	51	47
Los Angeles	0	1	0	1	8	18	15	18	18	
Louisville	0	0	0	0	2	9	10	10	9	16
Lowell	0	0	0	0	1	3	5	4	2	6
Memphis	1	0	1	0	1	14	12	11	11	9
Milwaukee	1	1		11	27	14	24	13	34	114
Minneapolis	1	2	3	2	46	19	10	7	7	
Nashville	0	0	3	2	2	4	6	8	4	10
Newark	0	3	0	4	14	15	14	14	26	41
New Haven	1	0	0	1	8	10	6	8	9	
New Orleans	5	3	0	4	9	13	24	27	23	
New York	6	13	13	108	557	189	205	248	403	751
Oakland	0	0	2	3	12	7	4	6	17	
Omaha	0	0	1	1	12	5	4	6	12	
Philadelphia	2	2	5	3	16	62	53	70	105	137
Pittsburgh	1	0	2	5	11	54	47	51	50	65
Portland, Oregon						4	13	8	9	
Providence	1	0	0	1	2	5	12	13	7	12
Richmond	0	0	1	0	8	6	2	8	6	13
Rochester	0	0	0	1	9	8	13	7	11	14
St. Louis	2	2	0	6	77	45	55	41	67	159
St. Paul	0	0		12	52	7	4		14	
San Francisco	1	1	6	15	27	19	13	20	33	32
Seattle	2		0	1	0	7	2	4	6	12
Spokane	0	0	1	0	1	0	4	2	3	
Syracuse	0	0	0	1	8	6	9	8	9	23
Toledo	0	1	0	2	7	8	8	8	7	11
Washington, D.C.	1	0	2	28	77	31	22	25	53	104
Worcester	0	0	0	0	4	5	10	9	7	10
Total	42	54	68	482	1,765	868	913	1,020	1,525	2,265

GIFTS TO THE NATIONAL RESEARCH COUNCIL

The last issue of the *Proceedings* of the National Academy of Sciences prints the minutes of a joint meeting of the executive board of the National Research Council with the council of the National Academy of Sciences on June 24, 1919, which records gifts for the support of the council from the Carnegie Corporation and the Rockefeller Foundation.

The president of the National Academy of Sciences presented the following resolution which was passed by the Carnegie Corporation of New York on June 3, 1919, making provision to cover expenses of the National Research Council during the coming year:

Resolved, that, pursuant to paragraph 3 of the resolution recording action taken at the special meeting of the board of trustees held March 28, 1919, the sum of one hundred thousand dollars ($100,000) be and it hereby is appropriated to the National Academy of Sciences for the use of the National Research Council for the year beginning July 1, 1919; and that the treasurer be and he hereby is authorized to make payments as needed to the extent of $100,000 on certificates of the chairman of the National Academy of Sciences and the chairman of the National Research Council.

Moved: That the executive board of the National Research Council go on record as appreciating the recognition by the Carnegie Corporation of New York of the work which it is accomplishing by appropriating the sum of $100,000 for its use for the year beginning July 1, 1919.

The chairman of the National Research Council presented the following letter from the Rockefeller Foundation, appropriating the sum of $20,000 to meet the expenses involved in conferences of special subcommittees on research subjects of the Division of Physical Sciences.

THE ROCKEFELLER FOUNDATION

June 20, 1919

My Dear Mr. Merriam: I have the honor to inform you that at a meeting of the executive committee of the Rockefeller Foundation held June 16, 1919, the following resolution was adopted:

Resolved: That the sum of twenty thousand dollars ($20,000) be, and it is hereby, appropriated to the National Research Council for the Division of Physical Sciences, of which so much as may be necessary shall be used to defray the necessary travelling and other expenses involved in conferences of the subcommittees of that division during the year 1919.

Very truly yours,
Edwin R. Embree,
Secretary

Moved: That the chairman of the National Research Council express in behalf of the executive board its appreciation of the interest which the Rockefeller Foundation has shown in the research work of the Division of Physical Sciences by appropriating the sum of $20,000 to meet the expenses involved in conferences of special subcommittees on research subjects of that division.

SCIENTIFIC NOTES AND NEWS

Officers of the Geological Society of America were elected at the Boston meeting, as follows: *President,* I. C. White, Morgantown, W. Va. *First Vice-president,* George P. Merrill, Washington, D. C. *Second Vice-president,* Willet G. Miller, Toronto, Canada. *Third Vice-president,* F. B. Loomis, Amherst, Mass. *Secretary,* Edward B. Mathews, Baltimore, Md. *Editor,* Joseph Stanley-Brown, New York, N. Y. *Councilors,* H. E. Gregory, New Haven, Conn.; R. A. Daly, Cambridge, Mass.; William S. Bayley, Urbana, Ill.; E. W. Shaw, Washington, D. C.; T. W. Vaughan, Washington, D. C.; George F. Kay, Iowa City, Iowa. *Past Presidents,* Frank D. Adams, Whitman Cross and John C. Merriam, are likewise *ex officio* on the council.

Professor Lafayette B. Mendel, of Yale University, has been elected an associate member of the Société Royale des Sciences Médicales et Naturelles of Brussels.

Dr. R. Bennett Bean has been elected a corresponding member of the Anthropological Society of Rome.

Professor Arthur Stanley Eddington, of the University of Cambridge, has received the G. de Pontécoulant prize of the Paris Academy of Sciences for his studies of stellar motions.

Professor H. G. Greenish, dean of the Pharmaceutical Society School of Pharmacy, London, has received the honorary doctorate from the University of Paris.

Dr. Hanz Gertz, of the physiological laboratory of Karolina Institute, Stockholm, has been awarded the Jubilee Prize by the Swedish Medical Association for his work on the functions of the labyrinth.

Mr. T. W. Reader has been selected by the British Geologists' Association as the first recipient of the Foulerton award. The sum of money which has enabled the association to make this award is the recent gift of Miss Foulerton in accordance with the wishes of her late uncle, Dr. John Foulerton, who was for many years secretary to the association.

Mr. R. M. Davis resigned from the Power Section of the Water Resources Branch, U. S. Geological Survey, in October, to take up work as statistician for the *Electrical World*. He takes the position of Mr. W. B. Heroy, formerly of the survey, who has entered the employ of the Sinclair Oil Corporation.

Professor W. S. Brown, who has been acting as chief of the division of horticulture of the Oregon Agricultural College since Professor C. I. Lewis resigned to become manager of the Oregon Fruit Growers' Association, has been appointed permanent chief.

Since the return of Mr. Eugene Stebinger from private work in the Tampico oil field of Mexico he has been appointed chief of the foreign section of the Mineral Resource Branch, U. S. Geological Survey.

Dr. Frank Schlesinger, director of the Allegheny Observatory, lectured on "The Einstein Theory of Relativity from the Point of View of an Astronomer" at the Carnegie Institute of Pittsburgh on January 27. The lecture was followed by a general discussion of the subject.

The death is announced of Dr. Christian R. Holmes, dean of the college of medicine, University of Cincinnati. It was largely through his energy and enthusiasm that the General Hospital with its fine equipment was built and the College of Medicine organized. By the terms of his will Dr. Holmes gave $25,000 to establish a medical journal. A memorial fund will be collected by popular subscription in order to establish a department of research in medicine.

Dr. David S. Pratt, who since the beginning of the year has been a practising chemist at St. Louis, has died at the age of thirty-four years. He had taught in the University of Pittsburgh and later had become an assistant director of the Mellon Institute of Industrial Research. He had received his doctor's degree from Cornell University.

Dr. E. R. Hoskins, assistant professor of anatomy in the University of Minnesota, died on January 30 after a brief illness with influenza and pneumonia.

The death is announced of Professor Severin Jolin, incumbent of the chair of chemistry and pharmacology at Stockholm and at Upsala. To him is ascribed in large part the high standard of the Swedish Pharmacopeia as he has taken an active share in the revision of the different editions. He had recently been elected president of the Swedish Medical Association.

The *Bulletin* of the American Mathematical Society records the deaths of the following German mathematicians: Professor E. Böttcher, of the University of Leipzig, at the age of seventy-two years; Professor O. Dziobek, of the Charlottenburg Technical School, at the age of sixty-three years; Professor F. Graefe, of the Charlottenburg Technical School, at the age of sixty-three years; Professor E. Netto, of the University of Giessen, at the age of seventy-two years; Dr. K. T. Reye, formerly professor at the University of Strassburg, at the age of eighty-one years; Professor R. Sturm, of the University of Breslau, at the age of seventy-seven years, and Dr. J. Wellstein, formerly professor at the University of Strassburg, in his fiftieth year.

The annual meeting of the Society of American Foresters was held in New York City on January 14, 1920. The meeting was given up to the consideration of papers on technical forestry presented by members, and reports of special committees and the officers for the past year.

On October 3, 4, 5 and 6 there was held at Batavia, Java, the first Dutch East Indies Scientific Congress with two hundred and seventy members in attendance. Papers were read before mathematical, biological, medical and geological sections and at the General Session it was decided to continue the association and to hold the next meeting in 1921. The congress concluded with a two-days' excursion to the island-volcano Krakatau to study the renewing vegetation and geological formations.

The eighth annual meeting of the American Association of Variable Star Observers, which was held at Harvard College Observatory on November 8, was attended by about fifty members and friends. Mr. Leon Campbell was elected president for the year and Professor Anne Young, of Mount Holyoke, was elected vice-president. The program of the meeting consisted of papers and reports, followed by a banquet at which Rev. Joel Metcalf was the guest of honor. This association is composed of amateur astronomers who are anxious to contribute observations of value, and over a hundred thousand observations have been published. It offers an opportunity for all lovers of astronomy to do work of value; particularly those who have small telescopes stored away and do not know how to put them to use. Any one interested should write to Mr. William T. Olcott, secretary, 62 Church Street, Norwich, Conn.

The University of Illinois has recently added to its collections a historical herbarium of about 3,000 specimens formed early in the last century by Dr. Jonathan Roberts (1805–1878). Dr. Paddock, after holding a professorship in the literary department of the college became a professor in Worthington Medical College, at Worthington, Ohio, when Dr. J. L. Riddell, well known as a botanist in his day, moved from that institution to the University of Louisiana. He is said to have been a scholarly man, and an ardent botanist, who enjoyed particularly the friendship of Sullivant, the banker-bryologist of Columbus.

A meeting was held in New York City on December 3 to commemorate the eightieth anniversary of the beginning of Captain John Ericsson's work in this country, and the thirtieth anniversary of the death of Captain Ericsson and of Mr. Cornelius H. DeLamater, founder of the DeLamater Iron Works, where Captain Ericsson's most important work was executed. The exercises included addresses by Hon. Lewis Nixon, commissioner of public works, Borough of Manhattan; Rear-Admiral Bradley A. Fiske and Hon. W. A. Ekengren, Sweden's Minister at Washington. Mr. H. F. J. Porter gave an illustrated historical review of the work performed at the Phœnix Foundry and the DeLameter Iron Works.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Charles H. Swift, of Chicago, has given $5,000 to the University of Chicago for its department of geography, for the purpose of sending a member of its staff to Asia the coming autumn. Assistant Professor Wellington D. Jones is to make the trip. He will carry on geographic studies either in China or in India, the choice being determined by conditions in Asia when the trip is made. This will be the second trip of Professor Jones to Asia made possible by Mr. Swift's generosity.

Boston University has concluded an arrangement for an exchange of professorships in mathematics for the college year 1920–21 with Tsing Hua College, Peking, China. Professor Robert E. Bruce, chairman of the department in Boston University, will exchange with Professor Albert H. Heinz, of Tsing Hua. Professor Heinz, head of the department of mathematics, is a graduate of the University of Missouri and has been at Tsing Hua nine years. This college is under the control of the Chinese government and was founded with part of the returned Boxer Indemnity. Professor Bruce will sail from the Pacific coast in April. Professor Heinz will reach this country in time to begin his work at Boston University at the opening of the college in September.

In recognition of the gift of £34,500 by Sir Ralph Forster, Bt., to the fund for the chemistry building and equipment at University College, London, the organic department of the chemical laboratories will be known by his name.

At the University of California, Assistant Professor B. M. Woods has been promoted to a full professorship of aerodynamics.

Dr. Carroll W. Dodge has succeeded Professor Harlan H. York, as head of the department of botany at Brown University and

Walter H. Snell, formerly of the Office of Investigations in Forest Pathology of the Department of Agriculture, has accepted an instructorship in the same department.

Professor A. K. Peitersen, who for the past seven years has been assistant professor of botany and assistant botanist of the experiment station, of the University of Vermont, has gone to Fort Collins, Colorado, where he has been elected professor of botany.

Professor Swale Vincent, who has occupied the chair of physiology at the University of Manitoba (Winnipeg) since 1904, has been appointed professor of physiology in the University of London (Middlesex Hospital). He will probably take up his duties in London at the beginning of May.

Dr. Harold Pringle, lecturer on histology and assistant in physiology in the University of Edinburgh, has been appointed professor of physiology in Trinity College, Dublin, succeeding the late Sir Henry Thompson.

DISCUSSION AND CORRESPONDENCE

FURTHER HISTORY OF THE CALCULUS

To the Editor of Science: Please make a correction of my college address to Rose Polytechnic Institute, in the paper on "The Early History of Calculus," in Science for July 11. The error is due perhaps to the fact that only my name was signed to the article.

The quotation from the "Encyclopedia Britannica" should be stated as from the ninth edition, since it has been omitted in the eleventh. The historical part of the article "Inf. Cal." is entirely changed in the last edition to one of still stronger German bias. It makes the statement, for example, that Leibniz did not meet Collins, nor see the tract "De analysi per aequationen . . ." on his first visit to London in 1673. No verification of this statement is offered. English histories and documents have it the other way with regard to Collins.

Evidence of the possible duplicity of Collins which indicates that he was an agent under Oldenberg as early as 1669, appears in the rewritten history. To quote:

> The tract "De analysi per aequationen . . ." was sent by Newton to Barrow, who sent it to John Collins with a request that it might be made known. One way of making it known would have been to print it in the *Philosophical Transactions* of the Royal Society, but this course was not adopted. Collins made a copy of the tract and sent it to Lord Brouncker, but neither of them brought it before the Royal Society. . . . In 1680 Collins sought the assistance of the Royal Society for the publication of the tract and this was granted in 1682, yet it remained unpublished. The reason is unknown. . . .

The usual history is that Collins was the active agent in soliciting the tract "to make it known." Also, Oldenberg was secretary of the Royal Society, and published the *Transactions* for his private profit, without supervision from the society. The relations of these two men were intimate. The tract was probably brought directly to Oldenberg—he has shown that he had knowledge of it—and that he did not act upon it in his official capacity is evidence of conspiracy to suppress it. When both were urging Newton, as already cited, to undertake "for the honor of England," a correspondence which Leibnitz had planned, it was at that time within their power to promote greater honor to England by publishing the tract in the *Transactions*. In reference to the threatened publication in 1680, the death of Oldenberg about two years before, had left Collins without his principal, if Oldenberg were such, and that transaction might have been a shrewd move on Collins' part to retain his honorariums through Leibniz. At least some cause delayed Leibniz seven years in the publication of his calculus, already prepared, while it was put in in the hands of the printer *immediately* after the death of Collins.

There is reason to believe that Leibniz had information of matters transpiring in England before he left Germany. It is difficult to explain otherwise the grandiloquent announcement of wonderful discoveries of new methods in mathematics, which heralded his visit to Paris in 1672, with no work to show, and with admittedly inferior mathematical knowledge for such work. The London exposure by

Pell, in 1673, is clarifying. Leibniz was a politician, not a mathematician, and worked and wrote for the power and prestige of Germany. To this end he founded the Berlin Academy of Science, and was perhaps the first to inaugurate that system of espionage on scientific work in foreign countries by which the usefulness and credit of as much of that work as possible might be transferred to Germany.

It may be urged that calculus has been benefited by the interference of Leibniz. This is true as to notation, but it has been harmful as to the theory and understanding of the subject. On the one hand we have an illogical infinitesimal method, on the other an incomplete derivative one in protest of the first, whose rival expounders reason along different lines, and hardly understand each other. Newton substitutes one rigorous theory, broader than either of these, neglecting no quantity, however small, leaving no unexplained symbol, and yet of an arithmetical character of the utmost simplicity. A free translation of his definition in "Quadrature of Curves," is as follows:

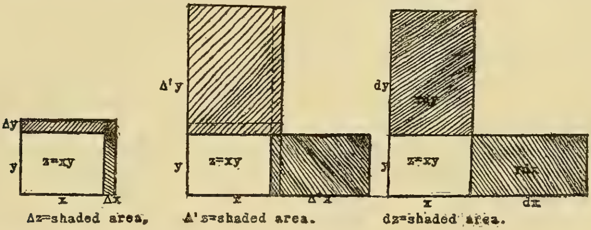
In their highest possible *approximation*, fluxions are quantities in the same ratio as the *smallest possible* corresponding increments of variables, or, in a form of exact statement, they are in the *first* ratio of nascent increments.

Thus fluxions, or differentials, are interpreted as ordinary arithmetical increments, but in a variation defined as *in the first ratio*, or, *as the variables begin to increase*, or, *in the instantaneous state*, which are all one. Starting from given corresponding values, x, y, z, the actual variables are corresponding increments to these with a common *first* value, 0; and starting with any corresponding increments, Δx, Δy, Δz, we form an *ideal* variation *in the same ratio*, $\Delta' x = N\Delta x$, $\Delta' y = N\Delta y$, $\Delta' z = N\Delta z$, where the common multiplier N, varies. This is the familiar law of uniform variation between two sets of values of the variables, and the symbols $\Delta' x$, etc., are not limited to small values but vary from 0 to ∞, as N so varies, however small Δx, etc., may be.

Such $\Delta' x$, $\Delta' y$, $\Delta' z$ are approximate fluxions; and the exact fluxions dx, dy, dz, are limits of these for lim. $\Delta x = 0$, lim. $\Delta y = 0$, lim. $\Delta z = 0$. For example, let $z = xy$, then $\Delta z = y\Delta x + (x + \Delta x)\Delta y$, and multiply both members by N.

$$\Delta' z = y\Delta' x + (x + \Delta x)\Delta' y,$$

whence by limits, $dz = ydx + xdy$.



We may illustrate the three variations geometrically:
(1) Actual. (2) In the Same Ratio. (3) In the First Ratio.

Arthur S. Hathaway
Rose Polytechnic Institute

SCIENTIFIC BOOKS

REPORT OF THE CANADIAN ARCTIC EXPEDITION, 1913–18

Shortly after the return of the Southern Party of the Canadian Arctic Expedition with their collections in the fall of 1916, steps were taken to arrange for the publication of the scientific results of the expedition. Although the general direction of the operations of the expedition had been under the Department of the Naval Service, most of the scientific men on the expedition were under the Geological Survey, of the Department of Mines, the collections were destined for the Victoria Memorial Museum, of Ottawa, and interdepartmental cooperation was desirable in publishing the results. An Arctic Biological Committee was appointed jointly by the two services, to select specialists to report on the various groups of specimens represented in the collections of the expedition, to distribute the specimens, and arrange for the final publication of the reports. This committee consisted of: Chairman, Professor E. E. Prince, commissioner of Dominion Fisheries; secretary, Mr. James M. Macoun, C.M.G., botanist and chief of the biological division of the Geological Survey; Professor A. B. Macallum, chairman of the Commission for Scientific and Industrial Research; Dr. C. Gordon Hewitt, Dominion Entomologist, of the Department of Agriculture, and Dr. R. M. Anderson, zoologist of the Geological Survey and lately chief of the Southern Party of the expedition, representing the expedition. Each member of the committee was made responsible for the editing of reports in his own section, and Dr. R. M. Anderson was appointed general editor of the reports. This committee has been at work for nearly three years, but owing to the difficulty of securing the services of the fifty or more competent specialists needed to work up the reports, on account of the exigencies of war and other reasons, the first of the technical reports was not issued from the press until July 10, 1919.

These biological reports, and to a large extent the geological and ethnological reports which it is hoped will follow them, were mainly the results of the work of the scientists of the Southern Party of the expedition, owing to the unfortunate death or elimination from work of most of the scientific staff of the Northern Party of the expedition and the total loss of their collections with the *Karluk* in 1914. As a result the later activities of the remainder of that party were practically all geographical and other work and collections merely incidental. The small amount of fragmentary material which was brought back in 1918 has in most cases been included in the reports issued, but in some cases a separate paper will be issued.

The plan adopted by the committee is to issue the report on each group or subject as a separate paper, of the regular octavo size which has been found to be the most convenient and popular for modern scientific papers. Most of the papers are illustrated by line drawings or half-tone engravings from photographs, and in some cases by heliotype or colored plates, illustrating many new species and a few new genera. These papers are mostly too technical to be of interest to the general reader, and the separates are intended to be distributed at time of issue to specialists interested in the particular branch covered, and 1,000 copies of each paper are to be kept by the government and bound into volumes for distribution to public libraries, universities, colleges and other scientific institutions. Eight volumes have been arranged for the biological series, including reports on mammalogy, ornithology, ichthyology and invertebrate marine biology, entomology and botany, and the parts as issued are numbered as parts of these volumes. They are not issued in consecutive order, but each part is printed as it is ready, in order to avoid delay in making the knowledge available to the scientific world and to the public. The amount of specimens and data available and the character and scientific reputation of the specialists engaged in the work promise to make this the most extensive and comprehensive publication on Canadian and western Arctic biology since Richardson and Swainson's "Fauna Boreali-Americana" (1829–31) and Hooker's "Flora Boreali-Americana" (1840).

The volumes in preparation are as follows:

Volume I: General Introduction and Narrative.
  A. Northern Party.
  B. Southern Party.
Volume II: A. Mammals. B. Birds.
Volume III: Insects. (10 parts.)
Volume IV: Botany. (Cryptogams) (5 parts).
Volume V: Botany. (Phanerogams.)
Volume VI: Fishes, Tunicates, etc. (2 parts.)
Volume VII: Crustacea. (12 parts.)
Volume VIII: Mollusks, Echinoderms, Coelenterates, etc. (9 parts.)
Volume IX: Annelids, Parasitic Worms, Protozoans, etc. (12 parts.)
Volume X: Plankton, Hydrography, Tides, etc.

Eleven of the separate parts of the different volumes have been issued:

Volume III.—Insects:

Part A—Collembola, by Justus W. Folsom. July 10, 1919.

Part B—Neuropteroid Insects, by Nathan Banks. July 11, 1919.

Part C—Diptera. July 14, 1919.

Crane-flies, by Charles P. Alexander.

Mosquitoes, by Harrison G. Dyar.

Diptera (excluding Tipulidae and Culicidae), by J. R. Malloch.

Part D—Mallophaga and Anoplura. September 12, 1919.

Mallophaga, by A. W. Baker.

Anoplura, by G. F. Ferris and G. H. F. Nuttall.

Part E—Coleoptera. December 12, 1919.

Forest Insects, including Ipidae, Cerambycidæ, and Buprestidæ, by J. M. Swaine.

Carabidæ and Silphidæ, by H. C. Fall.

Coccinnellidæ, Elateraidæ, Clerysomelidæ and Rhynchophora, by C. W. Leng.

Dystiscidæ, by J. D. Sherman, Jr.

Part F—Hemiptera, by E. P. Van Duzee. July 11, 1919.

Sawflies, by Alex. D. MacGillivray.

Parasitic Hymenoptera, by Charles T. Brues.

Wasps and Bees, by F. W. L. Sladen.

Plant Galls, by E. Porter Felt.

Part G—Hymenoptera and Plant Galls, November 3, 1919.

Sawflies, by Alex. D. MacGillivray.

Parasitic Hymenoptera, by Chas. T. Brues.

Wasps and Bees, by F. W. Sladen.

Plant Jalls, by E. P. Felt.

Part H—Spiders, Mites and Myriapods. July 14, 1919.

Spiders, by J. H. Emerton.

Acarina, by Nathan Banks.

Chilopoda, by Ralph V. Chamberlin.

Volume VII.—Crustacea.

Part A—Decapod Crustaceans, by Miss Mary J. Rathbun. August 18, 1919.

Part B—Schizopod Crustaceans, by Waldo L. Schmitt. September 22, 1919.

Volume VIII—Mollusks, Echinoderms, Coelenterates, etc.

Part A—Mollusks, Recent and Pleistocene, by Wm. Healey Dall. September 24, 1919.

Volume IX.—Annelids, Parasitic Worms, Protozoans, etc.

Part A—Oligochaeta, by Frank Smith and Paul S. Welch. September 29, 1919.

THE AMERICAN SOCIETY OF NATURALISTS

The thirty-seventh annual meeting of the American Society of Naturalists was held in Guyot Hall, Princeton University, on December 30 and 31, 1919.

The report of the treasurer showing a balance on hand of $327.33 was accepted.

The following changes in the constitution, recommended by the executive committee, were authorized.

Article III., Section 1, to read: The officers of the society shall be a president, a vice-president, a secretary and a treasurer. These, together with three past-presidents and the retiring vice-president, shall constitute the executive committee of the society.

Article III., Section 2, to read: The president and vice-president shall be elected for a term of one year, the secretary and treasurer for a term of three years. Each president on retirement shall serve on the executive committee for three years. Each vice-president on retirement shall serve on the executive committee for one year. The election of officers shall take place at the annual meeting of the society, and their official term shall commence at the close of the meeting at which they are elected.

On recommendation of the executive committee the society accepted an invitation from the National Research Council to appoint an advisory committee to act with the Division of Biology and Agriculture. The following were elected to this committee: Herbert S. Jennings, Alfred G. Mayor, George H. Shull, Ross G. Harrison, Bradley M. Davis.

A request for financial support from the management of Botanical Abstracts was discussed by the society with the result that a motion was carried to the effect that such appropriations were against the general policy of the American Society of Naturalists.

On motion the society approved of the appointment by the chair of a committee to consider and report on genetic form and nomenclature. This committee consists of Clarence C. Little, Donald F. Jones, Sewall Wright, Alfred H. Sturtevant and George H. Shull.

The following resolution presented by Charles B. Davenport and strongly supported from the floor was adopted.

Whereas, A current index of scientific publications is necessary to the progress of science and can be conducted properly only by bibliographers of experience, and at great expense; and

Whereas, The Concilium Bibliographicum of Zurich has for a quarter of a century maintained a valuable and unique service in international bibliography, especially in the fields of zoology, physiology, vertebrate anatomy and general biology; has continued the bibliography of Engelmann and Carus which covers the period from 1700 to the present; and has maintained a service of general bibliographic information; and

Whereas, the sciences named are the pure sciences upon which the science of medicine rests;

Therefore resolved, that the American Society of Naturalists (which has in the past made such subsidies to the Concilium as it could afford) cordially endorses the effort of the Concilium Bibliographicum to secure adequate financial support in this country.

There was elected to honorary membership in the society, William Bateson, John Innes Horticultural Institute, England.

The following were elected to membership: Joseph C. Arthur, Purdue University; Henry C. Cowles, University of Chicago; William Crocker, University of Chicago; Herbert M. Evans, University of California; Edward M. Freeman, University of Minnesota; Aleš Hrdlička, United States National Museum; Clarence M. Jackson, University of Minnesota; Warren H. Lewis, Johns Hopkins Medical School; Ann H. Morgan, Mount Holyoke College; John T. Patterson, University of Texas; Everett F. Phillips, United States Department of Agriculture; Donald Reddick, New York State College of Agriculture; Jacob R. Schramm, New York State College of Agriculture; Homer L. Shantz, United States Department of Agriculture; Henry B. Ward, University of Illinois.

The following program was presented at the morning session of December 30:

Causes of variation in sex ratio of the wasp, Hadrobracon: P. W. Whiting.

Population and race in the Pacific area: W. E. Ritter.

The evolution of Pacific coral reefs: A. G. Mayor.

The relative importance of heredity and environment in determining the piebald pattern of guinea-pigs: Sewall Wright.

Relations between nuclear number, chromatin mass, cytoplasmic mass and shell characteristics in Arcella: R. W. Hegner.

The function of the striae in the rotation of the Euglenoids and the problem of evolution: L. B. Walton.

Iodine and the thyroid: W. W. Swingle.

Selective fertilization in pollen mixtures: D. F. Jones.

Changing by castration the hen-feathered into the cock-feathered condition: T. H. Morgan.

Application of the chromosome theory to embryonic differentiation: E. G. Conklin.

The session of the afternoon of December 30 consisted of a symposium on *Some relations of biology to human welfare.*

The theoretical problems of forestry: Raphael Zon.

Biology in relation to ethics: W. E. Ritter.

Biology and society: W. M. Wheeler.

The significance of some general biological principles in public health problems: Raymond Pearl.

General biology in its relation to medicine: H. E. Jordan (read by title.)

The program of December 31 consisted of the following papers:

A type of primary non-disjunction in Drosophila melanogaster: A. H. Sturtevant.

A sex-linked recessive linkage variation in Drosophila melanogaster: C. B. Bridges.

A race of Drosophila willistoni giving a shortage of females: D. E. Lancefield and C. W. Metz.

Mutants and mutability in different species of Drosophila: C. W. Metz.

Two hereditary tumors in Drosophila: Mary B. Stark.

Inheritance of the rubricalyx character in Œnothera: G. H. Shull.

An analysis of an intergrading sex character: A. M. Banta and Mary Gover.

Precocious development in Salpa: a biological not a utilitarian phenomenon: M. M. Metcalf (read by title.)

Ontogeny versus phylogeny in the development of the sensory apparatus in mammalian embryos: H. H. Lane.

The influence of alcoholized grandparents upon the behavior of white rats: E. C. MacDowell and E. M. Vicari.

Evidence of specific evolution in the genus Partula in the Society Islands: H. E. Crampton.

Inheritance of flower form in Phlox Drummondii: J. P. Kelly.

An extra chromosome in Camnula pellucida; variations in the number of chromosomes within the testis: Mitchel Carroll.

Inheritance of milk production and butter-fat percentage as shown by first generation hybrids between the dairy and beef breeds of cattle: J. W. Gowen.

The vascular anatomy of dimerous and trimerous seedlings of Phaseolus vulgaris: J. ARTHUR HARRIS, E. W. SINNOTT AND J. Y. PENNYPACKER.

Genetic investigations in Crepis: E. B. BABCOCK (read by title.)

Relationships among the genes for color variation in rodents: L. C. DUNN (read by title.)

Dice casting and pedigree selection: H. H. LAUGHLIN.

Known matings in a species with heteromorphic homologous chromosomes; recombinations obtained in F_1 and F_2: E. ELEANOR CAROTHERS.

The relation of the somatic chromosomes in Œnothera Lamarckiana and O. gigas: R. T. HANCE.

Concerning the inheritance of broodiness in domestic fowl: H. D. GOODALE (read by title.)

Heredity of twining from the paternal side: C. B. DAVENPORT.

Notes on the human sex ratio: C. C. LITTLE.

An experiment on regulation in plants: E. N. HARVEY (read by title.)

A series of allelomorphs in Drosophila with non-quantitative relationships: H. J. MULLER.

The rate of evolution: E. G. CONKLIN.

The Naturalists' dinner was held on the evening of December 30 in the dining hall of the Graduate School of Princeton University with eighty-two in attendance. The presidential address by Edward M. East was entitled "Population."

The officers of the society for 1920 are:

President—Jacques Loeb, Rockefeller Institute for Medical Research.

Vice-president—Bradley M. Davis, University of Michigan.

Secretary—A. Franklin Shull, University of Michigan (1920–22).

Treasurer—J. Arthur Harris, Carnegie Station for Experimental Evolution (1918–20).

Additional members of the Executive Committee—John H. Gerould, Dartmouth College (1920); George H. Shull, Princeton University (1918–20); William E. Castle, Harvard University (1919–21); Edward M. East, Harvard University (1920–22).

BRADLEY M. DAVIS,
Secretary

THE AMERICAN PHYSICAL SOCIETY

THE twenty-first annual meeting (the 101st regular meeting) of the American Physical Society was held at Soldan High School in St. Louis, Missouri, on December 30, 31, 1919, and January 1, 1920, in affiliation with Section B—Physics—of the American Association for the Advancement of Science.

At the business session held on December 31, 1919, officers for 1920 were elected as follows:

President—J. S. Ames.

Vice-president—Theodore Lyman.

Secretary—D. C. Miller.

Treasurer—G. B. Pegram.

Managing Editor—F. Bedell.

Councillors—F. B. Jewett and Max Mason.

Members of the Editorial Board—E. L. Nichols, C. M. Sparrow and W. F. G. Swann.

The question of the relation of the society to the work of the trustees for the Preparation of Critical Tables of Physical and Chemical Constants was brought before the society; after discussion it was, by general consent, referred to the president, the councillor and the trustee representing the society, for such action as may seem best.

At the meeting of the council held on December 30, 1919, the following elections were made: to *regular membership,* T. H. Gronwall, E. H. Kennard, Henry A. McTaggart; to *associate membership,* William H. Agnew, W. H. Bair, Vola P. Barton, Henry M. Brook, J. T. Lindsay Brown, John A. David, E. C. Gaskill, Charles W. Henderson, F. F. Householder, Teizo Isshiki, Charles S. Jewell, P. Kirkpatrick, F. W. Kranz, Charles P. Miller, George S. Monk, Chalmer N. Patterson, Herbert J. Plagge, Geo. E. Raburn, S. P. Shackleton, George C. Southworth, John Alden Terrell, John A. Tobin, A. P. Vanselow, E. E. Zimmerman; *transferred from associate to regular membership,* Harold D. Babcock, Clifton G. Found, R. C. Gibbs, J. A. Gray, Frank B. Jewett, Edwin C. Kemble, Fred Loomis Mohler, Lindley Pyle, C. V. Raman, Paul E. Sabine, F. B. Silsbee, Elmer H. Williams.

On Tuesday afternoon, December 30, 1919, the president, J. S. Ames, delivered an address on "Einstein's theory of gravitation and some of its consequences." This was a masterly presentation of the development and conclusions of this theory, and it was listened to by the largest audience of the meetings.

The session on the afternoon of Wednesday, December 31, 1919, was under the auspices of Section B—Physics—of the American Association of the Advancement of Science. The retiring chairman of Section B, Dr. G. F. Hull, gave an address on "Some aspects of physics in war and peace." Following this there was a symposium of four special papers on "Phenomena in the ultra-violet spectrum, including X-rays," by R. A. Millikan, D. L. Webster, Wm. Duane and A. W. Hull.

The programs consisted of thirty-four papers, six of which were read by title only, presented at four different sessions. The program of eight papers given at the session of Wednesday morning, consisted exclusively of papers relating to acoustics. The average attendance was about eighty-five, the maximum being about one hundred and twenty-five. The program was as follows:

Variation of transparency to total radiation with temperature of source: S. Leroy Brown.

The dissipation of heat by various surfaces in still air: T. S. Taylor.

The influence of air velocity and the angle of incidence on the dissipation of heat: T. S. Taylor.

The measurement of thermal expansion of metals at ordinary temperatures: Charles D. Hodgman.

A method for determining the photographic absorption of lenses: G. W. Moffitt.

Defects in centered quadric lenses: Irwin Roman.

The sinker method applied to the rapid and accurate determination of specific gravities: N. W. Cummings. (Read by title.)

Amplification of currents in the Bunsen flame: C. W. Heaps.

A new type of non-inductive resistance: H. L. Dodge.

Some laboratory uses for the contract rectifier: J. C. Jensen.

An undamped wave method of determining dielectric constants of liquids: W. H. Hyslop and A. P. Carman. (Read by title.)

Difficulties in the theory of rain formation: W. J. Humphreys.

A physical theory of ocean or reservoir temperature distributions, regarded as effects of solar radiation, evaporation and the resulting convection: Geo. F. McEwen.

Electromagnetic induction and relative motion: W. F. G. Swann.

The influence of blowing pressure on pitch of organ pipes: Arthur C. Lunn.

A photographic study of explosions in gases: John B. Dutcher.

A photographic study of sound pulses through crooked and curved tubes, with deductions concerning telephone mouthpieces, phonograph horns, etc.: Arthur L. Foley.

A photographic method of measuring the instantaneous velocity of sound waves at points near the source: Arthur L. Foley.

A possible standard of sound—I., study of operating conditions; II., study of wave form: Chas. T. Knipp.

The performance of conical horns: G. W. Stewart.

A photographic study of the wave-form of sounds from large guns in action: Dayton C. Miller.

The calibration of a sound chamber and sound sources and the measurement of sound transmission of simple partitions: Paul E. Sabine.

Transmissions of sound through walls: F. R. Watson.

Charcoal absorption and cyclic changes: Thos. E. Doubt.

The heat of vaporization and work of ionization: C. S. Fazel. (Read by title.)

Energy content of characteristic radiations: Chester W. Rice.

The spectrum of radium emanation: R. E. Nyswander, S. C. Lind and R. B. Moore.

The Zeeman effect for electric furnace spectra: Arthur S. King. (Read by title.)

Critical potentials of the "L" series of platinum: David L. Webster.

On the possibility of pulling electrons from metals by powerful electric fields: R. A. Millikan and B. E. Shackelford.

On the recoil of Alpha particles from light atoms: L. B. Loeb. (Read by title.)

Reactive hydrogen in the electrical discharge: Gerald L. Wendt and Robert S. Landauer. (Read by title.)

The construction and design of a device permitting the application of a current pulse for a predeterminate number of milliseconds: Lyndley Pyle.

The spectral transmission of various glasses: Henry P. Gage.

Dayton C. Miller,
Secretary

SCIENCE

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FRIDAY, FEBRUARY 20, 1920

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE FUNCTIONS AND IDEALS OF A NATIONAL GEOLOGICAL SURVEY[1]

Introduction.—During the period of unrest and uncertainty through which we are still painfully groping, the many distracting calls upon my time and thoughts have made performance of the duty to prepare a presidential address particularly difficult. In view of these circumstances I may perhaps hope for some indulgence on your part if my effort shows some lack of thoroughness in its preparation and falls somewhat short of the high standard set by some of my distinguished predecessors. The subject of a presidential address to the academy should, I think, be of wider interest and more general character than would ordinarily be an account of work in the speaker's particular branch of science, and this condition I have attempted to fulfill. Although what follows will deal especially with national geological surveys much of it will apply in principle to any scientific bureau conducted as a government organization.

Reasons for the Existence of a National Geological Survey.—In the beginning it may be well to review briefly the reasons for the existence of a national geological survey. Why should the government undertake work in geology while investigations in other sciences are in general left to private initiation and enterprise? The reasons that may be adduced will differ with the point of view. The geologist will suggest that whereas some sciences, such as chemistry, physics or astronomy may be pursued with success with stationary and permanent equipment at any one of a number of localities, geology is regional in its scope and is primarily a field science as contrasted with a laboratory science. Geology, it is true, must avail itself of laboratory re-

[1] Address delivered as retiring president of the Washington Academy of Sciences on January 13, 1920.

sources and methods, but the geologist can not have the greater part of his material brought to him; he must himself seek it afield. Thus it comes that comprehensive geologic problems require for their solution the equipment of more or less expensive expeditions or travel over large areas. Such projects as a rule can not be undertaken by individual geologists or by local organizations. The preparation of a geologic map of a whole country, with its explanatory text, generally recognized as essential fundamental work, is an undertaking that requires consistent effort by a central organization extending over a period of years. Such a map is not likely to result from the patching together of the results of uncoordinated local effort. From a broadly utilitarian point of view, the intelligent layman as well as the geologist must recognize that the development of a country's natural resources in such a manner as to secure their maximum use for the greatest number of its citizens necessarily depends upon reliable information concerning the character, location and extent of these resources and that this information should be available before they are exploited, by those who have eyes only for their own immediate profit, or before they pass entirely into private control or are exhausted. Such information can best be obtained and published by an impartial national organization responsible for its results to the people as a whole. Such a layman will recognize also that knowledge of the mineral resources of a country must rest upon a geological foundation. As Professor J. C. Branner has recently said in his "Outlines of the Geology of Brazil":

> After a life spent chiefly in active geologic work and in the direction of such work, I should be remiss in my duty to Brazil if I did not use this occasion to urge on Brazilian statesmen the serious necessity for the active encouragement and support of scientific geologic work on the part of the national and state governments. Knowledge must precede the application of knowledge in geology as well as in other matters; and unless the development of the country's mineral resources be based on and proceed from a scientific knowledge of its geology, there must inevitably be waste of effort, loss of money, and the delay of national progress inseparable from haphazard methods.[2]

Finally, the citizen of narrower vision will regard as sufficient justification for a national geological survey the fact that he himself can turn to it for information and assistance in the development of particular mineral deposits, to his own material advantage.

As a matter of fact, most of the progressive countries of the world maintain geological surveys so that the desirability of such an organization appears to have been generally recognized, whatever may have been the particular reason or reasons that set in motion the machinery of organization in each country.

Recognizing the fact that most of the principal countries have established geological surveys and granting that there are good reasons for considering the maintenance of such an organization as a proper governmental function, we may next inquire: What should be the ideals and duties of such a geological survey? How may these ideals be realized and these duties performed?

General Legal Functions.—The organic act of the United States Geological Survey specifies indirectly and in general terms the field that the organization should occupy. It states, with reference to the director:

> This officer shall have the direction of the Geological Survey and the classification of the public lands and examination of the geological structure, mineral resources and products of the national domain.

Doubtless the laws or decrees under which other national geological surveys have been established also prescribe to some extent their duties. Such legal authorization, however, is a rule so general as to leave room for considerable latitude in its interpretation. I propose first to discuss the functions of a national geologic survey without reference to legal prescription or definition and afterwards to consider the extent to which some

[2] Branner, J. C., "Outlines of the Geology of Brazil," Geol. Soc. America, *Bull.*, Vol. 30, p. 194, 1919.

of the actual conditions interfere with the realization of these ideals.

Usefulness in Science.—It has been the fashion in some quarters of late to emphasize usefulness as the chief criterion by which to judge the value of scientific research under government auspices. It has been intimated that this or that scientific bureau of the government must do "useful" work if it is to justify its existence and its expenditure of public funds. The statement is usually made with an air of finality, as if a troublesome question had been once for all disposed of and the path of the future made plain. As a matter of fact, however, when it is said that science must be useful in order to receive government support we have really made very little advance. Probably the most idealistic scientific man will admit that ultimate usefulness is the justification for scientific research although that end may not enter into his thoughts when he undertakes any particular investigation with the hope of increasing human knowledge. Men will differ very widely however as to what is meant by usefulness in science. It is well known to all scientific men, although not yet as widely recognized by others as it should be, that the utility of research is not generally predictable. For example, the investigations on electricity for hundreds of years preceding the middle of the nineteenth century had, so far as could be seen, no practical bearing. The experiments of Volta, of Galvani, and even those of our own Franklin, outside of his invention of the lightning rod, were not conducted with any thought of utility and were probably looked upon by the people of the time as diversions of the learned, not likely to have much effect upon human life and progress. How erroneous such a view was it is unnecessary to point out to a generation accustomed to daily use of the trolley car, telegraph, telephone and electric lights. Not only is the utility of science not always predictable but it is of very different kinds. That astronomy has certain practical applications in navigation and geodesy is well known; but important as these applications are they seem insignificant in comparison with the debt that we owe to this science for enlarging our intellectual horizon. This, too, is usefulness which I venture to think is of a truer and higher sort than much that passes current for utility. The classic researches of Pasteur on the tartaric acids, on fermentation, on the anthrax bacillus, on the silkworm disease and on rabies, were so-called applied science of the very highest type, indistinguishable in the spirit and method of their pursuit from investigations in pure science. They were not merely the application of knowledge to industry but were extraordinarily fruitful scientific investigations undertaken to solve particular industrial and humanitarian problems. They are especially interesting in the present connection as probably the most conspicuous example in the history of research of the merging of pure and applied science. Pasteur was doubly fortunate in that he not only enormously enlarged human knowledge but was able to see, at least in part, the practical application of his discoveries to the benefit of humanity. The value of his results measurable in dollars is enormous, yet this is not their only value. Professor Arthur Schuster, in a recent address, remarks:

> The researches of Pasteur, Lister and their followers, are triumphs of science applied directly to the benefit of mankind; but I fancy that their hold on our imagination is mainly due to the new vista opened out on the nature of disease, the marvelous workings of the lower forms of life, and the almost human attributes of blood corpuscles, which have been disclosed.
>
> The effect on a community is only the summation of the effect on individuals, and if we judge by individuals there can be little doubt that, except under the stress of abnormal circumstances, pure knowledge has as great a hold upon the public mind as the story of its applications.

Quite independently of any recognized usefulness, investigations that yield results that are of *interest* to the public are willingly supported by the people and this fact is significant in connection with what I shall have to say later on the function of education. As illustrations of this truth may be cited our government Bureau of Ethnology and our large public museums. Probably few who read the admirable government reports on the aboriginal antiquities of our country and on the arts and customs of the Indian tribes could point out any particular usefulness in these studies but they have to do with human life and their popular appeal is undeniable. The average visitor to a museum probably has little conception of what to a scientific man is the real purpose of such an institution. He gazes with interest at the contents of the display cases without realizing that by far the greater part of the material upon which the scientific staff is working or upon which investigators will work in future, is hidden away in drawers and packing cases. The principal recognizable result so far as he is concerned is that he is interested in what he sees and feels that he is being pleasantly instructed.

In other words, it is as important for man to have his imagination quickened as to have his bodily needs supplied, and in ministering to either requirement science is entitled to be called useful or valuable.

It may be remarked in passing that Pasteur's work had this in common with pure science, or science pursued with the single aim of adding to human knowledge, in that Pasteur himself could not foresee all of the applications that would in future be made of his discoveries.

Enough, I think, has been said to show that the term usefulness as applied to science covers a wide range and that when employed by people of imagination and liberal culture may include much more than when used by those whose only standard of value is the unstable dollar.

Functions under an ideal Autocracy.—If government were in the hands of a wise and benevolent autocracy a national geological survey would be so conducted as to be useful to the people whose taxes go towards its support; but it would probably be useful in the broader sense that I have outlined. It would give the people not perhaps what they think they want but what, in the wisdom of their government, seems best for them. I believe that a survey so directed would aim to encourage and promote the study of geology by undertaking those general problems and regional investigations that would be likely to remain untouched if left to private enterprise. It would lay the foundation for the most economic and efficient development of the natural resources of the country by ascertaining and making known the location, character and extent of the national mineral resources. As an aid to the intelligent utilization of these resources, and to the discovery of deposits additional to those already known, it would properly occupy itself with problems concerning the origin and mode of formation of mineral deposits. Last, but not least, it would accept the responsibility, not only for making known the material resources of the country but for contributing to the moral and intellectual life of the nation and of the world by seeing to it that the country's resources in opportunities for progress in the science of geology are fully utilized. I may illustrate my meaning by examples taken from the publications of the U. S. Geological Survey. In my opinion such works as Dutton's Tertiary History of the Grand Canyon, Gilbert's Lake Bonneville, and the investigations of Marsh, Cope, and their successors, on the wonderful series of reptile, bird and mammal remains found in the Cretaceous and Tertiary strata of the west are fully as adequate and appropriate a return for the expenditure of public funds as a report describing the occurrence of a coal bed and giving the quantity of coal available in a given field. Many years ago when the United States Geological Survey was under heavy fire in Congress one member of that body in some unexplained way learned that Professor Marsh had discovered and had described in a government publication a wonderful fosssil bird with teeth—a great diver up to 6 feet in length. He held this up to ridicule as a glaring example of the waste of public funds in useless scientific work, quite unaware of the light that this and similar discoveries threw upon the interesting history of the development of birds from reptiles and upon evolution, or of the intellectual value of such a contribution to knowledge. The representative of a people educated in the value of geologic science would, by such an exhibition of ignorance, discredit himself in the eyes of his constituents.

Functions in a Democracy.—Our government, however, is not an all-wise benevolent autocracy but is democratic in plan and intent and suffers from certain well-known disadvantages from which no democracy has yet been free. The wishes of the politically active majority control and these wishes may or may not coincide with those of the wisest and most enlightened of the citizens. The funds for government work in science must be granted by Congress and the vote of each congressman is determined by the real or supposed desires of his constituents. A national scientific bureau, if it is to survive, must have popular support, and to obtain and hold such support it must do at least some work that the majority of the people can understand or can recognize as being worth the doing. Here evidently compromise with scientific ideals is necessary. Something must be sacrificed in order that something can be done. Such concessions and compromises are inseparable from democratic government and the scientific man of high ideals who is unable to recognize this fact will inevitably fail as a director of the scientific work of a government bureau. Such a man is likely to insist that no concessions are necessary and that the public will support science that is not interesting to it or from which it can see no immediate resulting material benefit. One very eminent geologist with whom I was once conversing held this view. He said that he had always found that he could go before a legislative body and secure appropriations for scientific research by being absolutely frank and making no attempt to show that the results of the work would be what the average man would term "useful" within the immediate future. His confidence was possibly well grounded, but I am inclined to think that the success gained by him was rather a tribute to his earnest eloquence and winning personality than a proof that the people are yet ready to contribute their taxes to the support of investigations that, so far as they can see, are neither useful nor interesting.

Character of Compromises.—Lest it be supposed that I am advocating the surrender of the high ideals of science to the political business of vote-getting I hasten to point out that surrender and compromise are not synonymous and may be very far apart. Some compromise there must be, but in my opinion the most delicate and critical problem in the direction of a national scientific bureau is to determine the nature and extent of this compromise so as to obtain the largest and steadiest support for real research with the least sacrifice. Complete surrender to popularity may mean large initial support, but is sure to be followed by deterioration in the spirit of the organization and in the quality of its work, by loss of scientific prestige, and by final bankruptcy even in that popular favor which had been so sedulously cultivated.

The extent to which concessions must be made will depend largely of course on the general level of intelligence of the people and upon the degree to which the less intelligent are influenced through the press and other channels by those who are able to appreciate the value of science. The more enlightened the people the more general and permanent will be their support of science.

Importance of Popular Education in Geology.—This leads us to the consideration of what I believe to be one of the most important of the functions of a government scientific bureau, namely, education. Of all forms of concession, if indeed it is really a concession, this is the least objectionable and most fruitful. Its results are constructive and cumulative. It is not, like other concessions to popularity, corrosive of the scientific spirit of an organization and in so far as it calls for clear thinking and attractive presentation on the part of those puting it into practise as well as the ability to grasp and expound essentials, its educational effect may be subjective as well as objective. Whatever may be true of other sciences, geologists in this country have shown little interest in popularizing their science or in encouraging its pursuit by amateurs. Such attempts as have been made have often been inept and unsuccessful and the professional geologists have looked with more or less disdain upon those of their fellows who have tried to expound their science to the people. They have felt that men with unusual ability for research should devote all of their energy to the work of enlarging the confines of knowledge rather than to dissemination and popularization of what is known to the few. There is undoubtedly much to be said for this view and when applied to certain exceptional men it is strictly correct. When, however, we think of Darwin and compare the magnitude of his achievements with the pains that he took to make his conclusions comprehensible by the multitude, we are inclined to feel that only by extraordinary ability and performance in certain directions can an investigator in natural science be altogether absolved from the duty of making himself intelligible to more than a few specialists in his own line. There are undoubtedly many scientific men, thoroughly and earnestly convinced of the importance of their researches, who would in the long run be doing more for humanity and perhaps for themselves if they would spare some time to tell us as clearly and attractively as possible what it is that they are doing. While I believe this to be true of scientific men in general, it is particularly true of those who are officially servants of a democracy. A democratic government might almost be characterized as a government by compromise, and this is one of the major compromises that confronts scientific men in the service of such a government. The conclusion that a very important function of a national geological survey is the education of the people in geology and the increasing of popular interest in that science, appears to be unavoidable, yet it is surprising how little this function has been recognized and exercised. The results of such education are cumulative and a direct and permanent gain to science whereas, on the other hand, the consequences of prostituting the opportunities for scientific work to satisfy this and that popular demand for so-called practical results in any problem that happens to be momentarily in the public eye, is a kind of charlatanry that is utterly demoralizing to those who practise it and that must ultimately bring even popular discredit on science. A bureau that follows such a policy can neither hold within it nor attract to its service men animated by the true spirit of investigation.

Methods of Education.—It is not practicable in the present address to discuss in detail the many possibilities of educational work in geology. Only a few general suggestions can be offered.

In the first place the importance of education by a national geological survey should be frankly recognized and the idea that it is beneath the dignity of a geologist to participate in this function should be discountenanced. A geological survey should include on its staff one or more men of high ability who are especially gifted in interesting the public in the purposes, methods and results of geologic work—men of imagination who can see the romance of science; men of broad sympathy who know the hearts and minds of their countrymen from the Atlantic to the Pacific; men imbued with the truthful spirit of science; and finally, men skilled in the art of illuminating the cold impersonal results of science with a warm glow of human interest.

It should be the duty of these men to see that so far as possible all of the results of geologic work are interpreted to the people so that every citizen can benefit to the limit of his individual capacity. Magazines, the daily papers, moving pictures, and all possible means of publication should be utilized. There should be close contact with educators and special pains taken to prepare material for use in schools and colleges. Carefully planned courses at university summer schools and elsewhere might be given by members of the educational or publicity staff, or by certain selected geologists from the field staff.

Geologists in preparing papers and reports should consider with particular care the question "Who may be reached by this?" Some scientific results can not be popularized and these may be written in the concise accurate language of science. Others, however, may by taking sufficient care and trouble, be made interesting to more than a small circle of scientific colleagues. Every effort should be made to enlarge this circle by simple and attractive presentation. In some cases I am inclined to think that a geologist might issue separately or as a part of his complete report, an abstract or résumé in which all effort is concentrated on an endeavor to be interesting and clear to as many people as possible. If this were done, I am sure that the writer would be in a position to appraise more truly the value of his complete report and might proceed to rewrite some portions of it and to omit others, without loss to science and at a saving in paper and printing.

Relations with Universities.—In connection with the subject of education attention may be called to the fundamental importance of establishing and maintaining close and cordial relationship between a government scientific bureau and the universities. The advantages of such a relationship are so many that it is difficult to enumerate them all but it may be pointed out that any plan of popular education in science will be seriously crippled if the professional teachers, whose influence in molding the thoughts and determining the careers of the young men and women of the country is so great, are out of sympathy with the government organization that is attempting to quicken the interest of the people in a particular branch of science. Moreover, it is vital to such an organization that it should attract to its service young men of exceptional ability in science. This it is not likely to do if professors of geology feel that they must conscientiously advise their most promising graduates to avoid government service. Doubtless some teachers of geology in the universities fail to realize the necessity for some of the compromises inevitable in a government bureau, or in their impatience at some of the stupidities of bureaucratic procedure are inclined to place the blame for these where it does not belong; a few may cherish personal grievances. No class of men is without its unreasonable members and neither rectitude nor tact can prevent occasional clashes; but if a national geological survey can not command the respect and hearty support of most of the geological faculties of the universities the consequences to the progress of geology must be deplorable. Any approach to such a condition demands immediate action with less emphasis on the question "Who is to blame?" for in all probability there is some fault on both sides, than on "What can be done to restore relations of mutual regard and helpfulness?"

The Amateur in Geology.—In the present age of specialization we are apt to forget how much geology owes to amateurs, particularly in Britain and France. Sir Archibald Geikie in the concluding chapter of his "Founders of Geology" dwells particularly on this debt. He says:

> In the account which has been presented in this volume of the work of some of the more notable men who have created the science of geology, one or two leading facts stand out prominently before us. In the first place, even in the list of selected names which we have considered, it is remarkable how varied have been the ordinary avocations[3] of these pioneers. The majority have been men engaged in other pursuits, who have devoted their leisure to the cultivation of geological studies. Steno, Guettard, Pallas, Füchsel, and many more were physicians, either led by their medical training to interest themselves in natural history, or not seldom, even from boyhood, so fond of natural history as to choose medicine as their profession because of its affinities with that branch of science. Giraud-Soulavie and Michell were clergymen. Murchison was a retired soldier. Alexandre Brogniart was at first engaged in superintending the porcelain manufactory of Sèvres. Demarest was a hard-worked civil servant who snatched his intervals for geology from the toils of incessant official occupation. William Smith found time for his researches in the midst of all the cares and anxieties of his profession as an engineer and surveyor. Hutton, Hall, De Saussure, Von Buch, Lyell and Darwin were men of means, who scorned

[3] *Vocations* would seem to be the right word here. F. L. R.

a life of slothful ease, and dedicated themselves and their fortune to the study of the history of the earth. Playfair and Cuvier were both teachers of other branches of science, irresistibly drawn into the sphere of geological inquiry and speculation. Of the whole gallery of worthies that have passed before us, a comparatively small proportion could be classed as in the strictest sense professional geologists, such as Werner, Sedgwick and Logan. Were we to step outside of that gallery, and include the names of all who have helped to lay the foundations of the science, we should find the proportion to be still less.

From the beginning of its career, geology has owed its foundation and its advance to no select and privileged class. It has been open to all who cared to undergo the trials which its successful prosecution demands. And what it has been in the past, it remains to-day. No branch of natural knowledge lies more invitingly open to every student who, loving the fresh face of Nature, is willing to train his faculty of observation in the field, and to discipline his mind by the patient correlation of facts and the fearless dissection of theories. To such an inquirer no limit can be set. He may be enabled to rebuild parts of the temple of science, or to add new towers and pinnacles to its superstructure. But even if he should never venture into such ambitious undertakings, he will gain, in the cultivation of geological pursuits, a solace and enjoyment amid the cares of life, which will become to him a source of the purest joy.

In this country at the present time, as Mr. David White in an as yet unpublished address, has I believe pointed out, the amateur geologist, due partly to the way in which the subject is taught, is rare and few indeed are the contributions made to the science by those who follow geology as an avocation or hobby. This is unfortunate and an improvement of this condition should be one of the major objects of the educational program of a national geological survey. The science lends itself particularly to its pursuit as a recreation by men of trained intellect who must find in the open air some relief from sedentary professions. In a country still so new as ours geologic problems lie on every hand and many of these can be solved wholly or in part without elaborate apparatus or laboratory facilities. The standards for the professional geologist should be high, but there is no necessity that maintenance of such standards should be accompanied by a patronizing or supercilious attitude toward the work of the amateur. Rather, let the professional geologist cultivate sympathy, tolerance, and generosity toward all who are earnestly seeking for the truth; let him help by encouragement instead of deterring by disdain. There is no better evidence of a wide interest in geology than the existence of numerous amateur workers and it is decidedly to the advantage of the professional geologist and to the science to encourage in every way possible the efforts of such workers and to increase their number.

F. L. Ransome

(*To be concluded*)

GEORGE MACLOSKIE

George Macloskie was born in Castledown, Ireland, in 1834. He studied at Queens' University, Ireland, receiving the degree of A.B. and A.M. Later, at the University of London, he took the degrees in course of LL.B. and LL.D. He was three times gold medalist. After he had been some years in America the University of Ireland granted him the honorary Sc.D.

He was for 13 years (1861–'74) pastor of the church of Ballygoney, Ireland. During his student life and while discharging his pastorial duties he was actively interested in the study of natural history. This interest had attracted the attention of his friend and one-time teacher, Dr. McCosh, the new President of Princeton College, who called him in to occupy the chair of natural history in the recently established John C. Green School of Science, at Princeton.

In this chair, later termed biology, with unfailing devotion he served the college and university for 31 years, retiring in 1906 as professor emeritus. During this period, in addition to his teaching and executive duties, he wrote his "Elementary Botany with Student's guide to the Examination of Plants" published by Henry Holt & Company, 1883, which for several years was used in his classes. He published also a number of papers on botanical subjects, chiefly in the *Torrey Bulletin* and entomological papers, in

The American Naturalist and *Psyche,* dealing mainly with the structure of the head and mouth parts of the house fly and mosquitoes, and the tracheæ of insects.

An omnivorous reader, he kept abreast of the advances of his science and at the same time retained a keen interest in mathematical, physical and linguistic studies, publishing papers dealing with the mathematical properties of lenses, and on hyperbolic functions. His self-acquired mastery of a reading knowledge of the modern languages led him to a desire for some more universal means of communication, so that he was attracted to the Esperanto movement and became one of its early American promoters.

Bred as a theologian he was nevertheless in sympathy with the then new doctrine of evolution, and throughout his life was a firm upholder of the essential harmony of science and religion. His papers on this subject were numerous.

His retirement from the active duties of a professor did not lessen his abounding zeal for work, for he then began and carried through to completion a three-volume report on the Flora of Patagonia—a labor that might tax the energies of a much younger man.

Dr. Macloskie was true and loyal to his adopted country while cherishing with pride his Scotch-Irish ancestry. He was a man of strictest probity, affectionate, enthusiastic and impulsive; he was just and sympathetic in his dealings with his students; a most devoted and unselfish collaborator in the work of his own and other departments; loyally devoted to his friends through good and evil report; a good citizen and a Christian gentleman.

In 1896 Princeton University granted him the honorary A.M. As one of her adopted sons he served her faithfully in his life and his death comes as a loss to his former pupils and colleagues. W. M. RANKIN

SCIENTIFIC EVENTS

THE CALIFORNIA INSTITUTE OF TECHNOLOGY

IN view of the many developments taking place in the institution, by which it is being rapidly transformed from a college or primarily local relationships into a scientific school of national importance, the trustees of Throop College of Technology, at Pasadena, voted at their annual meeting on February tenth to change its name to the California Institute of Technology.

The developments of the recent past and those assured in the near future that have seemed to justify this action are briefly as follows:

There have been received by the institution two gifts of $200,000 each to form permanent endowments for the support of research in physics and chemistry, respectively; and in addition $800,000 has been given for general purposes, on condition that this endowment be increased by additional subscriptions to two million dollars.

Other gifts aggregating $380,000 have been received for the construction of new buildings. With the aid of these funds a building for chemical instruction and research, named after the donors the Gates Chemical Laboratory, has already been completed and is occupied by the chemistry department, which includes five professors and assistant professors, two instructors, and six teaching fellows. A laboratory for aeronautical research has also been built, and investigations on airplane propellers are in progress. During the latter part of the war a laboratory for submarine detection was erected and the researches in that field are still in progress, with reference to both commercial uses and future military developments. This work will next year be transferred to the new physics building; and the war laboratory will be equipped for advanced instruction and research in applied chemistry and chemical engineering. A building for instruction and research in physics is now being planned, and is to be erected during the year. In recognition of the donation which made it possible, it will be known as the Norman Bridge Physical Laboratory. In addition, a building to serve as an auditorium and music hall, both for the Institute and for the Pasadena Music and Art Association is to be built at once upon the campus.

An impressive architectural plan for the whole campus has been prepared by the distinguished New York architect, Mr. Bertram G. Goodhue, and all the new construction is being carried out in accordance with this plan.

There have recently become associated with the faculty of the institute a number of well known investigators. Dr. Arthur A. Noyes has resigned his position at the Massachusetts Institute of Technology to become director of chemical research at the California Institute. Dr. Robert A. Millikan, of the University of Chicago, has arranged to spend one term of each year at the institute, and will have general supervision of the research and instruction in physics. Professor Albert A. Michelson, of the University of Chicago, will also spend much of his time there for the purpose of carrying on researches on the fundamental problem of earth tides, for which the necessary equipment is now being installed. Dr. Harry Bateman, formerly of Cambridge University and Johns Hopkins University, had previously joined the faculty as professor of aeronautical research and mathematical physics.

In the development of the institute special emphasis is being placed upon research, not only because every institution of higher education should contribute to the advancement of science, but also and particularly because a prominent feature of the work of instruction is to be the training of engineers of the research or creative type. While the institute will continue to offer four-year undergraduate courses which fit its students directly for the positions of operating and constructing engineers, two new courses of instruction, to be known as the courses in physics and engineering and in chemistry and engineering, will soon be announced by the faculty, in which special stress will be laid on an unusually thorough grounding in the three fundamental sciences of physics, chemistry and mathematics; and in the last two years of which much time will be assigned to research in physics and chemistry; the time required for these purposes being secured by omitting some of the more technical engineering subjects included in the other engineering courses.

The faculty has also been strengthened on the side of humanistic studies by renewal of the arrangement with Alfred Noyes, the English poet, which was in effect before the war, under which he will during the next year give courses of lectures on English literature; and by the appointment of Paul Perigord as professor of economics.

THE ANNUAL MEETING OF THE BOARD OF TRUSTEES OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Announcement of the nature and scope of the activities of the American Museum of Natural History during the past year and of a prospectus for the coming fifty years was made on February 2 by President Henry Fairfield Osborn, at the annual meeting of the board of trustees, held at the home of Arthur Curtiss James, 39 East 69th Street, who acted at host.

Due to its urgency, the matter of maintenance and building funds was given prominence. It was reported that the Museum is now facing the most critical time of its history.

While progress is being made in many directions, President Osborn said, it is not symmetrical, and in order to secure a harmonious educational treatment and to truthfully arrange our present collections, the museum needs double the space which it now occupies. It is fifteen years since the building has been enlarged, and during this time the collections have nearly doubled. President Osborn ascribes this marking time of progress not to lack of cooperation on the part of the board of estimate and apportionment of the city, which has recently manifested its confidence in the institution by increasing the annual maintenance fund fifty per cent.; nor to lack of interest on the part of the trustees, who have been signally generous, contributing the sum of over $100,000 in 1919 alone to meet deficiencies in the budget; nor to lack of friendliness on the part of the Board of Education, which has also given its cooperation. He gave three very sufficient reasons in the following: the unprecedented growth of the collections; the actual shortage of funds in the city treasury; and the interruption by the war of building extension through personal subscription of the trustees which was planned in 1913.

He went on to point out that the whole educational system of New York city and state has suffered from the same causes; that conditions have arisen where we are compelled to take a very large and constructive view of the future. The need of the hour as felt in every one's mind is Americanization, which can be accomplished only through the thorough training of our youth according to American ideals. The free schools, colleges, libraries, museums, scientifically arranged parks and aquaria, free lectures and free concerts designed for instruction and inspiration form the structure on which Americanization rests. In this structure, the American Museum has won a vital place. In its school educational work, the museum holds a strong position. In the last five years it has reached 5,650,595 children directly and indirectly through its lecture system and traveling museums; it has expended $89,126.08 of its own funds directly on public education, in addition to the $1,538,057 expended on explorations, collections and researches, the results of which ultimately find their way into the school mind. The scope and efficiency of its public educational work is such as to have called forth the enthusiastic admiration of the British Educational Mission on its recent visit, and to be taken as a model for educational development in Great Britain.

With all this obvious advance, the museum has in certain ways come to a full stop in its educational activities. This is particularly true of exhibition work. In hall after hall the arrangement is less truthful and more misleading than it was twenty years ago, for the collections are jumbled together out of their natural order, giving, in cases entirely erroneous impressions. It is therefore, not a civic luxury, but a *paramount educational necessity* which demands the enlargement of the museum buildings and the provision of the necessary equipment. The most important thing for the museum to-day is immediate building space and equipment. And the next most important thing is the immediate increase of its general endowment by not less than $2,000,000 in addition to the munificent bequest of Mrs. Russell Sage.

In exploration and field work but little more activity was possible than in 1918. Roy C. Andrews continued his work in northern China and Mongolia, and has been eminently successful in securing valuable series of goral, serow and mountain sheep. Paul D. Ruthling and Karl P. Schmidt have collected reptiles and amphibians in Mexico and Porto Rico. Henry E. Crampton has continued his work in the Society Islands; George K Cherrie and Harry Watkins have secured collections of small mammals and birds in Venezuela and Peru; and Herbert J. Spinden has made archeological collections in Peru, Colombia, Dutch Guiana and Central America. In the United States, valuable and unique archeological and ethnological material was secured in Arizona and New Mexico by Leslie Speir and Earl H. Morris, and a collection of Miocene fossils including a slab containing a number of skeletons of the two-horned Rhinoceros *Diceratherium* were obtained by Albert Thomas in Nebraska.

During the year over 600 accessions to the collections were recorded. Some of the more important gifts were: the painting of the eclipse of the sun in 1918 by H. R. Sutler, presented by Edward D. Adams; a Chinese painting on silk of the last dynastic period, 1761, presented by Ogden Mills; a lacquered dog-house from a Chinese imperial palace, from Miss Theodora Wilbour; skin of an albino deer, from Archibald Harrison; a series of bronze objects from Sumatra from Arthur S. Walcott; and a collection of ethnological specimens from Zuni, from Mrs. Elsie Clews Parsons.

Nearly 900,000 people visited the museum in 1919, exceeding by 175,000 the attendance of 1918. The net gain in membership was 615, the total membership now being 5,183.

Childa Frick was elected a trustee.

Those present at the annual meeting were: Thomas DeWitt Cuyler, Cleveland H. Dodge, Walter Douglas, Madison Grant, William Averell Harriman; Archer M. Huntington, Adrian Iselin, Arthur Curtis James, J. P. Morgan, Henry Fairfield Osborn, Percy R. Pyne, Theodore Roosevelt, John B. Trevor and Francis D. Gallatin.

NEW YORK MEETING OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

The American Institute of Mining and Metallurgical Engineers under the presidency of Mr. Hoover, met in New York City this week. Three sessions of the annual meeting were devoted to the subject of coal. In the first of these facts were brought out on some of the questions around which controversies raged during the recent strike, including: Why is production intermittent? How and when do the irregularities occur? How many days a year do the men actually work? What are the actual wages received by men during each season and in what way can the wage basis be changed? How and where can coal be stored at the mine, at industrial plants or elsewhere?

The fundamentals of the problem were presented in a series of papers by authorities. Van H. Manning, director of the U. S. Bureau of Mines, outlined conditions in a paper on "The problems of the coal industry." George Otis Smith, director, U. S. Geological Survey, presented a statistical analysis of the rate of output over a period of years, showing the relative effect of shortage of transportation and of labor and lack of market and other factors in the production of coal. H. H. Stoek, of the University of Illinois, discussed the storage of bituminous coal at the point of production, at centers of distribution and by the consumer. S. L. Yerkes discussed transportation as a factor in irregularity of coal-mine operation.

The business side was presented by Eugene McAuliffe, president of the Union Colliery Company, in a paper on stabilizing the market. Edwin Ludlow, of the Lehigh Coal and Navigation Co., discussed conservation as applied to mining methods, by-products and consumption.

Unpaid taxes on mines amounting to $200,000,000 were involved in a discussion at an open forum held on the subject of mine taxation. The views both of the government and the mine owners were presented, the discussion being led by Ralph Arnold, valuation expert of the Petroleum Division of the Internal Revenue Department; J. R. Finlay, who evaluated the mines of the state of Michigan; J. Parke Channing, of New York, and R. C. Allen, vice-president of the Lake Superior Ore Association.

In the evening of February 17 more than one thousand delegates and their friends attended a banquet at the Waldorf-Astoria at which Lawrence Addicks was toastmaster. President Herbert Hoover, retiring President Horace V. Winchell and Professor James F. Kemp, of Columbia University, were the speakers.

Besides Mr. Hoover as president, the following officers were elected: Frederick Laist, Anaconda, Mont., and Seeley W. Mudd, Los Angeles, vice-presidents. W. R. Walker, New York; A. S. Dwight, New York; R. M. Catlin, Franklin Furnace, N. J.; G. H. Clevenger, Washington, D. C., and W. A. Carlyle, Ottawa, Canada, directors.

RESOLUTIONS ON THE DEATH OF SIR WILLIAM OSLER

On motion of the executive committee of the Federation of American Societies for Experimental Biology in Cincinnati December 30, 1919, the following minute was drafted:

In the death of Dr. Osler, the medical profession has suffered an immeasurable loss. Belonging to no cult, or age, or clime, but descended in direct line from Hippocrates, he was master of the art of medicine in its purest form. As a teacher, he was again master, painting with broad strokes pictures of disease never to be forgotten by the student. An investigator and an inspirer of investigation, a worthy counsellor of brother physicians, a delver in the history of medicine, and an ornament to its letters; and withal so human and of such rare personal charm as to be beloved of all who came in contact with him. Such was the man we mourn.

We grieve not only at loss of leader and friend, but also that death overtook him in the very shadow of the great conflict which brought him so great personal loss and sorrow and robbed him of the mellow years which were so fully his due.

(Singned)
C. H. Bunting,
Henry A. Christian,
A. S. Loevenhart,
Committee

SCIENTIFIC NOTES AND NEWS

Dr. Ludvig Hektoen, of the John McCormick Institute for Infectious Diseases, Chicago, has been elected honorary member of the Pathological Society of Philadelphia.

Dr. E. V. McCollum, professor of chemical hygiene, school of hygiene and public health, Johns Hopkins University, has been made corresponding member of the Academie Royale de Médecine de Belgique.

Dr. Herbert E. Gregory, Silliman professor of geology, Yale University, sailed on February 17, to resume his duties as acting director of the Bishop Museum at Honolulu, Hawaii. Professor Gregory will return to New Haven in September.

Dr. William T. Sedgwick, senior professor of the Institute of Technology and head of the department of biology and public health, will be the first exchange professor with the British universities of Cambridge and Leeds. Dr. Sedgwick will leave for England early in April, and expects to spend the summer in Europe, returning to Boston in September.

Dr. Robert W. Hegner, associate professor of protozoology in charge of the department of medical zoology in the School of Hygiene and Public Health, has been appointed a delegate from The Johns Hopkins University to the Congress of the Royal Institute of Public Health which meets in Brussels from May 20 to May 24, 1920. Dr. Hegner will read a paper at the Congress on "The relation of medical zoology to public health problems." He expects to spend the months of June, July and August in study at the Liverpool and London Schools of Tropical Medicine and in visiting other institutions in Europe and Africa where medical zoology is being taught or investigated.

Ernest F. Burchard, geologist in charge of the iron and steel section, U. S. Geological Survey, has been granted a ten months' absence and will make geologic investigations in the Philippines.

Dr. M. W. Lyon, Jr., formerly professor of pathology and bacteriology, George Washington University, and at one time connected with the Division of Mammals, U. S. National Museum, and captain in the Medical Corps during the war, has left Washington to take charge of pathological work at South Bend, Indiana.

We learn from the *Journal* of the American Medical Association that, following the usual custom, Professor Laveran, formerly vice-president, has assumed the duties of president of the Paris Academy of Medicine for the year 1920. Dr. L. G. Richelot, hospital surgeon and professor of medicine in the University of Paris, was chosen vice-president for the year 1920, and Dr. Arcard, also of the University of Paris, was elected secretary for the year. Dr. F. Lejars, professor of clinical surgery, has been elected president of the Surgical Society for the year 1920.

It is announced in *Nature* that Professor R. T. Leiper, reader in helminthology in the University of London, has been awarded the Straits Settlement gold medal by the senate of the University of Glasgow. The medal was founded some years ago by Scottish medical practitioners in the Malay States, and is given periodically to a graduate in medicine of the Scottish universities for a thesis on a subject of tropical medicine.

Dr. Carlos E. Porter, editor of the *Revista Chilena de Historia Natural,* of Santiago, Chile, is about to publish a work, upon which he has been engaged for fifteen years, on the museums and naturalists of Latin America. The work will comprise three volumes abundantly illustrated. Dr. Porter is enabled to publish this work through the financial support of Dr. Chistobal M. Hicken, professor of botany and geology in the faculty of natural science of Buenos Aires, known through his explorations of Patagonia.

SIR ARTHUR NEWSHOLME, lecturer on public health administration, school of hygiene and public health, Johns Hopkins University, delivered the annual Frederick A. Packard Lecture of the Philadelphia Pediatric Society in Thompson Hall, College of Physicians, February 10, on "Neo-Natal Infant Mortality."

AT the meeting of the Institute of Medicine of Chicago, January 30, at the City Club, Dr. Victor C. Vaughan, of the University of Michigan, Ann Arbor, presented a paper on "Remarks on the Chemistry of the Protein Molecule in Relation to Infection," and Dr. Karl K. Koessler spoke on "The Relations of Proteinogenous Amins to Medicine."

AMONG the speakers at "Farmers' Week" at the Michigan Agricultural College from February 2 to 6 inclusive, were Dr. E. V. McCollum, of the Johns Hopkins University; Dr. F. J. Alway, of the University of Minnesota, and Dean Alfred Vivian, of the Ohio State University. Being members of the American Chemical Society they were the guests of honor at a luncheon given by the local section of that society on February 5, at which about forty members were present.

As a permanent memorial of Dr. Christian R. Holmes, his friends have inaugurated plans to raise a fund of $1,000,000 for medical research, the endowment to be known as the Christian R. Holmes Medical Research Fund. The Carnegie Corporation has made a gift of $250,000 to the medical college of the University of Cincinnati, as a tribute to Dr. Holmes's services and to endow a chair in his memory.

ROBERT HOLLISTER CHAPMAN, for many years topographical engineer of the U. S. Geological Survey, died of pneumonia in New York where he was attending a meeting of the American Alpine Club, of which he was secretary. After the United States entered the war Mr. Chapman became a major in the Engineers' Reserve Corps. He was born in New Haven in 1868.

DR. ELMER ERNST SOUTHARD, Bullard professor of neuro-pathology at the Harvard Medical School, died from pneumonia on February 8, aged forty-four years.

SIR THOMAS R. FRASER, F.R.S., emeritus professor of materia medica, University of Edinburgh, died on January 4, at seventy-eight years of age.

DR. EDWIN A. STRONG, emeritus professor of physics at the Michigan State Normal College, died on February 4 at the age of eighty-six years. He devoted nearly sixty years of his life to the promotion of education and science in Michigan in long terms of service at Grand Rapids and Ypsilanti.

A REGULAR meeting of the American Physical Society will be held in Fayerweather Hall, Columbia University, New York, on Saturday, February 28. If the length of the program requires it, there will also be sessions on Friday, February 27. The next following meeting of the society will be held in Washington on April 23 and 24.

MR. JAMES SIMPSON, vice-president of Marshall Field & Co., Chicago, will present the Field Museum of Natural History with a large assembly hall or theater. The seating capacity will be 925, exclusive of lobbies extending around three sides of the theater. The theater is to be in the west wing of the main building of the museum.

A PASTEUR INSTITUTE has been inaugurated at Managua, Nicaragua, presented to that country by the President of Mexico. The institute has therefore been named Instituto Antirábico Carranza.

UNDER the auspices of the Pan-Pacific Union, arrangements are being made for a scientific conference to be held in Honolulu, Hawaii, August, 1920. The purpose of the conference is to outline some of the fundamental scientific problems of the Pacific Ocean region and to formulate methods for their solution. The plan involves the cooperation of representative scientists and institutions from the countries whose interests lie within or about the Pacific with the hope that a program of research may be developed which will eliminate duplication of effort and of funds. The program of the conference is in the hands of the Committee on Pacific Exploration of the National Research Council.

The U. S. Bureau of Chemistry at Washington announces that the work on photosensitizing dyes begun during the war for the Bureau of Aircraft Production has met with such success as to make possible the preparation in the United States of dyes of all the recognized types: pinaverdol (including Orthochrome T), cyanine, pinacyanol and dicyanine; and of a new type useful for astrophotographic work. The Color Laboratory of the bureau will place its experience at the disposal of any manufacturer who wishes to prepare these important photographic aids for the American market; and pending their commercial availability is prepared to supply them to users at a price fixed by the secretary of agriculture.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Edgar F. Smith, provost of the University of Pennsylvania since 1911, tendered his resignation to the board of trustees on February 9. Dr. Smith became professor of chemistry in the University of Pennsylvania in 1888.

Dr. Jacob Gould Schurman has resigned the presidency of Cornell University. Dr. Schurman, previously professor of philosophy, became president of Cornell University in 1892.

Dr. Charles W. Dabney has resigned the presidency of the University of Cincinnati, which he has held since 1904.

Dr. John M. T. Finney, Baltimore, has declined the offer made him by Harvard University and will continue his connection with the Johns Hopkins Hospital and Medical School.

Dr. H. H. Lane, who has since 1905 been head of the department of zoology of the University of Oklahoma, has accepted a position for next year as head of department of zoology, of Phillips University, Enid, Oklahoma.

DISCUSSION AND CORRESPONDENCE

BLOOD-INHABITING PROTOZOA FOR CLASS USE

At the present time there are several large and important groups of Protozoa that remain unknown to students of biology chiefly because they are not easy to obtain when they are needed. One of these groups that is of added interest because of the economic importance of some of its members contains the hemoflagellates, including the trypanosomes. Trypanosomes are responsible for the human disease known as sleeping sickness, that is prevalent in certain parts of Africa, and for Chagas' disease in South America. They also cause diseases in domestic animals such as surra, nagana, murrina, mal de caderas and dourine which result in great losses every year.

The first trypanosome described was found in the frog in 1843 and was given the name *Trypanosoma rotatorium*. Specimens belonging to this species occur in the frogs of this country, particularly in the "water" frogs such as the green frog, *Rana clamitans*, and the bullfrog, *Rana catesbiana*, but they are present usually in small numbers and not all frogs are infected. If it is desired to obtain for study this type species the centrifuge may be used to concentrate the specimens. Blood may be obtained from an etherized frog and mixed to prevent clotting with a solution of sodium citrate made up as follows: sodium citrate, 1½ grams; sodium chloride 1½ grams; water 250 c.c. After centrifuging for about ten minutes the trypanosomes, if present, will be found in a layer at the top of the mass of red blood cells.

A much more simple method of furnishing trypanosomes to a large class of students is to collect a few newts, *Diemyctylus viridescens*, from the water. Tobey in 1906 first described the species in these newts naming it *Trypanosoma diemyctyli*. He found them present in every specimen that he had purchased in an animal store in Boston. The writer has had a similar experience with newts collected for him in Pennsylvania. Seventy-eight of the olive-green water form and seven of the vermillion land form were examined. Every one of the former was abundantly supplied with the parasites, but only two of the land forms were infected.

All that is necessary to obtain living specimens of the trypanosomes for study is to snip off a little piece from the end of the tail, and then squeeze out several drops of blood on each slide. A cover glass can be added directly or a ring of vaseline may first be spread around the blood so that the preparation will be sealed when the cover glass is put in place. In such a preparation the spiral movement of the organism is evident, and the flagellum and undulating membrane are easily observed in action. The nucleus and other structures are clearly revealed in dried films stained with Wright's or Leishman's stains. Obtain a drop of blood near one end of a clean slide. Place the end of another slide near the drop of blood at an angle of about 30 degrees with the shorter end of the slide. Draw this slide along until it touches the drop. When the blood has spread along the edge, push the slide fairly rapidly toward the other end. A thin even film will result covering about one half of the slide. Allow this to dry. Then place a few drops of the stain on the film and allow to remain one minute. Add double the volume of distilled water and after five minutes wash the film with distilled water, and dry in the air. Balsam and a cover glass may then be added but the stain will fade. If oil immersion objectives are available no cover glass should be used but the oil placed directly on the film, and after the examination is completed this oil may be wiped off with lens paper or washed off with xylol. The stain may be obtained in small 0.1 gram tubes. This amount is dissolved in 10 c.c. of pure methyl alcohol and is then ready for use.

R. W. Hegner
School of Hygiene and Public Health,
The Johns Hopkins University

HORIZONTAL RAINBOWS

To the Editor of Science: With respect to Reese's account of an "unusual form of rainbow" in Science for December 12, 1919 (Vol. L., p. 542), it may be said that, in Europe, rainbows on the surfaces of ponds and lakes have been reported from time to time during the past fifty years. They have been observed, also, on several bodies of water in Japan during the past few years and the investigators of that country have given some attention to the mathematical explanation of these phenomena.

In the United States these spectral displays have been seen frequently on the surface of Lake Mendota at Madison, Wisconsin, during the past ten or twelve years. Some of these displays have been unusually brilliant and varied; double and triple primary bows together with a secondary bow have been noted at times. These phenomena have been described in the *Monthly Weather Review* for February, 1916 (Vol. 44, p. 65).

The complete bows that have appeared on the surface of Lake Mendota possessed a very different outline from the diagram shown by Reese. They were parabolic in shape instead of circular; neither did they possess an inverted segment connecting the outer extremities as in his figure.

As far as the present writer is aware, these horizontal rainbows have been reported for only two lakes in this country, namely, Lake Mendota and the lake referred to by Reese. This seems to indicate that it is not a widespread phenomenon, or else other observers have not taken the trouble to publish accounts of their observations. It would be interesting to know whether these spectral colors have been seen on any other bodies of water in this country.

Chancey Juday
Madison, Wisconsin

CHEMISTRY APPLIED TO COMMERCE

The divorce of science and industry, which has long been a noisesome skeleton in our economic household, is fast being annulled. "During the war, American industry acquired —or had thrust upon it—a wholesome respect for American science," *Drug and Chemical*

Markets said in a recent editorial, and this organ of commercial chemistry might well have added that at the same time American science learned the wholesome lesson that American industry has problems and aims not altogether ignoble. It is no longer the hall-mark of the practical business man openly to hold in contempt all knowledge gained from books or laboratories. The man of science no longer believes that the application of his training and talents to practical problems is prostitution.

During the war period, the practical problems of the chemical industry were problems of production. American chemists helped solve these production problems, and, now that war conditions are passing, American chemical manufacturers naturally turn to them for help in solving the problems of distribution. This help must come finally from our colleges and universities.

It is not necessary for me to point out that chemical manufacture is a "key industry," nor to emphasize the fact that, if we are to keep the tremendous advantages we have won during the past five years in the development of the American chemical industry, a bitter trade war must be successfully waged. Soon our manufacturers will meet, both at home and abroad, the products of foreign competitors. Then the trade war will be declared in earnest, since our domestic consumption of chemicals is not sufficient to support a self-contained industry. Our Allies have all increased their chemical productivity greatly, and they appreciate, quite as well as we do, the vital importance of this industry. Germany has always had a nice comprehension of the place of chemicals in industry and in warfare, and her chemical equipment, both men and plants, is intact.

To make chemical products in competition with the world avails us nothing if we can not market them successfully in world-competition. Chemical manufacturing is the most diversified and technical of industries, and its basic conditions place a premium upon technical training; its productive branches are as complex, for the diversified products to be marketed are bought by many consumers and their uses are various and often highly technical. Men of technical, chemical training who can market our American-made chemicals are needed to-day.

Detailed, expert knowledge of the goods he handles is an important part of the salesman's equipment, for, since he can no longer sell his customers by means of cigars and jokes, he must render them a service. This service is often expert advice. Dyes must be properly applied; medicinals must be intelligently prescribed; aromatics must be skillfully combined. New markets must be developed for old chemicals and new products must be introduced. A smattering of chemical trade jargon is poor equipment for such work, and it is worth remembering that the German dye trusts took pains to send out salesmen trained in the chemistry of dyestuffs and speaking the language of the countries they visited. The haphazard supply of men who have taken more or less chemistry at college and who chance to become salesmen is in no way able to meet this kind of selling competition. Graduates in chemistry are seldom fitted by temperament or experience for this work: salesmen are not often equipped with technical training. Chemistry applied commercially to distribution is even further removed from the pure science than are industrial research and production work. The commercial instinct, however, is not to be condemned, and courses in commercial chemistry would attract undergraduates who, after a year's course, would normally drop out of the ken of the chemistry department. The training of so-called chemical engineers has brought to the study of chemistry many students anxious to become plant executives, but quite indifferent to analysis, research, or teaching. Courses in commercial chemistry would, in like manner, open up new opportunities.

The foundation of such courses would naturally be a broad one of chemistry upon which could be raised a working knowledge of analysis and of important industrial processes. The uses of chemical products in the industries—steel, textile, leather, rubber, paper, glass, fertilizers, etc.—ought to be treated in such courses, and crude drugs, essential and fixed oils, and petroleum, are products closely allied commercially to chemicals about which the student should know something. A series of lectures on the chemical markets—how chemicals are sold, containers, insurance, fire risks, sales contracts, etc.—might well be delivered by some sales manager or broker familiar through daily, practical experience with this subject. Supplementary courses in applied economics, such as given in many of the larger universities on banking and finance, commercial law, traffic and transportation, business administration, advertising, and even actual salesmanship, might to advantage be offered to the students of commercial chemistry.

A definite and very real need for men with technical training in chemistry as applied to commerce exists and, as yet, there has been no systematic, serious effort on the part of our colleges and universities to supply this demand. Young men equipped with this training would find places in the most highly paid branch of industry open to them, and institutions giving this training would increase the scope of their chemistry departments. Moreover, to supply the American chemical industry with technically trained merchandizing experts will strengthen a "key industry," necessary to national prosperity and, in event of war, essential to national preservation.

Williams Haynes

New York City

SCIENTIFIC BOOKS

The Physical Chemistry of the Metals. By Rudolph Schenck, Professor of Physical Chemistry in the Technischen Hochschule in Aachen. Translated by Reginald Scott Dean, Research Metallurgist, American Zinc, Lead and Smelting Company. New York. John Wiley and Sons, Inc. 1919. VIII + 239 pages.

It is surprising that this book published in Germany in 1908 should have escaped the eye of the translator until now. It is, however, most encouraging to the future of American industry to find the translator connected with one of the large metallurgical plants. Usually texts which deal largely with theoretical subjects are translated by college men for use in their classes and find their way into the practical field only indirectly. It is, therefore, doubly welcome to see a translation emanating from an industrial plant.

The book deals very largely with principles, but is eminently practical for the metallurgist. The chapter headings: I. Properties of Metals; II. Metallic Solutions and Alloys; III. Alloys of Metals with Carbides, Oxides and Sulphides, Iron and Steel, Mattes, Phase Rule; IV. Metallurgical Reactions, Oxidation and Reduction; V. Decomposition of Carbon Monoxide, Blast Furnace Process; VI. The Reactions of Sulphides give a good idea of the subject matter contained in the book. All of this material is essential to the well-trained metallurgist, but particularly that in the last four chapters. Each subject is treated briefly, but clearly and special emphasis is laid upon equilibrium phenomena and the factors which influence equilibrium. The reactions between carbon and oxygen and metallic oxides receive the full attention they deserve.

With the many merits which the book has it is surprising that it has some simple faults which might easily have been corrected. As examples might be mentioned the following: the omission of the eutectic lines in the diagram on page 51; the form of curves 1, 2, and 4 in diagram on p. 50; the inadequacy of the treatment of Crystal Growth on p. 20; the synonymous use of the terms martensite and austenite; the use of the term sorbitic as applied to chilled cast iron. These are, however, unimportant and it is hoped and believed that the book will be a distinct help to American metallurgists.

H. F.

SPECIAL ARTICLES

THE DEVELOPMENTAL ORIGIN OF THE NOTOCHORD

The notochord is so constant, fundamental and distinctive a structure in the Chordate group that its interpretation—as is of course thoroughly known—has received great attention, and it plays a part in many of the theories of "the origin of vertebrates." Despite the great theoretical importance attaching to the origin of the chorda dorsalis or notochord, we find in the current text-books statements of its origin most conflicting—and as it seems to me unnecessarily so. Of five standard text-books of human anatomy in the English language, two give the notochord as entodermal, three as derived from the primitive streak. Of five text-books of histology, two describe the notochord as entodermal, one as ectodermal, while two make no statement; two standard comparative anatomies give the notochord as entodermal; of seven embryology texts, five state that it is of entodermal origin, although three of these qualify it as an apparent origin only, one gives the notochord as mesodermal, while one states that it may in different vertebrate groups be ectodermal, mesodermal, or entodermal. Three standard text-books of pathology state that the notochord is an endodermal structure. Most text-books of zoology will probably be found to adhere to the entodermal origin of the notochord. The preponderant statement is thus that the notochord is an entodermal structure, and since this is the origin in the latest human anatomy and in the latest vertebrate embryology, it is clear that this interpretation is not an old obsolete one held over from edition to edition.

In the attempt to reconcile the apparent differences of origin of the notochord or the different interpretations, we have two attitudes illustrated: (1) Kellicott in his "General Embryology" confessedly accepts an origin from any one of the three germ-layers when he says (p. 358): The "notochord may with equal correctness be described as entodermal, mesodermal or even ectodermal, in various forms." Kingsley, in his "Comparative Anatomy of Vertebrates," who accepts the entodermal origin says, however (p. 13, footnote): "The statement is made that in some groups the notochord arises from another germ layer than the entoderm, but these statements apparently rest on erroneous observations or interpretations. Different origins in different vertebrates would tend to show that what are called notochord are not homologous." It requires but brief review of the early development of the chick (for example) to recognize that the notochord is here developed from the primitive streak and hence not entodermal. Furthermore, the fundamental plan of the vertebrate body is so constant and the occurrence, position, extent and relations of the notochord so uniform that any suggestion that the notochord is not homologous in the different vertebrate classes must be rejected at once as without evidence. Finally, it would be improbable that such a structure as the notochord should have fundamentally different origins in different forms as Kellicott felt forced to asume.

When the facts of vertebrate development are fully examined, it becomes at once apparent that it is unnecessary to assume lack of homology, error in interpretation or real diversity in origin, but that in all vertebrates whose development has been traced—from *Amphioxus* up to man—the notochord is formed from the dorsal lip of the blastopore or (in higher forms) its equivalent the primitive streak. For the preponderance of the view that the notochord is an entodermal structure perhaps three things are mainly responsible: (*a*) the prevailing tendency to interpret development as seen in the convenient transverse plane, with (*b*) neglect of the concomitant changes in the long axis and without an appreciation of the dorsal lip of the blastopore as the center of differential growth which lays down, along with other structures, the notochord. (*c*) The preponderant work done upon the development of the lower vertebrates, particularly *Amphioxus* and the *Amphibia*, where, as followed in transection without an accompanying consideration of the growth in the longitudinal planes, it would be unhesitatingly stated that the notochord was folded off from the entoderm. But even in these forms, it would be only the first, more cephalic, portion, of the notochord that could be under any interpretation termed entodermic, since as soon as the so-called "tail-bud" has formed by growth-transformation of the blastoporic lip, differential growth in that region continues to form notochord that has no association with the entoderm whatever. Cerfontaine,[1] it may be pointed out, in his classical paper on the early development of *Amphioxus*, has critically studied the development of the notochord from the dorsal blastoporic lip, and accordingly ranks it as an ectodermal structure.

It is unnecessary to take up here in detail the evidence of the formation of the notochord from the blastoporic lip. There is no reason to consider the development of the chick as exceptional among birds. In mammals, the evidence as it accumulates shows the same mode of origin (from the primitive streak), as exemplified by the recent careful description of Huber[2] for the guinea pig.

The acceptance of the origin of the notochord from the dorsal lip of the blastopore (resp. primitive streak) throughout the vertebrate group (including *Amphioxus*) leads naturally to the statement that the notochord is to be regarded as ectodermal in origin. For many years it has seemed to the writer that the conception of a germ-layer should include nore than topographical relation. It is therefore advantageous to consider the blastoporic lip, primitive streak and so-called "tail bud," undifferentiated material rather than definitive ectoderm, and having within it the "potentialities" of the several structures developed out of it. Its cells would be "totipotent" or at least "pluripotent," if we wish to use these terms. Particularly from the pathological viewpoint, in the interpretation of teratomata from the persistence of undifferentiated cells of primitive streak or tail-bud origin would this be helpful.

The notochord throughout the vertebrate class shows the marked association with the entoderm, which is of course directly responsible for the prevailing view that the notochord is an entodermal structure. While in the phylogenetic interpretation of the origin of the notochord this fact must ultimately be taken full account of, ontogenetically, the entoderm is the only one of the three germ-layers which can not be considered as the source of its cells—the one to which it may be referred. Many, as indicated above, from the fact of the superficial location of the formative centers in the blastoporic lip will regard the notochord as ectodermic. One may, as Keibel clearly does,[3] consider it unnecessary to refer the notochord to any germ-layer. However, if we must group the notochord in with one of the three fundamental germ-layers, it has seemed to the writer that the notochord must be included among the mesodermal structures, for the following reasons: (1) The mesoderm—or, to make due allowance for other possible sources of mesoderm—that portion of the mesoderm with which the notochord is associated is developed from the blastoporic lip (resp. primitive streak, tail-bud), and is similarly "handled" in development. When, as in *Amphioxus* the notochord is at first associated with the entoderm, forming temporarily part of the roof of the archenteron, the mesoderm is similarly associated. (2) It attains like the mesoderm an interior (intermediate) position. (3) It is endoskeletal in its physiologic significance. (4) The notochord in amphibia and reptilia at least gives rise to hyalin cartilage, a tissue of recognized mesodermal characteristic. This seems to be clearly shown by a number of investigators.[4] Considerations similar to the above led Triepel[5] to pronounce the notochord a mesodermal structure.

Were the pathologists to accept the notochord as a mesodermal structure rather than entodermal, it may be suggested that the close resemblance of chordomata to myxomata, myxo-chondromata and chondromata, which I

[1] Cerfontaine, P. *Arch. de Biol.*, Vol. 22, 1906.

[2] Huber, G. Karl, 1918, *Anat. Record*, Vol. 14.

[3] Keibel, Franz, 1900, *Anat. Hefte*, Vol. X.; Keibel, Fr., 1910; Keibel and Mall, Vol. I., Ch. V.

[4] Bruni, A., 1912, *Anat. Hefte*, Vol. 45. Krauss, Fr., 1909, *Arch. f. mikr. Anat.*, Vol. 73. Pusanow, I., 1913, *Anat. Anzeiger*, Vol. 44. Schauinsland, H., 1906, in Hertwig's *Handbuch d. vergel. Entw. ges.*, Vol. III., Pt. 2.

[5] Triepel, H., 1914, *Anat. Hefte*, Vol. 50.

understand so frequently makes diagnosis difficult, might have added significance.

B. F. Kingsbury
Department of Histology and Embryology,
Cornell University

THE CONFERENCE AT CLEVELAND ON THE HISTORY OF SCIENCE

Readers of Science may be interested in some account of what was probably both the most novel and significant conference of all those held by the various learned associations at their recent holiday meetings, namely, the conference devoted to the History of Science at the Annual Meeting of the American Historical Association in Cleveland. Of even more value than the papers read and the public discussion, although these were marked by an unusual degree of originality, interest, and enthusiasm, and were heard by an audience of very gratifying numbers, most of whom remained throughout the unusually long session, was the opportunity offered—in many instances for the first time—to those engaged in research in this promising field to become personally acquainted, and to talk over matters of common interest informally and face to face.

The chairman of the conference, George L. Burr, librarian, and Andrew D. White professor of history at Cornell University, and a former president of the American Historical Association, presided with something even more than his characteristic charm and felicity. In his opening remarks he noted the fact that while isolated papers bearing on the history of science had been presented at some previous meetings of the American Historical Association, this was the first time in the history of that organization that a conference had been especially devoted to that subject. He also emphasized the rapid strides that research in this subject had made in recent years. Of the papers which followed it will be possible to give only a very brief and, I fear, otherwise imperfect summary here; it is to be hoped that they may be published in full at an early date.

T. Wingate Todd, professor of anatomy in the medical school of Western Reserve University, in an illustrated address on Egyptian medicine showed the predominance of ritual and superstition in that field and the employment of similar postures and paraphernalia by the natives of modern Africa. He questioned whether the priest-physicians of the Nile Valley advanced far beyond the stage of primitive practise in dentistry, general surgery, and therapeutics; and was also skeptical as to their contributions to pharmacology. Before the Eighteenth Dynasty abscesses were incised and fatty tumors removed, but surgery of the extremities is doubtful. During the Fifth Dynasty splints were used with the idea of supporting the injured limb rather than of controlling the fragments.

The paper on "Peter of Abano: A Medieval Scientist," 1250–1316(?), by the present writer discussed the sources for and chief events of his life, showing that he perhaps lived beyond 1316 and taught at Treviso and Montpellier as well as at Paris and Padua, that the evidence for his being protected and employed by popes is better than that for his supposed trial by the inquisition, and that he was a commentator on Aristotle, a critical translator especially from the Greek, and an experimental astronomer, as well as a keen student of medicine and natural science. He was far, however, from being free from the superstition of his age.

Louis C. Karpinski, professor of mathematics in the University of Michigan, spoke concerning "The history of algebra." After touching briefly upon the contribution to mathematical speculation made by the Egyptians, he illustrated the relations of Greek geometry, especially in such a problem as that of the construction of a regular pentagon, to the development of algebraic thinking. He concluded with a summary of the contributions made by several Arabian mathematicians to the growth of algebra.

Henry Crew, professor of physics in Northwestern University, discussing "The problem of the history of science in the college curriculum," pled for a more human treatment of the sciences and argued that the teaching of science might be made more stimulating to young minds by some treatment in each case of the personality and achievement of the man who had discovered the scientific fact or law in question. He further advocated separate courses in the history of science in the four fundamental fields of physics and chemistry, zoology and botany. He also raised the question of the age and academic position of the men to offer such courses.

The discussion was opened by Dr. Harry E. Barnes, of The New School for Social Research, who noted that of the four papers on the program only one was by a professor of history and expressed regret that of all the workers in the history of science probably even less than this twenty-five per cent. were professed historians. He emphasized the high value and promise of the history of science compared to the old political history, and sketched the progress particularly of American historiography of science. He also mentioned the increased space given to the history of science in the new Syllabus of Professor James Harvey Robinson's well-known course in the Intellectual History of Europe.

Charles H. Haskins, dean of the graduate school of Harvard University, who was chosen at this meeting second vice-president of the American Historical Association, expressed his sense of the importance of the history of science and desire that a conference in the subject might become a permanent feature of the program. In speaking of Professor Henderson's course at Harvard in the history of science, he suggested the advisability of requiring one laboratory course as a prerequisite to the course in the history of science, so that the students would not consider the history of science as a substitute for science itself.

Dr. Walter Libby, of the University of Pittsburgh, after a brief tribute to the memory of Sir William Osler as a friend of the history of science, advised that courses should be given for freshmen in the general history of science, and saw large possibilities for advanced work in this new field of university research. As for the less easy problem of the intermediate courses, he suggested the treatment of the history of physics, chemistry, and the like by experts in those subjects with the possible cooperation of the professor of the history of science. A treatment of various epochs by the department of general history with emphasis on the relation of scientific progress to the advance of civilization was also to be desired. He alluded to the course in the history of science and civilization now required of freshmen in the combined arts and medical course at the University of Toronto, and to courses offered in the histories of medicine, pharmacy, and psychology at Pittsburgh.

In view of the good attendance at this conference, although it was not arranged for until almost the last moment, and the fact that the program was a little too crowded, I am inclined to suggest that another time there should be at least two conferences planned, one for papers embodying historical research, and the other for a discussion of the teaching of the history of science.

Lynn Thorndike
Western Reserve University,
Cleveland, Ohio

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FINANCIAL REPORT OF THE PERMANENT SECRETARY

L. O. HOWARD, PERMANENT SECRETARY, IN ACCOUNT WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Dr.

To balance from last account		$7,575.45
To receipts from members:		
Annual dues previous to 1918	$435.00	
Annual dues 1918	479.00	
Annual dues 1919	31,330.00	
Admission fees	535.00	
Life membership fees	500.00	33,279.00
To other receipts:		
Sale of publications	$22.50	
Interest on accounts at bank	114.35	
Miscellaneous receipts, including treasurer's pay-		

ment of SCIENCE subscriptions for life members, foreign postage, sale of programs, etc.	901.96	1,038.81
		$41,893.26

Cr.

By publications:		
Publishers SCIENCE		$22,108.85
By expenses, Baltimore meeting:		
Sectional secretaries' commutations, accounts, carpenter, preliminary announcements, badges, programs, press secretary, local secretary, etc.		1,822.50
By expenses, Pacific Division		1,500.00
By expenses, Washington office:		
Salary, Permanent Sec'y.	$1,500.00	
Salary, Assistant Sec'y	2,100.00	
Extra clerical help	2,356.25	
Postage	1,391.07	
Office supplies	115.88	
Stationery and forms	1,564.45	
Express, telegrams and telephone	139.96	9,167.61
By miscellaneous expenses:		
To treasurer, life membership fees	$1,250.00	
To refund of overpaid dues.	7.00	
To unredeemed bad check of member	3.00	
To exchange charges by Amer. National Bank	2.52	
To auditor, Committee of One Hundred on Scientific Research and Committee grants	42.88	1,305.40
		$35,904.36
By balance to new account		5,988.90
		$41,893.26

The foregoing account has been examined and found correct, the expenditures being supported by proper vouchers. The balance of $5,988.90 is with the following Washington, D. C., banks:

American Nat. Bank of Washington	$405.38
Ditto (Savings Department)	3,205.59
American Security and Trust Co.	2,377.93
	$5,988.90

HERBERT A. GILL,
Auditor

WASHINGTON, D. C.,
December 20, 1919

REPORT OF THE TREASURER

BALANCE SHEET

Assets

Investments:	
Securities (Exhibit "A")	$114.766.75
Cash in banks	3,657.69
	$118,424.44

Liabilities

Funds:	
Life Memberships 343 at $50	$17,150.00
Jane M. Smith Fund	5,000.00
Colburn Fund	77,755.74
Miscellaneous Funds	14,861.01
	114,766.75
Uninvested Interest	3,657.69
	$118,424.44

CASH STATEMENT

Receipts

1918			
Dec. 16.	Balance from last report		$3,827.95
	Interest from securities	$5,447.18	
	Interest from bank balance	52.94	
	25 Life Commutations	1,250.00	6,750.12
			$10,578.07

Disbursements

Investments		
$2,000 U. S. Victory Loan Bonds		$1,989.25
Grants		
W. P. Whiting	$200.00	
Myra M. Hulst	200.00	
R. L. Moodie	200.00	
A. L. Foley	150.00	
Orin Tugman	100.00	
E. M. Terry	150.00	
F. C. Blake	100.00	
E. B. Frost	500.00	
Donald Reddick	500.00	
S. D. Towney	250.00	
C. H. Eigenmann	500.00	
A. Hrdlička	200.00	
G. L. Wendt	350.00	
S. A. Courtis	100.00	
Gilbert M. Smith	100.00	
L. B. Arey	400.00	4,000.00

Interest on Life Memberships		
343 members ($17,150 at 4 per cent.) for 1918...	686.00	
4 members (Jane M. Smith Fund)	200.00	886.00
Accrued Interest on purchase of $2,000 Victory Loan Bonds		45.13
		$6,920.38
Cash in Banks		
Fifth Avenue Bank of New York	$1,499.49	
U. S. Trust Company of New York	2,158.20	3,657.69
		$10,578.07

(Exhibit "A")

SCHEDULE OF SECURITIES

Securities Purchased

Par Value	Purchase Value	
$10,000 Chicago and Northwestern Railway Co. general mortgage 4 per cent. bonds, due 1987	$9,425.00	
$10,000 Atchison, Topeka and Santa Fe Railway Co. general mortgage 4 per cent. bonds, due 1995.....	9,287.50	
$10,000 Great Northern Railway Co. first and refunding mortgage 4.25 per cent. bonds, due 1961....	10,050.00	
$10,000 Pennsylvania Railroad Co. consolidated mortgage 4.5 per cent. bonds, due 1960	10,487.50	
$10,000 Chicago, Burlington and Quincy Railroad Co. general mortgage 4 per cent. bonds due 1918.	9,350.00	
$10,000 Union Pacific Railroad Co. first lien and refunding mortgage 4 per cent. bonds, due 2008.....	9,012.50	
$10,000 Northern Pacific Railway Co prior lien railway and land grant 4 per cent. bonds, due 1997.	9,187.50	
$10,000 New York Central and Hudson River Rail-Co. 3.5 per cent. bonds, due 1997	8,237.50	
$8,000 U. S. Second Liberty Loan Bonds	8,000.00	
$2,000 U. S. Third Liberty Loan Bonds	2,000.00	
$2,000 U. S. Fourth Liberty Loan Bonds	2,000.00	
$2,000 U. S. Victory Liberty Loan Bonds	1,989.25	$89,026.75

Bonds from Colburn Estate

Par Value	Appraised Value	
$20,000 Acker, Merrill and Condit Co. debenture 6 per cent. bonds	$13,600.00	
$7,000 Buffalo City Gas Co. first mortgage 5 per cent. bonds	1,540.00	
$8,000 Park and Tilford Co. sinking fund debenture 6 per cent. bonds	6,400.00	
$42,000 Pittsburgh, Shawmut and Northern Railway first mortgage 4 per cent. bonds, due February 1, 1952	4,200.00	$25,740.00
$171,000		$114,766.75

I certify that I have audited the accounts of the Treasurer of the American Association for the Advancement of Science for the period December 16, 1918, to December 20, 1919; that the securities representing the investments of the association have been exhibited and verified; and that the income therefrom has been duly accounted for.

The financial statements accompanying the Treasurer's report are in accord with the books of the association and correctly summarize the accounts thereof.

Herbert A. Gill,
Auditor

Dated December 20, 1919.

SCIENCE

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FRIDAY, FEBRUARY 27, 1920

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

ON THE RELATIONS OF ANTHROPOLOGY AND PSYCHOLOGY[1]

IF we are to compare two objects and study their relations, we will naturally want data as to their dimensions, their composition, and their observed influence upon each other. In comparing two branches of science we should thoroughly know their scope, the intrinsic work and the tendencies of each, and their mutual interplay and cooperation. This stipulates, in the first place, a clear definition of both of the branches concerned; in the second, a good acquaintance with their workings and their possibilities; and lastly, a possession of some satisfactory measure of the field of activities of each of the two branches for direct comparison.

In considering the relations of anthropology and psychology, the conditions just named are regrettably, not all fulfillable. We are fairly clear to-day as to the definition of scope, and work done, as well as doing and to be done, in physical anthropology; but we are less clear in these respects when it comes to other subdivisions of the "science of man," and matters are even less satisfactory when we approach psychology.

In a general way, we all feel that psychology and anthropology are related. The very existence of this joint Section, as well as that of the joint committee of our two branches in the National Research Council, are sufficient proofs of this feeling, in this country at least. We all know also that anthropological studies of human activities, both in the far past and at present, the studies of language, beliefs, ceremonies, music and habits, as well as the studies upon the human and animal brain and on the sense organs and their functions, are

[1] Address of the vice-president and chairman of Section H—Anthropology, American Association for the Advancement of Science, St. Louis, December, 1919.

of direct and intense concern to psychology; while on the other hand we are equally aware of the fact that many of the studies of the psychologists, such as those on hereditary and group conditions, and on behavior of primitive peoples are of considerable interest to anthropology. But when we examine more closely into these relations, we meet with various setbacks and difficulties. We soon see, although again only in a general way, that the psychologists and anthropologists of whatever shade of color can and do exist quite independently; that they actually work to a very large extent unknown to each other; that as time goes on they associate rather less than more at the colleges and universities; that they progressively drift further apart in nomenclature, methods and other respects, and that in no important way are they really coming closer together. No one, I am sure, would claim that if every anthropologist disappeared to-day, psychology could not go on as well as it has hitherto; and no one could claim on the other hand, that anthropology could not exist without the aid of psychology.

In our institutions the two branches proceed to-day, as well known to all of us, quite independently. Our great museums all have their departments of anthropology, but none that of psychology; while in some of the colleges, in the War Department, and the Public Health Service, matters are the reverse. The publications of one of the branches are scarcely known to the workers in the other, and barring rare exceptions there is no thought of exchanges, references or mutual reviewing of literature. The terminology is divergent, instruments and methods differ; our most important international congresses and relations are wholly distinct; at our meetings we mingle only through courtesy and habit; and as has well been shown during the years of war there was no actual cooperation of the two branches in this greatest of contingencies, and but little concern in one of what the other might be doing or planning. If the anthropologist takes up the list of psychological publications such as furnished by the Psychological Index he will note that as this proceeds from year to year it progressively drops reference to anthropological publications; and the same condition is observable in the anthropological bibliographies in relation to what may be considered more strictly psychological work.

It is also known to you that for several years now increasingly strong efforts have been put forward from both sides to separate in this association anthropology from psychology and have each form its own section, efforts which now have been successful.

Bearing all this in mind we can not help asking: Is there really any relation of consequence between modern anthropology and psychology?

There is indeed such a relation; but it has never thus far been sufficiently defined and never as yet sufficiently exploited. This relation is of such a nature, that during the preliminary and earlier work in both branches it could and had to be neglected; but as psychology progresses it will grow in strength, to eventually become of importance.

I may be permitted, in the first place, to point out the areas of contact and interdigitation of the two branches.

Unfortunately, I meet here with the serious initial difficulty of defining psychology. After striking this snag in the preparation of my address, I turned to a series of the foremost representatives of your science for help, and the help did not materialize. Some of those appealed to would give no definition; others would attempt it only circumstantially, so that it was of little use for my purpose; while the rest defined or inclined to define psychology as the "science of behavior," which characterization does not seem to be sufficiently comprehensive.

I then turned to the publications given in the last few volumes of the Psychological Index and particularly the volume for 1918, which presumably is the most representative. It gives 1,585 titles. Out of these I found, so far as I could judge from the titles, 14 per cent. dealing with neurology and physiology; 28 per cent. dealing with neuropathology and psychiatry; 6.5 per cent. dealing with sociology, ethics, and philosophy; 2.5 per cent. with religion, mysticism, and metaphysics; 3.5 per cent. of the titles were mixed and indefinite; 4 per cent. dealt with animal psychology; 36 per cent. with human psychology; and 6.5 per cent. with what approached physical and general anthropology.

I found further that the publications included in your index, and hence those in which you are interested, range from anatomy and histology of the nervous system to mathematics on the one hand and metaphysics on the other, covering practically the whole vast range of phenomena relating to the nervous system and mental activities of man and animals. This shows indefiniteness, incomplete crystallization.

As psychology advances, its field will doubtless become better differentiated, and possibly separated into a number of special subbranches. When this happens the relations of the various subdivisions of psychology and those of anthropology will be more evident and easier of precision. It will then be found that your anatomical and physiological section will have many points of contact with physical anthropology, while your sections on behavior, beliefs, habits, dreams, etc., will connect in many respects with the anthropological studies which are to-day grouped under the terms of ethnology and ethnography.

However, even such clarified relations would be of no great importance, were it not for the fact that psychology must as time passes on enlarge the scope of its activities, until no small part of these shall really become anthropological.

And here I must define anthropology. Its old definition as the "science of man" is not sufficient, being too comprehensive and too indefinite. But if you will examine the activities in any branch of anthropology, you will find that although they deal with a vast array of subjects they are all characterized by certain something distinctive, and this is the *comparative* element. Anthropology is essentially a science of comparisons. It is comparative human anatomy, physiology, psychology, sociology, linguistics, etc. And being comparative it does not deal with individuals or mere abstract averages, but with groups of mankind, whether these are social, occupational, environmental, racial, or pathological. In brief, it is the science of human variation, both in man himself and in his activities.

Let us now return to psychology. In the course of its development, psychology will unquestionably find its choicest field in group studies. It has already begun in this direction. It compares classes with classes, as during the late war; it will enter in the not far distant future into race psychology; and it will compare other definite human groups with groups, study their variations and the causes of these, study evolution, involution, and degenerations of the nervous organs of mankind as a whole—and all this will be or be very near to anthropology.

A word in conclusion. Anthropology and psychology as they are to-day, are fairly independent branches of scientific activities, with no closer actual bonds and interdependence than those that exist, for instance, between either of them and sociology, or history. But in their further development and particularly that of psychology, the two branches will approach closer together until an important part of their activities will be in the same orbit.

A. Hrdlička

THE FUNCTIONS AND IDEALS OF A NATIONAL GEOLOGICAL SURVEY. II

Kinds of Work to be Undertaken by a National Geological Survey.—There has been considerable difference of opinion as to the kinds of work that should be undertaken by a national geological survey. Shall its field be confined to what may be included under geology or shall it embrace other activities, such as topographic mapping, hydrography and hydraulic engineering, mining engineering, the classification of public lands, the collection and publication of statistics of mineral production and the mechanical arts of publication such as printing and engraving. These various lines of activity may be divided into two main classes—those that are more or less contributory to or subordinate to the publication of geologic results, and those that have little if any connection with geology.

The speaker is one of those who believe that a geological survey should be essentially what its name implies—that it should confine its activity to the science of geology. This opinion is held, however, in full realization of the fact that here as elsewhere some compromise may be necessary. This may be dictated by law or may be determined by policy.

The organic law of the U. S. Geological Survey, for example, includes among the duties of the organization "the classification of the public lands." There may be some difference of opinion as to what the framers of the law meant by this provision, but it is at least a reasonable conclusion that they intended the sort of classification adopted by the General Land Office. If so, the determination of the so-called "mineral" or "non-mineral" character of public lands is undoubtedly a proper function of the U. S. Geological Survey, although it is one that was neglected by that survey for many years and has not yet received the recognition of a specific appropriation, except recently, in connection with the stock-raising and enlarged homestead acts.

Topographic Mapping.—Inasmuch as the preparation of a topographic map is a necessary preliminary to accurate and detailed geologic mapping, a geological survey is vitally interested in seeing that satisfactory maps are available as needed. Whether the national geological survey should itself undertake this mapping depends upon circumstances. If another government organization is equipped for doing this work and can provide maps of the requisite quality when needed, it would appear that the geological bureau should leave this work to the other organization, particularly as the maps required to keep abreast of geologic requirements are likely to constitute only a part of the work of the topographic bureau. There are certain decided advantages, however, in having the topographic work done by the geological survey and these advantages must be weighed against other considerations. With the topographic and geologic work under a single control, the geologist is more likely to be assured of getting the kind of map desired at the time needed. Cooperation between geologists and topographers is apt to be both closer and more flexible than were the two staffs in separate organizations. Finally the field work in topography and geology is in some respects alike and is carried out by similar methods and equipment. Occasionally the two kinds of work can be combined and carried on simultaneously.

The general question, Whether a national geological survey shall do its own topographic mapping, appears to be one that can not be answered once for all but must be determined for each country. In an old country where accurate and detailed maps have long been made by military and other organizations, a geological survey may be under no necessity of providing its own topographic base maps. In a new country, where exploration is still in progress, the geological survey may have to make its own topographic surveys. The The main point, as I see it, is that the geological survey must have maps of the standard required by it with the least possible delay, but should not undertake to make them itself if other organizations that can and will providc the maps needed are already in the field.

We have seen that there is at least a very close connection between topographic and geologic mapping and that in this relation may lie a sufficient reason why both kinds of work should be undertaken by the same organization. Is there as good a reason why the study of geology and the collection of statistics of mineral production should be united?

Statistics of Mineral Production.—When shortly after the organization of the U. S. Geological Survey the collection of statistics was begun, those geologists who were most influential in urging that the survey should undertake statistical work adduced as the principal reason that the people desired such figures and if the Geological Survey did the work it would be able to secure larger appropriations than if the task were left for others.

It does not appear to have been thought at that time that geologists were the only men who could satisfactorily do statistical work or that it was necessary to impose this task on them. Subsequently, however, the work was apportioned among the geologists. The reasons for this step appear to have been first, that the results of having the statistical reports prepared under contract by specialists who were not on the regular staff of the organization had proved unsatisfactory; second, that by apportioning the work among the geologists already on the staff not only would the apparent cost in money be less than under the former arrangement, but it would, in a book-keeping sense, be very much cheaper than taking on new men for this particular work; finally, it was argued that geologists could apply their knowledge of the field relations of ore deposits to improve the character of statistical reports and would themselves benefit by additional opportunities to visit and examine many deposits that they might not otherwise see.

It is undoubtedly true that the statistical reports of the United States Geological Survey have greatly improved in accuracy, fullness, and general interest since this plan was adopted. It is also true that some geologists have turned their opportunities as statistical experts to good account both in enlarging their experience and by gathering material that has been worked into geological papers. Nevertheless, the policy has, in my opinion, been a mistake both economically and scientifically. It has insidiously filched the time of highly trained men who have shown originality and capacity for geologic research and has tied these men down to comparatively easy and more or less routine tasks. Some geologists who were once scientifically productive no longer contribute anything to geological literature but are immersed in work that men without their special geological training could do as well. To a certain extent the policy is destructive of scientific morale. A young geologist sees that a man who publishes annually or at shorter periods reports on the statistics of production of some metal becomes widely known to all interested in that metal and is considered by them as the United States Geological Survey's principal expert on that commodity. This easily won recognition, with all that it implies or seems to imply in the way of promotion and of industrial opportunity must constitute a real temptation so long as a scientific man is expected to contribute his own enthusiastic devotion to science as part payment of his salary. The incidental geological opportunities offered by statistical work are found chiefly in connection with a few of the minor mineral resources, rather than with such industrially dominant commodities as petroleum, iron or copper, and these opportunities for the individual geologist are soon exhausted and are likely to be purchased at a price far out of proportion to their value. The supposition that geological training is essential for good statistical work in mineral products is a fallacy, and no man who shows promise of making real contributions to geologic science should be placed in such circumstances that he is virtually forced to worship an idol whose head may be of gold and precious stones but whose feet are assuredly of clay. I am emphatically of the opinion that the collection of mineral statistics is not logically a function of a national geological survey. If, however, such a survey is committed to this task by law, by the lack of any other organization to do the work, or by well considered reasons of policy, then it is even more certain that the duty should not devolve upon geologists at the expense of their own science, but should be cared for by a special staff. Some cooperation between the statistical staff and the geologic staff may be advisable but the extent of this cooperation should be determined by those fully alive to the necessity of safeguarding geology against encroachments by statistical work.

Water Resources.—Studies concerned with the occurrence of underground water are of course as much geological as those concerned with the occurrence of petroleum. Investigations of surface waters, however, including stream gaging and the study of water-power come within the field of engineering and have so little connection with geology that it is difficult to see any logical ground for their inclusion within the group of activities belonging properly to a geological survey. In an ideal apportionment of fields of endeavor among the scientific and technical bureaus of a government, stream gaging and estimation of water-power would scarcely fall to the national geological survey. As it happens, the United States Geological Survey does perform these functions and I am not prepared to say that there is not ample legal and practical justification for this adventitious growth on a geological bureau. There has been little or no tendency to draft geologists into hydraulic engineering and consequently the principal objection urged against the inclusion of statistical work within the sphere of a geological survey does not here apply. Apparently the only practical disadvantages are the introduction of additional complexity into a primarily scientific organization and the consequent danger of the partial submergence of principal and primary functions by those of adventitious character.

It should be pointed out in this connection that certain studies of surface waters, especially those that are concerned with the character and quantity of material carried in suspension and in solution in river waters, have much geological importance. Such studies supply data for estimating the rate of erosion and sedimentation. They are to be regarded, however, rather as an illustration of the way in which geology overlaps other branches of science and utilizes their results than as reason for considering hydraulic engineering as normally a function of a geological survey.

Foreign Mineral Resources.—One of the results of the war was to suggest the advantage to the citizens and government of the United States of a central source of information concerning the mineral resources of foreign countries. The United States Geological Survey undertook to gather this information, primarily for the specific purpose of supplying data to the American representatives at the Peace Conference. As the director of the survey states in his fortieth annual report:

> Two general purposes were served—first that of obtaining a clear understanding of the relations between our own war needs and the foreign sources of supply from which these needs must or could be met; second, that of obtaining an understanding of the bearing of mineral resources upon the origin and conduct of the war and upon the political and commercial readjustments that would follow the end of hostilities.

This work, of a kind that so far as known had not previously been undertaken by any national geological survey, has been continued with the view that it is important for those who direct American industries to possess as much information as possible concerning those foreign mineral resources upon which they can draw or against which they must compete. The results aimed at are directly practical and are largely obtained by compilation of available published and unpublished material as it is manifestly impossible to make direct detailed investigation of the mineral resources of all foreign countries. Nevertheless the work appears to fall appropriately within the field of a geological bureau and if it can be made to furnish the opportunity, hitherto lacking, for geologists in the government service to make first-hand comparison between our own mineral deposits and those of other lands the experiment will probably bear scientific fruit.

Mineralogy and Paleontology.—Mineralogy and paleontology are so closely related to geology that there can be no question of the propriety of including the pursuit of these sciences within the scope of a geological survey.

Chemistry and Physics.—The application of chemistry and physics to geological problems admits of more discussion. Chemical work, however, as carried on in connection with geological investigations is of such special character and must be conducted in such intimate contact with geological data as to make it almost certain that better results can be obtained with a special staff and equipment than would be possible were the routine and investigative work in geological chemistry turned over to some central bureau of chemistry. The same argument is believed to be applicable also to physics. Research in geophysics was at one time a recognized function of the United States Geological Survey but since the founding of the geophysical laboratory of the Carnegie Institution of Washington, this field has been left almost entirely to that splendid organization which is unhampered by some of the unfortunate restrictions of a government bureau. Under these particular and unusual conditions this course may have been wise, although it does not negative the conclusion that, in general, investigations in geophysics are logically and properly a function of a national geological survey.

Soils.—The study of soils, with reference to origin, composition and classification, is unquestionably a branch of geology, but the geologist, with tradition behind him, generally looks upon soil as a nuisance and geological surveys have reflected his attitude. In the United States the classification and mapping of soil types has for some years been in progress by the Department of Agriculture. While quite devoid of any enthusiasm for engaging in soil mapping, I wish to point out merely that this work, if its results justify its performance by the government, and if the classification adopted is based on chemical, physical and mineralogical character rather than on crop adaptability, is properly a function of the national geological survey.

Seismology.—Another subject that is comparatively neglected by national geological surveys is seismology. It can scarcely be asserted that earthquakes have no economic bearing and conspicuous or destructive examples usually receive some official attention —after the event. The comparative neglect of systematic study of earthquakes is probably due to a number of causes. One of these is that few geologists specialize in seismology—a science in which little progress can be made unless the investigator possesses unusual qualifications in mathematics and physics. Another reason probably is that to most men the difficulties in the way of gaining real knowledge of the causes of earthquakes and especially of predicting with any certainty the time, place, intensity and effects of earthquakes appear rather appalling. Finally earthquake prediction or even the recognition of the possibility of future earthquakes in a particular part of the country is likely to have consequences decidedly unpleasant to those responsible for the prediction. Experience in California has shown that a community still staggering from a violent shaking may insist with some acerbity that nothing of any consequence has happened and that it never felt better in its life.

Notwithstanding these difficulties, I believe that a national geological survey, in a country where serious earthquakes have taken place and may occur again, should consider the collection and interpretation of seismological data as part of its duty. Such work is regional in scope and can not be carried far by local initiative and by individual investigators on their own resources. In spite of difficulties I believe that it is within the range of possibility that some day we shall be able to predict earthquakes with sufficient reliability to give the prediction practical utility.

Summary.—Briefly summarizing what has gone before, I conclude that the chief primary function of a geological survey is geological research and that the spirit of investigation should be the same whether the work is undertaken to increase knowledge and to serve as the starting point for further attacks on the unknown, or is begun with a definite economic or practical result as its desired goal. Compromise and concession are inevitable but the necessity for making them should not and need not permit the real purpose of the organization to sink from sight. If the members of a scientific bureau can confidently feel that those charged with its direction make such concessions wisely with the higher purposes of the bureau really at heart their whole attitude towards their work will be entirely different from that into which they will fall if they become convinced that scientific ideals receive only perfunctory regard and that the real allegiance is directed elsewhere.

What may be called the chief secondary function of a national geological survey is believed to be popular education in geology both for the benefit of the people and as providing the most enduring basis for the support of such an organization by a democracy. Such education should be conducted through every possible channel and in close cooperation with all of the educational institutions of the country. One of its objects should be the revival and encouragement of amateur geological observation and study. In this connection I heartily approve the present trend in the policy of the American Association for the Advancement of Science and believe that this great organization will fulfill its purpose and advance science much more effectively than in the past if it will leave to the various special scientific societies the holding of meetings devoted to the presentation of scientific papers, and devote itself to the popularization of science and to the encouragement of cooperation between different branches of science.

Personnel.—Finally a few words may be said concerning the relation between the personnel of a geological survey and the results obtained by the organization. If such a survey is to attract to its service men of first-rate ability and to hold these men after their development and experience has made them of the highest value, certain inducements must be offered. Salary is unfortunately the first of these that comes to mind under conditions that continually force the scientific men in government service to recognize painfully how inadequate at present is the stipend upon which he had existed before the war. It is all very well to insist that the scientific man does not work for money and should not trouble his thoughts with such an unworthy consideration. Nevertheless if he is to do the best of which he is capable he must be lifted above the grind of poverty, be able to give his children those educational advantages that he can so well appreciate, have opportunity for mental cultivation and feel his social position to be such that he can mingle without humiliation with his intellectual peers. If it is destructive to the scientific spirit to set up material gain as an object it may be equally blighting to scientific achievement to force the attention continually downward to the problem of meager existence. The normal scientific man usually has other human beings dependent upon him and the traditional spirit of self-sacrifice and the indifference to material reward that are commonly attributed to the true investigator may, when these members of his family are considered, come very close to selfishness.

However, salary, important as it is, is by no means the only determinant. If it is reasonably adequate most men who are animated by the spirit of science will find additional reward in their work itself if this is felt to be worthy of their best efforts. A man of first rate scientific ability, however, will not enter an organization in which consecutive application to a problem is thwarted, in which he is expected to turn to this or that comparatively unimportant task as political expediency may dictate or in which the general atmosphere is unfavorable to the initiation and prosecution of research problems of any magnitude. If a man of the type in mind finds himself in such an uncongenial environment he is likely to go elsewhere. The final effect upon the organization will be that its scientific staff will be mediocre or worse and it will become chiefly a statistical and engineering bureau from which leadership in geology will have departed.

If, on the other hand, a young geologist can feel that every possible opportunity and encouragement will be given to him in advancing the science of geology; that results on the whole will be considered more important than adherence to a schedule; that imagination and originality will be more highly valued than routine efficiency or mere executive capacity; that he will not be diverted to tasks for which, important as they may be, his training and inclination do not particularly fit him; that those directing the organization are interested in his development and will give him all possible opportunity to demonstrate his power of growth; and that appreciation and material reward will be in proportion to his scientific achievement; he will then be capable of the best that is in him and will cheerfully contribute that best to the credit of the organization that he serves.

A national geological survey should hold recognized leadership in geology in the country to which it belongs and attainment of this proud position must obviously depend upon the quality of its geological personnel. With respect to personnel at least three conditions may be recognized—first, that in which the ablest geologists in the country are drawn to, and remain in service; second, that in which geologists perhaps of a somewhat lower grade as regards scientific promise are attracted to the service for a few years of training and then pass out to positions where the opportunities for research or for increased earnings are greater; and third, that in which able young men no longer look upon the geological survey as a desirable stepping stone to a future career. Who can doubt that it is the first condition that raises an organization to preeminence in science and the last that marks opportunities lost or unattained? Those responsible for the success of a geological survey, if they be wise, will watch the trend of the organization with reference to these conditions much as the mariner watches his barometer and, like him, if the indication be threatening, take action to forestall disaster.

F. L. Ransome

DAVID S. PRATT

Dr. David S. Pratt, formerly assistant director of the Mellon Institute of Industrial Research of the University of Pittsburgh, died in St. Louis, Mo., on January 28, after a short illness from pneumonia. He was a member of the American Chemical Society and of the following fraternities: Phi Kappa Sigma, Sigma Xi, Alpha Chi Sigma, and Phi Lambda Upsilon.

Dr. David Shepard Pratt was born in Towanda, Pa., on September 20, 1885, the son of Charles Manville and Louise Hale (Woodford) Pratt. Following the completion of the collegiate course at Cornell University (A.B., 1908), he was appointed a fellow in chemistry at that institution (1909-1911) and in 1911 he received the degree of Ph.D. Dr. Pratt then joined the staff of the Bureau of Chemistry, Washington, D. C., as asistant chemist, but shortly afterward was selected as chief of the Organic Division of the Bureau of Science in Manila, P. I., where he spent three productive years in chemical research and as a member of the Pure Food and Drug Board. In 1914 he decided to return to the states and accepted a professorship of chemistry at the University of Pittsburgh. Dr. Pratt occupied that chair and the headship of the organic department of the school of chemistry at "Pitt" from 1914 to 1917, in which year he was made an assistant director of the Mellon Institute of Industrial Research. On January 1, 1920, Dr. Pratt resigned at the institute and was arranging to enter consulting chemical practise in St. Louis, Mo., at the time of his fatal illness.

Dr. Pratt was known principally for his published investigations on phthalic acid derivatives, but his reports of researches on various problems in the domain of tropical chemistry have also been of importance and he was a recognized authority on chemical Philippiniana. At the Mellon Institute Dr. Pratt enjoyed broad opportunities to apply, in the inquiries of the industrial fellowships under his supervision, his splendid equipment in chemistry and many results of technical importance were obtained through his suggestive aid. His profound knowledge of pure organic chemistry and his familiarity with research methodology were respected by his associates and played a prominent part in establishing the high success of the system in operation at the institute. His departure to enter professional practise was sincerely regretted by all of the members of the institution. He is survived by his wife, Fredonia Elizabeth (Johnson) Pratt, and an infant son, David Shepard Pratt, Jr.

W. A. H.

SCIENTIFIC EVENTS

THE BONAPARTE AND LOUTREUIL FOUNDATIONS OF THE PARIS ACADEMY OF SCIENCES

We learn from *Nature* that of the 72,500 francs placed at the disposal of the Academy by Prince Bonaparte, it proposed to allocate 30,000 francs as follows:

Five thousand francs to Charles Alluaud, traveling naturalist to the National Natural History Museum, for a geological and botanical expedition in the Moroccan Grand Atlas Chain.

Two thousand francs to A. Boutaric, for the construction of an apparatus for recording nocturnal radiation.

One thousand francs to Emile Brumpt, for continuing his work on parasitic hæmoglobinuria or piroplasmos of cattle.

Three thousand francs to E. Fauré-Fremiet, for undertaking a series of studies on histogenesis and certain surgical applications.

Three thousand francs to A. Guilliermond, for pursuing his researches on lower organisms and on mitochondria.

Three thousand francs to Joseph Martinet, for continuing his researches on the isatins capable of serving as raw material for the synthesis of indigo coloring matters.

Three thousand francs to A. Vavssières, for the continuation of his researches of the marine molluscs, family Cypræidæ.

Ten thousand francs to the Fédération française des Sociétés de Sciences naturelles, for the publication of a fauna of France.

The committee appointed to allocate the Loutreuil foundations recommended the following grants:

1. To establishments named by the founder:

Ten thousand francs to the National Museum of Natural History, for the reorganization of its library.

Seven thousand five hundred francs to the Paris Observatory, at the request of the Central Council of the Observatories, for purchasing an instrument.

2. Grants applied for direct:

Six thousand francs to the Société Géologique du Nord, to enable it to take up work interrupted by the war.

Ten thousand francs to l'Ecole des hautes études industrielles et commerciales ed Lille, for restoring the material of its chemical laboratory.

Twenty thousand francs to the Observatory of Ksara (near Beyrout). This laboratory was practically destroyed by the Turks and Germans. The grant is towards its restoration.

Eight thousand francs to Henri Deslandres, for the study of the radical movements of the solar vapors and the thickness of the gaseous atmosphere of the sun.

Seven thousand five hundred francs to Maurice Hamy, to carry out certain improvements in astronomical apparatus of precision.

Three thousand five hundred francs to Félix Boquet, for the publication of Kepler tables.

One thousand francs to G. Raymond, for the continuation of his actinometric experiments.

Ten thousand francs to Charles Marie, for exceptional expense connected with the publication of the "Tables annuelles de constants et données numériques de chimie, de physique et de technologie."

Ten thousand francs to the Fédération française des Sociétés de Sciences naturelles, for the publication of a French fauna.

Two thousand francs to P. Lesne, for his researches on the insects of peat-bogs.

Two thousand francs to A. Paillot, for his researches on the microbial diseases of insects.

Two thousand francs to Just Aumiot, for the methodical study of the varieties of potato.

Five thousand francs to Albert Peyron and Gabriel Petit, for the experimental study of cancer in the larger mammals.

Three thousand francs to Th. Nogier, for completing the installation of the radio-physiological laboratory of the Bacteriological Institute of Lyons.

AWARD OF THE NOBEL PRIZE TO PROFESSOR HABER

By order of the minister from Sweden the first secretary of the legation has made public the following statement correcting certain remarks that have appeared in the daily press concerning the award by the Swedish Academy of Science of a Nobel Prize for chemistry to Professor Fritz Haber of Berlin-Dahlen.

1. The invention for which the prize was awarded to Professor Haber was the synthesis of ammonia by direct way out of its constituent elements.

2. The report on which the award was made stated that the Haber method of producing

ammonia is cheaper than any other so far known, that the production of cheap nitric fertilizers is of a universal importance to the increase of food production, and that consequently the Haber invention was of the greatest value to the world at large.

3. The Haber method was invented and published several years before the outbreak of the great war. At the International Congress for Applied Chemistry held in the United States in 1912, it was described by Professor Bernthsen. The method was consequently known to all nations before the war and available to them to the same extent. It seems to have been put into practise in the United States.

4. Ammonia, the product of the Haber method, must be converted into nitric acid in order to give rise to explosives or to corrosive gases. As a matter of fact, the Haber plants in Germany were erected with a view to producing agricultural fertilizers.

5. As far as I know, no gas masks have ever been manufactured in Sweden. In all events, there existed in Sweden during the whole war an export prohibition on all sorts of war material. That prohibition has been rigorously upheld.

6. The Nobel Prizes are paid in one single post and not in monthly installments.

DYE SECTION OF THE AMERICAN CHEMICAL SOCIETY

THE second meeting of the Dye Section will be held in St. Louis, beginning Wednesday, April 14. At this meeting the committee on permanent organization will submit "By-Laws" for the consideration of the Section, the approval of which by the Section and by the Council, will be the necessary steps to the permanent organization of the Dye Chemists of the United States, as the Dye Division of the American Chemical Society.

The secretary asks all scientific workers in the field of dyes to present the results of their researches and experiences at these meetings of the dye chemists. Papers on the manufacture, properties or application of dyes, both of coal tar or natural origin, will be of timely interest. Any chemist having any such scientific information ready for presentation is asked to communicate at once with the secretary, giving subject and time for presentation.

As is usual, full details of the final program, time and place of meeting can be obtained by addressing Dr. C. L. Parsons, 1709 G. Street, N. W., Washington, D. C., or the undersigned.

R. NORRIS SHREVE,
Secretary

43 FIFTH AVENUE,
NEW YORK CITY

SCIENTIFIC NOTES AND NEWS

REAR ADMIRAL ROBERT EDWIN PEARY, retired, the distinguished arctic explorer, died at his home in Washington, on February 20, from pernicious anemia, aged sixty-three years.

PROFESSOR E. G. CONKLIN, of Princeton University, and Professor T. H. Morgan, of Columbia University, have been elected honorary members of the Belgian Society of Zoology and Malacology.

DR. JOHN R. SWANTON, of the Bureau of American Ethnology, and Dr. Truman Michelson, of the Bureau of American Ethnology and professor in George Washington University, have been elected corresponding members of the Société des Américanistes de Paris.

THE *Bulletin of the Johns Hopkins Hospital* for December contains a record by Dr. Thomas S. Cullen, of the work and writings of Dr. Henry Mills Hurd, Baltimore, who was the first superintendent of the hospital.

DR. JAMES HARRIS ROGERS, of Hyattsville, Maryland, has received from the Maryland Academy of Sciences, Baltimore, its inventor's medal for his work on "underground and sub-sea wireless."

IT is stated in *Nature* that the council of the Glass Research Association has appointed Mr. R. L. Frink, Lancaster, Ohio, director of research. The secretary of the association says: "Mr. Frink has a lifelong experience of the American glass trade and glass research, is well known to the foremost English glass manufacturers, and his appointment is welcomed by the British glass industry."

Professor Frank G. Haughwout has been placed in charge of the work and investigation in protozoology and parasitology in the Bureau of Science, Manila. He has resigned his chair in the University of the Philippines, but will continue to lecture to the medical students.

Messrs. C. G. Derick, William Hoskins, F. A. Lidbury, A. D. Little, Charles L. Reese, and C. P. Townsend, have been appointed associate editors with Dr. John Johnston, editor of the *Technological Monographs* of the American Chemical Society. Messrs. G. N. Lewis, L. B. Mendel, Julius Stieglitz and A. A. Noyes, have been appointed associate editors with A. A. Noyes, editor of the *Scientific Monographs* of the society.

Professor H. A. Curtis, who has held the chair of organic chemistry at Northwestern University, has resigned to enter industrial work.

Mr. R. K. Brodie has been transferred from the position of industrial fellow at the Mellon Institute of Industrial Research to the chemical department of the chemical division of Proctor and Gamble Company, Ivorydale, Ohio.

Dr. George Heyl has become vice-president and technical director of the Heyl Laboratories, Inc., New York City.

The directors of the Fenger Memorial Association have awarded Dr. Harry Culver a grant to aid in the study of certain urinary infections.

Dr. Edwin Deller, secretary of the Brown Animal Sanatory Institution, University of London, has been appointed assistant secretary to the Royal Society to succeed Mr. R. W. F. Harrison, who, owing to the state of his health, has resigned the office, which he has held for twenty-four years.

The following awards have been made by the council of the British Institution of Mining and Metallurgy: (1) Gold medal of the institution to Mr. H. Livingstone Sulman, in recognition of his contributions to metallurgical science, with special reference to his work in the development of flotation and its application to the recovery of minerals. (2) "The Consolidated Gold Fields of South Africa, Ltd." gold medal to Mr. William Henry Goodchild, for his papers on "The Economic Geology of the Insizwa Range" and "The Genesis of Igneous Ore Deposits." (3) "The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to Dr. Edward Thomas Mellor, for his paper on "The Conglomerates of the Witwatersrand."

At a recent meeting of the advisory committee of the American Chemical Society it was voted to recommend to the Board of Directors that a sum not to exceed $1,000 for traveling expenses be placed at the disposal of Professor W. A. Noyes, the president of the society, for the year 1920, for the purpose of visiting local sections of the society, such trips to be made by arrangement with the president but only on condition that the section or sections visited pay one half such expenses. It was suggested that local sections so far as possible arrange with the president or among themselves for joint meetings or continuous routing.

It is noted in *Nature* that December 31, marked the bicentenary of the death of John Flamsteed, first astronomer royal of England, and the rector of the parish of Burstow, Surrey, where he is buried. Flamsteed was born four years after Newton. Though prevented by illness from attending a university, he was devoted to mathematical studies, and in 1671 sent a paper to the Royal Society. Three years later he published his "Ephemerides," a copy of which, being presented to Charles II. by Sir Jonas Moore, led to Flamsteed being appointed on March 4, 1675, "our astronomical observer" at a salary of £100 per annum, his duty being "forthwith to apply himself with the most exact care and diligence to the rectifying the tables of the motions of the heavens and the places of the fixed stars, so as to find out the so much desired longitude of places for the perfecting the art of navigation." The observatory at Greenwich, constructed partly of brick from old Tilbury Fort and of timber and lead from the Tower of London, was designed by Wren and built at a cost of £520, the money being derived from the sale of spoilt gunpowder.

A Research Medical Society was organized recently at the Loyola University School of Medicine. The following officers were elected for the academic year 1919–20: *President,* R. M. Strong; *Vice-president,* F. M. Phifer; *Secretary,* A. B. Dawson; *Treasurer,* E. S. Maxwell; *Members of the council,* S. A. Matthews, George W. Wilson, and F. B. Lusk.

Professor Frederic S. Lee, of Columbia University, lectured recently on "Problems of industrial physiology" before the Royal Canadian Institute, Toronto, and the Johns Hopkins School of Hygiene and Public Health.

Professor H. N. Holmes, head of the chemistry department in Oberlin College, has recently lectured at Case School of Applied Science, Cleveland, and before the Cincinnati section of the American Chemical Society on "The industrial applications of colloid chemistry."

An address on the "Theories regarding the formation of phosphate deposits" was given at the Ohio Agricultural Experiment Station on February 16, by Dr. Walter H. Bucher, of the department of geology of the University of Cincinnati.

Professor H. Shipley Fry, director of chemical laboratories, University of Cincinnati, lectured on "The electronic conception of valence and the constitution of benzene" before a joint meeting of the Leigh Chemical Society and the Lexington, Kentucky, section of the American Chemical Society at Georgetown College on February 13.

At a meeting of the Faculty Club of the University of Mississippi on February 2, 1920, Dr. Hiram Byrd, director of the department of hygiene, delivered a lecture on "Rattlesnakes."

The president of the Royal College of Physicians, London, has appointed Dr. F. W. Andrews to be Harveian orator, and Dr. R. C. Wall to be Bradshaw lecturer for this year. The council has appointed Dr. Martin Flack to be Milroy lecturer for 1921. The Oliver-Sharpey prize for 1920 has been awarded to Professor Emil Roux, of the Pasteur Institute, Paris.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. J. Ogden Armour has made a further gift of six million dollars to the Armour Institute of Chicago. A new site for the school has been purchased at the cost of one million dollars, and five million dollars will be expended on buildings.

At Yale University, Dr. W. H. Sheldon, of Dartmouth College, has been appointed professor of philosophy. Dr. W. R. Longley, has been promoted to a full professorship of mathematics.

Dr. E. F. Hopkins, associate plant pathologist at the Alabama Polytechnic Institute and Experiment Station, has been appointed plant pathologist and assistant professor of botany at the University of Missouri. Dr. Hopkins will begin his work on April 1.

Dr. C. L. Metcalf has been promoted to be professor of entomology in the Ohio State University.

Dr. H. G. Fitzgerald has received an appointment as profesor of hygiene at the University of Toronto, to succeed Dr. J. A. Amyst, who has been appointed deputy minister of health in the Federal Department of Health, Ottawa.

DISCUSSION AND CORRESPONDENCE

A PROPOSED METHOD FOR CARRYING TRIANGULATION ACROSS WIDE GAPS

So far as is known, the possibility of extending an arc of triangulation across straits or arms of the sea has been limited in the past to cases in which one shore is visible from the other, or at most where the masts of a vessel anchored in mid-channel are visible from both shores. It has occurred to us that much wider gaps may be bridged by the use of lights raised to a high altitude by aircraft or pilot balloons. For example, the distance between the Florida reefs and Cuba is about 90 miles, and the shores not high enough to permit of intervisibility. From an aircraft at a height of 5,000 feet or more above the middle of the straits both sides would be readily visible in clear weather. Suppose now that a series of stations along the Florida coast had been connected in the usual manner with the triangulation net of the United States, and that another series of points on the Cuban coast had been connected with a triangulation covering the island. A light carried by a dirigible or pilot balloon above the middle of the straits could be observed from two or more stations on each shore, and its position accurately fixed with respect to both systems of triangulation. If two or three such aerial points at distances of 30 or 40 miles along the axis of the channel have been tied in this fashion to both triangulations, a strong connection will have been established between them.

It is obviously necessary either that the "aerial point" should remain fixed while observations are being made on it, or that the observations at the different stations should all be exactly synchronized. The first is impossible, but the second alternative can easily be realized by using practically instantaneous flashes as signals and observing them photographically. A quantity of flash powder sufficient to produce a signal which could be photographed from 50 miles distance could probably be carried by an unmanned balloon of moderate size and cost, or failing this, a series of such charges attached to parachutes and ignited by time fuses could be dropped from a dirigible.

The photographic records would preferably be made with lenses of moderately large aperture and long focus, such as are used for astronomical chart work, which give a field of good definition several degrees in diameter. If the observation stations are several miles back from the shore line, a series of reference lights can be established on the shore, and their azimuths accurately determined in advance. The photographs will then show these lights as well as the distant flashes, and the angular elevation and azimuth of the latter can be determined directly from the plates themselves, in exactly the same manner in which astronomers determine the position of a planet with reference to neighboring stars. A number of successive flashes could be recorded on one plate, provided they were so spaced as to avoid confusion, with marked economy both in flying time and computation. Clear weather would be necessary, but not more so than in the case of ordinary methods of observation.

With regard to accuracy, it is well known that this standard method of determining angular position by the measurement of photographic plates is capable of very high precision. For example, at the Allegheny Observatory with a 4-inch objective the probable error of a resulting angular coordinate derived from two plates was found to be $\pm 0.2''$. The apparent angular diameter of the flash as seen from a distance of 50 miles would be roughly $1''$ for each foot of its actual linear diameter. As settings may be made on the center of a photographic image within 1 per cent. or 2 per cent. of its diameter, the azimuth of the flash should be obtainable with sufficient accuracy for purposes of primary triangulation, particularly as the mean position determined from the several successive flashes on one plate should be regarded as the real unit of observation. Irregularities in refraction are likely to be less serious than in the case of rays which pass closer to the earth's surface.

This method might also be advantageous in crossing wide areas of swamp or jungle. The limiting distance over which it is available can be determined only by actual experiment, but it is likely to exceed 100 miles, which would be great enough to permit the extension of continuous triangulation along the whole chain of the West Indies. The theoretical distance of the horizon from an altitude of 20,000 feet is over 170 miles, so that if the difficulties involved in producing flashes photographically observable at this great distance can be surmounted, it may ultimately be possible to connect Australia with the East Indies and so with Asia.

H. L. Cooke,
Henry Norris Russell
Princeton University

TWO NEW BASE MAPS OF THE UNITED STATES

An outline base map of the United States on the Lambert Zenithal equal area projection, scale 1–7,500,000, dimensions 19¾ inches by 25¾ inches, price 15 cents, has just been issued by the Coast and Geodetic Survey.

The map covers the whole of the United States, including the northern part of Mexico. Only state names and boundaries, principal rivers, capitals, and largest cities are shown, the chief object being to furnish a base map for political, census, or statistical purposes on a projection in which the property of equivalence of area is one of the essential features. It is the first publication of a projection of this type by the Coast and Geodetic Survey.

The two errors, to one or both of which all map projections are liable, are change of area and distortion, as applying to portions of the earth's surface. Errors of distortion imply deviation from right shape in the graticules or network of meridians and parallels of the map, involving deformation of angles, curvature of meridians, changes of scale, and errors of distance, bearings, or area.

In the mercator projection as well as in the Lambert Conformal Conic projection, the changes in scale and area can not truly be considered as distortion or as error. A mere alteration of size in the same ratio in all directions is not considered distortion or error. These projections being conformal, both scale and area are correct in any restricted locality when referred to the scale of that locality, but as the scale varies in latitude from point to point large areas are not correctly represented.

In the Lambert Zenithal projection the zenith of the central point of the surface to be represented appears as pole in the center of the map; the azimuth of any point within the surface, as seen from the central point, is the same as that for the corresponding points of the map; and from the same central point, in all directions, equal great circle distances to points on the earth are represented by equal linear distances on the map. The amount of scale error, as we depart from the center of the map radially, increases (scale becoming smaller), while in a direction at right angles thereto the scale is by the same amount too great.

For a distance from the assumed center of the map equal to 22 degrees of arc of a great circle, an extent embracing the whole of the United States, the maximum scale error is but one and seven eighths per cent. The amount of this error is less than one third of the scale error in a polyconic projection of the same area, while the direction errors (errors of angles and azimuths) are likewise considerably less than in the latter projection.

An outline base map of the United States on the Lambert Conformal Conic projection, scale, 1–5,000,000, dimensions, 25 by 39 inches, price, 25 cents, has also been issued by the Coast and Geodetic Survey. This map is similar to the one on the Zenithal Equal Area projection in general treatment. It is larger in scale, however, but embraces a lesser extent of latitude, being limited to the area of the United States, whereas the zenithal equal area map includes the greater portion of Mexico.

The map is of special interest from the fact that it is based on the same system of projection as that which was employed by the allied forces in the military operations in France.

The term *conformal* has been defined as follows: If at any point the scale along the meridian and the parallel is the same (not correct, but the same in the two directions) and the parallels and meridians of the map are at right angles to one another, then the shape of any very small area on the map is the same as the shape of the corresponding small area upon the earth. The projection is then called orthomorphic (right shape).

The value of this new outline map can best be realized when it is stated that throughout the larger and most important part of the United States, that is, between latitudes 30½° and 47½°, the maximum scale error is only one half of one per cent. Only in southernmost Florida and Texas does this projection attain its maximum scale error of 2¼ per cent. This implies, however, an error in the areas at these extreme parts equal to the square of the linear distortion, or an error of 5¼ per cent.

While this error in area may be accounted for by methods already described, the Zenithal projection on the other hand is free from this inconvenience.

The choice then between the Lambert zenithal and the Lambert conformal for a base map of the United States, disregarding scale and direction errors which are conveniently small in both projections, rests largely upon the choice of *equal area* as represented by the Zenithal and *conformality* as represented by the Conformal Conic projection—the former property appealing directly to the practical use of the map, the latter property being one of mathematical refinement and symmetry with definite scale factors available, the projection having two parallels of latitude of true scale, the advantages of straight meridians as an element of prime importance, and the possibilities of indefinite east and west extension without increase of scale error.

SPECIAL ARTICLES

SUBSTITUTES FOR PHENOLPHTHALEIN AND METHYL ORANGE IN THE TITRATION OF FIXED AND HALF-BOUND CO_2[1]

During the past year the writer has had occasion to make a great many determinations of sodium carbonate in the presence of the hydrate by the double titration method with phenolphthalein and methyl orange as indicators. The end point with methyl orange was not satisfactory. A number of new indicators were tried with the result that two were found which may be used as substitutes for phenolphthalein and methyl orange. An added advantage of these two indicators[2] is that both have the same color changes. Six drops of one indicator in 75 c.c. of solution gives a fairly deep blue in the presence of sodium hydrate and carbonate and on titration with hydrochloric acid retains this color until the hydrate is all neutralized and the carbonate converted into bicarbonate when it changes at the neutral point to a muddy green and then with a slight excess of acid to a lemon yellow. The addition of three drops of the second indicator will now change the solution to a deep blue, which continues until the bicarbonate has all been destroyed, when the solution shows the same intermediate change as before and becomes a lemon yellow again when a slight excess of acid is present.

These indicators are among the nine recommended by Clark & Lubs[3] for the colorimetric determination of hydrogen ion concentration. The first indicator, thymol blue (thymol sulfon phthalein) is prepared by introducing 1 decigram of the substance into a Florence flask and then adding 4.3 c.c. of $n/20$ sodium hydroxid. The solution is best heated by introducing the flask into hot water and agitating until the indicator is all dissolved. When solution is complete, the volume is made up to 250 c.c. with distilled water.

The substitute for methyl orange is brom phenol blue (tetra bromo phenol sulfon phthalein). This indicator is made up in the same way except that 1 decigram requires only 3.0 c.c. of $n/20$ sodium hydroxide.

F. M. Scales
U. S. Department of Agriculture

[1] Published by permission of the Secretary of Agriculture.

[2] These indicators may be obtained from Hynson, Westcott & Dunning, of Baltimore, Maryland.

[3] Clark, Wm. Mansfield, and Lubs, Herbert A., *Jour. of Bacteriology*, Vol. II., Nos. 1, 2 and 3.

THE AMERICAN SOCIETY OF ZOOLOGISTS

The American Society of Zoologists held its seventeenth annual meeting in conjunction with Section F of the American Association for the Advancement of Science and the Ecological Society of America, December 29, 30 and 31, in the Soldan High School building, St. Louis, Missouri. President C. M. Child presided throughout the meetings. The other officers for the year were: *Vice-president,* H. H. Wilder; *Secretary-Treasurer,* W. C. Allee; *Executive Committee,* L. J. Cole, R. P. Bigelow, H V. Wilson, M. M. Metcalf, George Lefevre; *Member Council A. A. A. S., C. P.* Sigerfoos; *Local Representative,* Caswell Grave.

ELECTION OF MEMBERS

At the business meeting the Executive Committee recommended the following persons for election to membership in the society: George Delwin Allen, Albert W. Bellamy, William Charles Boeck, Calvin O. Esterly, Frank Blair Hanson, Charles Eugene Johnson, Ernest Everett Just, James Ernest Kindred, Mrs. Ruth Stocking Lynch, Thomas Byrd Magath, James Watt Mayor, Dwight Elmer Minnich, Carl R. Moore, Thurlow Chase Nelson, Nadine Nowlin, Charles H. O. Donoghue, Albert Duncan Robertson, Francis Metcalf Root, Elizabeth Anita Smith, Dayton Stoner, Gertrude Marean White, Sadao Yoshida. All were duly elected.

The treasurer's report showed a balance of $809.59, an increase for the year of $63.21.

ADVISORY BOARD

At the request of Frank R. Lillie, chairman of the committee on cooperation and coordination of the Division of Biology and Agriculture of the National Research Council, the executive committee approved, and the society passed the following resolution:

Resolved: That there be established a permanent committee to be called the advisory board of the American Society of Zoologists, consisting of eight members appointed by the executive committee, two each for periods of one, two, three and four years; and thereafter two each year for a four-year term. The chairman of the board shall be elected annually by the board.

The duties of the board shall be:

1. To represent the American Society of Zoologists before the National Research Council.

2. To correlate the various research agencies of the country in zoology; including various government bodies, both national and state, museums, research establishments and universities.

3. To promote international relations in zoology.

4. To take up other problems for the promotion of research in zoology, subject to the approval of The Executive Committee.

President Child announced the appointment by the executive committee of the following advisory board: F. R. Lillie, Wm. E. Castle, C. C. Nutting, G. N. Calkins, J. T. Patterson, M. M. Metcalf, V. E. Shelford, Robert Chambers, Jr.

THE JOURNAL OF MORPHOLOGY

Owing to the request of Professor J. S. Kingsley to be relieved of the editorial management of the *Journal of Morphology* at a date in 1920 not yet definitely fixed, The Wistar Institute through M. J. Greenman, its director, approached the American Society of Zoologists, proposing that the society assume responsibility for the scientific policy and the election of the editorial board of the *Journal of Morphology,* subject to the approval of the advisory board of The Wistar Institute and full financial responsibility for the *Journal* to be kept by The Wistar Institute.

Mr. Greenman further proposed that the society appoint a small special committee on publication which should meet with the advisory board of The Wistar Institute in Philadelphia at certain of its regular meetings held in April to discuss journal affairs in general, and those of the *Journal of Morphology* in particular.

Whenever the committee was called to attend a meeting in Philadelphia all expenses of travel and entertainment incident thereto are to be paid by The Wistar Institute.

After discussion it was voted to approve the general proposition of assuming responsibility for the scientific policy, and the appointment of the editorial board of the *Journal of Morphology;* and the Executive Committee was instructed to appoint a committee on publication whose duties would be:

1. To initiate a scientific policy concerning the *Journal of Morphology.*

2. To nominate an editorial board.

3. To consult with the advisory board of The Wistar Institute concerning both the proposed policy and the editorial nominations.

4. To refer the recommendations for final decision to the executive committee in 1920, and thereafter through the executive committee to the society at its annual meeting.

M. M. Metcalf, Caswell Grave and W. E. Castle have been duly appointed members of the Committee on Publication.

NEW BY-LAW

The following new By-law was adopted:

By-Laws (Add) No. 4

The National Research Council allows the society three representatives on the Division of Biology and Agriculture. Of these three representatives, one shall be elected each year to serve three years. The method of election shall be the same as that used in the election of the officers of the society.

PROPOSED CHANGE IN CONSTITUTION

Although final action could not be taken at this meeting, the following proposed amendment to the Constitution was read:

Article II. (Add) Section 4

Honorary fellows, regardless of membership in the society, may be elected upon unanimous recommendation of the executive committee, by a majority vote of the members present at any meeting of the society. The number of honorary fellows shall be limited to ten and not more than one shall be elected on any one meeting of the society. Honorary fellowships does not involve the payment of dues nor does it confer the right to vote.

After discussion, it was voted that any amendment to the constitution shall not contemplate the elevation of members of the society, and that honorary membership shall be limited to members of foreign societies.

RESOLUTIONS

The resolution committee, consisting of Caswell Grave, Bennet M. Allen and Chancey Juday, reported the following resolutions, which were adopted by standing vote, and ordered spread on the records:

William Erskine Kellicott
1878–1919

Mindful of the great loss sustained by the American Society of Zoologists and zoological science in the death of William Erskine Kellicott, the members of the society find comfort and satisfaction in recalling the mature and substantial character of his scientific contributions, the unusual abilities he displayed as a teacher of zoology, and above all the pleasing personality of their co-worker and friend.

The society, therefore, desires to record this minute in recognition of his services to zoological science and to mankind.

George L. Kite
1882–1919

During the brief period of his labors, George L. Kite showed special aptitude, and an adequate preparation for the investigation of the difficult problems which lie in the field where zoology, chemistry and physics meet. His loss is only partially repaired by the inspiration which the methods he developed and the results he attained are affording to the workers who have taken up the problems he relinquished.

The American Society of Zoologists places this minute on record, thereby expressing its regret at the early loss of this promising member.

ELECTION OF OFFICERS

The nominating committee composed of S. O. Mast, V. E. Shelford and B. M. Allen, reported the following nominations:

President, Gilman A. Drew.

Vice-president, Caswell Grave.

Member Executive Committee to serve five years, C. M. Child.

Member of Division of Biology and Agriculture, National Research Council, to serve three years, F. R. Lillie.

Nominations from the floor were called for but none was suggested, and the officers as presented by the Nominating Committee were duly elected.

On nomination of the executive committee, C. C. Nutting was elected member of the council of the American Association for the Advancement of Science in place of C. P. Sigerfoos, resigned.

SESSIONS FOR THE PRESENTATION AND DISCUSSION OF PAPERS

At the meetings of the society for the presentation and discussion of papers a total of 42 papers were presented in full, and 28 were read by title. Seventeen of the papers were followed by discussion.

List of Titles

The titles have been arranged by the secretary of the zoologists according to the rules of the society, in the order of their arrival.

Papers marked with an asterisk were read by title.

Embryology

**The individuality of the germ-nuclei during the cleavage of the egg of Cryptobranchus allegheniensis:* Bertram G. Smith, Michigan State Normal College.

**A sex intergrade pig which resembles a free-martin:* Will Scott, Indiana University.

Retention of dead fetuses in utero and its bearing on the problems of superfetation and superfecundation: Albert Kuntz, St. Louis University, School of Medicine.

**An explanation of the early development of the peripheral nervous system in the vertebrate embryo:* H. H. Lane, University of Oklahoma.

The thyroid and parathyroid glands of Bufo tadpoles deprived of the pituitary glands: Bennet M. Allen, University of Kansas.

The influence of thyroid extirpation upon the various organs of Bufo larvæ: Bennet M. Allen, University of Kansas.

Stages in the development of the thymus, parathyroid and ultimobranchial bodies in turtles: Charles Eugene Johnson, department of zoology, University of Kansas.

The results of the extirpation of the thyroid and of the pituitary anlagen on the suprarenal tissue in Rana pipiens: Alice L. Brown, Kansas State Agricultural College. (Introduced by B. M. Allen.)

Cytology

**The effect of hypotonic and hypertonic solutions on fibroblasts of the embryonic chick heart in vitro:* M. J. Hogue, school of hygiene and public health, Johns Hopkins University.

**Coelenterates and the evolution of germ cells:* George T. Hargitt, Syracuse University.

Cytological criteria for the determination of Amœbic cysts in man: S. I. Kornhauser, Denison University.

The spermatogenesis of Anolis carolinensis: Theophilus S. Painter, University of Texas.

The presence of a longitudinal split in chromosomes prior to their union in parasynapsis: W. R. B. Robertson, University of Kansas.

Chromosome studies in Tettigidæ. II. Chromosomes of BB, CC and the hybrid BC in the genus Paratettix: Mary T. Harman, zoology department, Kansas State Agricultural College.

Parasitology

Notes on the life-cycle of two species of Acanthocephala from fresh-water fishes: H. J. Van Cleave, University of Illinois.

On the life-history of the gape-worm (Synagamus trachealis): B. H. Ransom, U. S. Bureau of Animal Industry, Washington, D. C.

A new bladder fluke from the frog: John E. Guberlet, Oklahoma Agricultural Experiment Station, Stillwater, Okla.

Studies on the development of Ascarida perspicillum, parasitic in fowls: James E. Ackert, Kansas State Agricultural College.

**New data bearing on the life-history of Sarcocystis tenella:* John W. Scott, University of Wyoming.

Contributions to the life-history of Gordius robustus Leidy: H. G. May, Mississippi College.

Leucochloridium problematicum n. sp.: Thomas Byrd Magath, Mayo Clinic. (Lantern.)

Two new genera of Acanthocephala from Venezuelan fishes: H. J. Van Cleave, University of Illinois.

**Note on the behavior of embryos of the fringed tapeworm:* John W. Scott, University of Wyoming.

Contributions to the life-history of Paragordius varius (Leidy): H. G. May, Mississippi College.

Genetics

Selection for increased and decreased bristle number in the mutant strain "reduced": F. Payne, Indiana University.

The mutational series, full to bar to ultra bar, in Drosophila: Charles Zeleny, University of Illinois.

Variation in the percentage of crossovers and selection: J. A. Detlefsen and E. Roberts, College of Agriculture, University of Illinois.

Inheritance of color in the domestic turkey: W. R. B. Robertson, University of Kansas.

Heredity of orange eye color: F. Payne and Margaret Denny, Indiana University.

The tabulation of factorial values for eye-facet number in the bar races of Drosophila: Charles Zeleny, University of Illinois.

Linkage of genetic factors in mice: J. A. Detlefsen and E. Roberts, College of Agriculture, University of Illinois.

Forty-two generations of selection for high and low facet number in the white bar-eyed race of Drosophila: Charles Zeleny, University of Illinois.

On the inheritance of congenital cataract in dairy cattle: J. A. Detlefsen and W. W. Yapp, College of Agriculture University of Illinois.

Ecology and General Physiology

Observations on the habits of larval colonies of Pectinatella: Stephen R. Williams, Miami University.

Animal aggregations: W. C. Allee, Lake Forest College.

Behavior of the larvæ of Corethra punctipennis Say: Chauncey Juday, Wisconsin Natural History Survey.

**Studies on chitons:* W. J. Crozier, Hull Zoological Laboratory, University of Chicago.

**On the natural history of Onchidium:* Leslie B. Arey and W. J. Crozier, Northwestern University, University of Chicago.

**The olfactory sense of Orthoptera:* N. E. McIndoo, Bureau of Entomology, Washington, D. C.

On a new principle underlying movement in organisms: A. A. Schaeffer, University of Tennessee.

The relation of the concentration of oxygen to the rate of respiratory metabolism in Planaria: E. J. Lund, Laboratory of General Physiology, University of Minnesota.

**Experimental studies on the cerebral cortex and* *corpus striatum of the pigeon:* F. T. Rogers, Marquette School of Medicine.

**Photic orientation in the drone-fly, Eristalis tenax:* S. O. Mast, Johns Hopkins University.

**Behavior of a tunicate larva:* W. J. Crozier, The University of Chicago.

**Vision in the seventeen-year locust, Cicada septendecim:* S. O. Mast, Johns Hopkins University.

**Periodicity in the photic responses of the euglenoid, Septocinclis texta, and its bearing on reversion in the sense of orientation:* S. O. Mast, Johns Hopkins University.

**Adaptation to light in Euglena variabilis (?) and its bearing on reversion in orientation:* S. O. Mast, Johns Hopkins University.

**The maze-behavior of white rats in the second generation after alcoholic treatment:* E. C. MacDowell and E. M. Vicari, Carnegie Institution of Washington.

**The relation of modifiability of behavior and metabolism in land isopods:* C. H. Abbott, Massachusetts Agricultural College. (From the Osborn Zoological Laboratory, Yale University; introduced by Henry Laurens.)

The rate of carbon dioxide production by pieces of Planaria, in relation to the theory of axial gradients: George Delwin Allen, University of Minnesota. (Introduced by E. J. Lund.)

Evolution

**Irreversible differentiation and orthogenesis:* C. Judson Herrick, The University of Chicago.

**An analysis of the sexual modifications of an appendage in sex-intergrade Daphnia longispina:* A. M. Banta and Mary Gover, Station for Experimental Evolution.

Comparative Anatomy

**The Urodele vomer:* Inez Whipple Wilder, Smith College.

**The origin, function and fate of the test-vesicles of Amaroucium constellatum:* Caswell Grave, Washington University. (Lantern.)

Respiratory organs of Ucides caudatus, a West Indian land crab: C. C. Nutting, University of Iowa. (Lantern.)

**The homologies and development of the papal organ of male spiders:* W. M. Barrows, Ohio State University.

**Morphology of the enteron of the periodical cicada, Tibicen septendecim Linn:* Charles W. Hargitt and L. M. Hickernell, Syracuse University.

**Sexual dimorphism in Nemertians:* W. R. Coe, Yale University.

The columella auris of the Reptilia: Edward L. Rice, Ohio Wesleyan University.

**The spiracular organ of elasmobranch, ganoid and dipnoan fishes:* H. W. Norris and Sally P. Hughes, Grinnell College.

Invitation Program

Faunal areas on the Pacific slope of South America: C. H. Eigenmann, University of Indiana.

Discussion led by C. C. Nutting, University of Iowa.

Polyembryony and sex: J. T. Patterson, Texas University.

Discussion led by S. I. Kornhauser, Denison University.

Physiological life histories of terrestrial animals: V. E. Shelford, Illinois Natural History Survey and the University of Illinois.

Discussion led by Thomas Headlee, New Jersey Agricultural Experiment Station.

The work of the National Research Council in relation to zoology: C. E. McClung, chairman, Division of Biology and Agriculture, National Research Council.

Papers Contributed by The Ecological Society of America

Hydrogen ion concentration in the different stages of pond succession: V. E. Shelford, Illinois Natural History Survey.

Distribution of life on a river bottom: A. D. Howard, U. S. Bureau of Fisheries.

Changes observed in river fauna above Keokuk Dam: A. D. Howard, U. S. Bureau of Fisheries.

Ecological succession of insects in stored food products: Royal N. Chapman, University of Minnesota.

Papers following the Zoology Dinner

The message of the biologist, vice-presidential address for Section F: William Patten, Dartmouth College.

Motion pictures of the Barbadoes-Antigua Expedition: C. C. Nutting, University of Iowa.

EXHIBITS

Slides of stained cysts of the intestinal amœbas and flagellates of man: S. I. Kornhauser, Denison University.

Wire models of paths of oyster larvæ, dero, etc.: A. A. Schaeffer, University of Tennessee.

The embryonic columella auria of the lizard, *Eumeces:* Edward L. Rice, Ohio Wesleyan University.

Phenotypes in coat colors in mice: J. A. Detlefsen and Elmer Roberts, Laboratory of Genetics, College of Agriculture, University of Illinois.

Demonstration of synapsis stages in the chromosomes of grouse locusts and other grasshoppers: W. R. B. Robertson, University of Kansas.

Feathers illustrating the inheritance of color in varieties of the domestic turkey: W. R. B. Robertson, University of Kansas.

The development of the asexual larvæ in *Paracopidosomopsis:* J. T. Patterson, University of Texas.

Full proceedings of the meeting together with abstracts of papers and a list of members and their addresses will be found in the *Anatomical Record* for January, 1920.

W. C. Allee,
Secretary

THE MINERALOGICAL SOCIETY OF AMERICA

At a meeting held in the quarters of the Department of Mineralogy at Harvard University on December 30 a group of 28 mineralogists from all sections of the United States, including representatives from Canada, organized a new society to be known as the Mineralogical Society of America. This action was the outcome of a movement started at the Albany meeting of the Geological Society of America in 1916 for the bringing together into a permanent organization of workers in science whose interest lay largely or wholly in mineralogy, crystallography or those allied sciences which include physical crystallography and mineral synthesis.

A provisional Constitution and By-Laws were adopted which defined the object of the society as the advancement of mineralogy, crystallography and the allied sciences and provided for several forms of membership, as follows:

1. *Fellows,* who are to be nominated by the council, must qualify for eligibility by having produced some published results of research in mineralogy, crystallography or the allied sciences. Fellows are eligible for office in the society and may vote upon amendments to the Constitution.

2. *Members,* who comprise persons who are engaged in or interested in mineralogy, crystallography or the allied sciences, but who are not qualified for fellowship. Membership carries with it the right to vote upon all matters except the amendment of the Constitution, but members are not eligible for office.

The Constitution also provides for *Patrons,* who shall have conferred material favors upon the society and *Correspondents,* or residents outside of North America who are sufficiently distinguished in the subjects for which the society stands to warrant their receiving this recognition.

Because it was recognized that the comparatively small attendance at the meeting did not adequately represent the probable initial membership of the society, the lists of charter fellows and members have been kept open until a later meeting of the society.

It is expected that the general membership of the society at the close of 1920 will number some 350 to 400 fellows and members.

It was decided to publish a journal devoted to mineralogy, crystallography and the allied sciences, which shall be the official organ of the society, and which the general membership of the society shall be entitled to receive. The present plan is to enlarge the *American Mineralogist* to include research papers and abstracts, but at the same time to retain the valuable features of this publication which has become recognized as of permanent interest to such collectors and amateurs who are eligible to membership but not fellowship. The council of the society has under consideration the question of affiliation with the Geological Society of America.

The provisional officers of the new society which were elected at the December meeting are: President, E. H. Kraus, of the University of Michigan; Vice-president, T. L. Walker, of the University of Toronto; Secretary, H. P. Whitlock, of the American Museum of Natural History; Treasurer, A. B. Peck, of the Bureau of Standards, Washington;

Editor, E. T. Wherry, of the Bureau of Chemistry, Washington; and Councilors, A. S. Eakle, of the University of California (1 year); F. R. Van Horn, of the Case School of Applied Science, Cleveland (2 years); F. E. Wright, of the Carnegie Geophysical Laboratory, Washington (3 years); and A. H. Phillips, of Princeton University (4 years).

The formation of a society whose object is to promote and foster the mineralogical sciences comes at a time when there is a distinct need in this country for such a body. The growing importance of this field of research, already felt to a marked degree in the period preceding the war, has now with the necessary curtailing of scientific activity in Europe, assumed scope and size. It is acknowledged by observers of the trend of events that scientific prestige has come to abide in America rather than in the countries of the Old World. No more keenly is this tendency sensed than in those industries which are demanding trained workers in crystallography and physical mineralogy for their research laboratories. If then, science is to keep pace with industry in this period of reconstruction and if our universities and technical schools are to supply to the increasing stream of students coming to us from abroad, the high standard of scientific education which has come to be demanded of us, it is eminently right and fitting that such specialized bodies as the Mineralogical Society of America should be formed and fostered.

Herbert P. Whitlock,
Secretary

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION A—MATHEMATICS AND ASTRONOMY

Inasmuch as the American Mathematical Society and the Mathematical Association of America both had meetings at St. Louis during the period of the meeting of the American Association, only one formal meeting was held of Section A. At this meeting, which was a joint meeting with the American Mathematical Society, the following papers were given:

Recent progress in dynamics: Professor G. D. Birkhoff, retiring vice-president of Section A.

Some recent developments in the calculus of variations: Professor G. A. Bliss, retiring chairman of the Chicago Section of the American Mathematical Society.

A suggestion for the utilization of atmospheric molecular energy: Mr. H. H. Platt.

What has been heretofore Section A has been divided into two sections, "A"—Mathematics, and "B"—Astronomy. The officers of Section A are as follows:

Vice-president—D. R. Curtiss, Northwestern University.

Secretary—Wm. H. Roever, Washington University.

Members of Sectional Committee—5 years, Dunham Jackson, University of Minnesota; 4 years, A. D. Pitchard, Western Reserve University; 3 years, G. A. Bliss, University of Chicago; 2 years, James Page, University of Virginia; 1 year, H. L. Rietz, University of Iowa.

Member of the Council—G. A. Miller, University of Illinois.

Member of General Committee—E. V. Huntington, Harvard University.

The officers of Section B are:

Vice-president—Joel Stebbins, University of Illinois.

Secretary—F. R. Moulton, University of Chicago.

Members of the Sectional Committee—5 years, Philip Fox, Northwestern University; 4 years, H. N. Russell, Princeton University; 3 years, Harlow Shapley, Solar Observatory; 2 years, H. D. Curtis, Lick Observatory; 1 year, J. M. Poor, Dartmouth College.

Member of the Council—S. A. Mitchell, University of Virginia.

Member of General Committee—E. B. Frost, Yerkes Observatory.

F. R. Moulton,
Secretary

SCIENCE

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SOME ASPECTS OF PHYSICS IN WAR AND PEACE[1]

PART I. SOME APPLICATIONS OF PHYSICS TO WAR PROBLEMS

A YEAR ago in Baltimore we met with peace in prospect. The armistice had been signed. But like a strong runner who had just gotten under way we found it difficult to stop. We continued many of the programs of war. Many of us were still in uniform. Our thoughts were still largely concerned with those problems upon which we had been engaged. But now most of us are back to our normal pursuits, eager as we had been during the war to contribute our energies to securing the welfare of the nation. The tumult and the shouting dies, the captains and the kings depart, still stands the ancient and abiding sacrifice, the labor of unselfish service which we regard as the natural birthright of scientific men.

We are still too near the war to get a clear perspective of the extent to which the various agencies contributed to its successful prosecution. But we can examine it in part and later the results of our examination can be gathered together. It had been my intention to pass in review the many ways in which physics had been applied to the problems of war, but these had been so numerous and so extensive that my time would be given to a mere enumeration of the activities. For the war was one of many elements and many dimensions. Leaving aside the human and, I may add, the inhuman elements, and considering those confined to space, we had warfare in the air, on the surface of the earth, under the earth, on and under the sea. Applications of science were everywhere. Many of the applications of physics have been presented else-

[1] Address of the vice-president and chairman of Section B—Physics—American Association for the Advancement of Science, St. Louis, December, 1919.

where and at length. You have been told the story of aviation, of the physical laboratory on wing; the story of wireless between stations on the surface of the earth, under water and high in the air; the story of signaling through the darkness of night or the brightness of day; the story of sound-ranging, of spotting enemy guns and the explosions of our own projectiles seeking out those guns and of the re-directing of our guns until those of the enemy had been destroyed; the story of submarine detection and of the extremely valuable applications which the study of that problem brought to us—the ability literally to sound the ocean—the ability to guide a ship through fog or past shoals. These and other stories you know. Indeed, many of you contributed to their unfolding. It is my desire here to present briefly some developments in a branch concerning which little has been written, viz., warfare with guns, projectiles, bombs. Later I want to turn from the contemplation of problems of war to view our subject in its relation to peace.

The English playwright, John Drinkwater, represents Abraham Lincoln as saying "the appeal to force is the misdeed of an imperfect world." Unfortunately the world is still imperfect. In the horrible business of killing people in war, guns of all sizes and kinds are the effective weapons. Have you reflected on the enormous extent to which artillery was used in the Great War? According to Sir Charles Parsons, on the British Front alone, in one day, nearly one million rounds of nearly 20,000 tons of projectiles were fired. Extend this along both sides of the Eastern and Western fronts and you may gain some idea of the daily amount of metal fired by guns.

The actual American contribution of artillery to the war was very small but at the time of the Armistice we were making progress. In America we often measure things by money. The total amount of money authorized for artillery, including motor equipment, was $3,188,000,000, and for machine guns was $1,102,600,000. Judged by the money expended for them, guns are of importance. It is essential that we get as effective guns as possible and that we know how to use them. Aircraft, and anti-aircraft warfare, barrage firing, long range guns—all of these call for a very complete and accurate knowledge concerning the motion of a projectile and the energy required to carry it to a certain place and to cause it there to explode at a chosen time. Exterior and interior ballistics are thus matters of great importance.

For two hundred years or more the subject of exterior ballistics has been regarded as belonging to pure mathematics. But into this realm physicists at times intruded. To Newton we ascribe the law that the resistance which a body experiences in passing through the air varies as the square of the velocity. But that great scientist made it clear that that might not be the only law. Euler, one hundred and fifty years ago, proved various mathematical results. Assuming the air resistance to vary as the square of the velocity and that the density of the air did not change with altitude, he showed that the coordinates x, y, and the time can be computed by quadratures. His method of taking the angle of slope of the trajectory as the independent variable has been followed by most of his successors in ballistics.

Even in Euler's method the variation of the density of the air with altitude can be allowed for by using small arcs and by changing the constant of proportionality in the law of air resistance to accord with the new density. His method can in general be followed where the law of air resistance is that given by Mayevski, viz.,

$$R = \frac{A_n V^n}{C}$$

where

$n = 2$	for V between	0 and	790 f.s.
$= 3$		790	970
$= 5$		970	1,230
$= 3$		1,230	1,370
$= 2$		1,370	1,800
$= 1.7$		1,800	2,600
$= 1.55$		2,600	3,600

Siacci, with his elusive pseudo-velocity, has been the chief contributor along this line. His method as elaborated by Ingalls and Hamilton has been the standard in American works on ballistics.

In Mayevski's law as given in American texts

$$R = \frac{A_n V^n}{C},$$

C is called the ballistic coefficient. Being the reciprocal of a resistance it represents the penetrating power or ability of a projectile to continue in motion. It is assumed to be constant for any definite projectile. But it was found that when the angle of elevation was changed, or even the muzzle velocity, in general C had to be changed to allow for the new range. Attempts have repeatedly been made to find a functional relation between C and these variables. At certain proving grounds in the United States a relation was supposed to have been established but we find that the law adopted does not agree with data which we have secured from Aberdeen. It follows that, though the mathematical computations have been carried through with great rigor and accuracy, actual firings for various elevations have to be made in order, from the ranges observed, to compute the ballistic coefficient for those elevations. In other words, the ballistic coefficient always contains in it a factor which represents the amount by which the theoretical range has to be multiplied in order to obtain the actual range. If range and time be the only quantities required these can be found by actual firings and almost any approximate law of air resistance will satisfy. But it costs money to range-fire guns. For example, this cost for a 12-inch gun is of the order of $12,000 and for a 14-inch naval gun $20,000. These amounts are apt to be exceeded.

It would be a very great saving in time and money if the range and trajectory of a projectile could be determined with a known powder charge without range firing. This can only be done when the complete law of air resistance is known. The modern problems connected with antiaircraft warfare and with accurate barrage firing absolutely require such a law.

Notwithstanding the fact that the law of air resistance for modern projectiles is unknown and that the ballistic coefficient merely represents an approximate relation between the theoretical and actual ranges, great confidence has been placed in so-called experimental determinations of this quantity. For example, in the official manual for the U. S. Rifle the value of the ballistic coefficient of the ordinary service rifle bullet (.30-inch caliber) is given as 0.3894075 "as determined experimentally at the Frankford Arsenal." The experimental skill which can determine to an accuracy indicated by seven places of decimals a quantity as highly capricious as the so-called ballistic coefficient, is of rather questionable value.

Going back to the law of air resistance, it is evident that Mayevski's law is not satisfactory either to mathematicians or to physicists. There are abrupt changes when the index n is changed. The mathematician can not differentiate at these corners, the physicist can not see the necessity for their existence. The law as laid down by the Gavre Commission which is ordinarily written in the form $R = cv^2B(v)$, where $B(v)$ is a function of v, is satisfactory in that it has no discontinuities. But though it is satisfactory in this respect it may still be incomplete.

The Gavre law or any other smooth law lends itself to numerical integration by the method of Gauss, who developed it one hundred years ago. He used this method in the problem of special perturbations in celestial mechanics. It has since been presented in some text-books in theoretical astronomy. An early application to physics curiously enough was made by an astronomer, John Couch Adams, in the integration of an equation occurring in the theory of capillarity. But though Adams was thoroughly acquainted with this method he apparently did not feel that it was as satisfactory for computing a trajectory as that of Euler. For in an article on "Certain Approximate Solutions for Calculating the Trajectory of a Shot" (Collected Works), he refers the motion to the angle that the tangent to the trajectory makes with

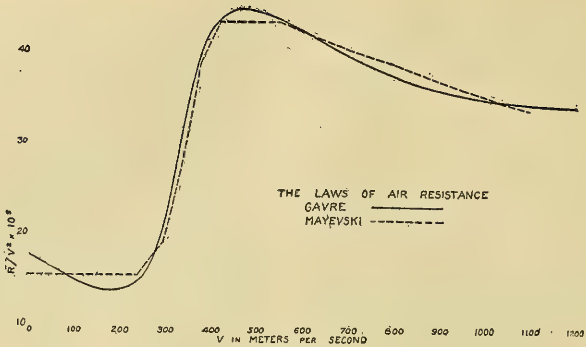

Fig. 1.

the horizontal and uses as a resistance law $R = A_n V^n$, the constants being taken from Bashforth's experimental results.

The method of Gauss, *i. e.*, of using rectangular coordinates, has been used by physicists, to first order differences at any rate, for various computations. In the case of a projectile, if the retardation follows the square law $R = kv^2$, the equations of motion take the well-known form

$$\frac{\partial^2 x}{\partial t^2} = -k\frac{\partial s}{\partial t}\cdot\frac{\partial x}{\partial t},$$

$$\frac{\partial^2 y}{\partial t^2} = -g - k\frac{\partial s}{\partial t}\cdot\frac{\partial y}{\partial t},$$

or

$$\ddot{x} = -kv\dot{x},$$

$$\ddot{y} = -g - kv\dot{y}.$$

If we take as the law of retardation

$$R = cv^2B(vy) = vF(v\cdot y) \quad \text{where} \quad F = \frac{G(v)H(y)}{C}$$

the equations take the form

$$\ddot{x} = -\dot{x}F(v\cdot y),$$

$$\ddot{y} = -g - \dot{y}F(v, y).$$

The change in the retardation due to change in density of the air with height y can be taken account of in the function $H(y)$. As a result of many meteorological observations $H(y)$ may be written

$$H(y) = 10^{-.000045y},$$

y being measured in meters.

In the notation introduced by Professor Moulton $G(v), = vB(v)$, is computed directly from the French tables giving $B(v)$ as a function of v. The form of the function $B(v)$ plotted against v is shown in Fig. 1, and will be called the B curve.

Now if C the ballistic coefficient or penetration coefficient, and the velocity and altitude are known at any time, then $\ddot{x}$ and $\ddot{y}$ are known. If these x and y retardations are constant or nearly so, then the values of the x and y velocities at any later time are known if the time intervals be short. But the retardation depends on the velocity, hence its value for any interval will in general lie between the retardations computed for the velocities at the beginning and end of an interval. One is soon able to approximate to the average—consequently the values of the x and y velocities at the end of the first, and beginning of the second, interval are known. Integration can be performed to find the new x and y and the process can be repeated for the next interval.

After x and y and their first and second derivatives are tabulated for the first four or five short intervals (of $\frac{1}{4}$ or $\frac{1}{2}$ second), first and second differences are tabulated and the computation can proceed in longer time intervals, usually one or two seconds. The formulas for extrapolation are made use of for extending the computation, and the results are checked. Hence a trajectory can be computed taking account of variations of air density with height, and satisfying at all points the assumed law of retardation.

Since the retardation depends on the relative velocity of air and projectile, winds can be allowed for by considering the motion relative to the air at every point. This involves the principal of moving axes. It implies however, that the projectile is a sphere or that the retardation is independent of the angle which the projectile presents to the air, or else that the projectile always turns nose on to meet the air. We know, however, definitely that an air stream of a few miles per hour at right angles to the axis of a projectile may have several times as great a force as the same stream would exert along the axis, and that a spinning projectile can not turn quickly to meet every wind that blows, even though the wind may have but small influence upon the angle at which the air meets the projectile.

It was this method of short arc computation which Professor Moulton applied to the problem of exterior ballistics when he was made head of that branch in the Ordnance Department. For his courage in setting aside the long-established, revered but rather empirical method in use in the War Department, and in introducing a logical, simple method of computing trajectories, and for his energy in initiating and pushing through certain experimental projects, he deserves great commendation. Valuable contributions to the method were made by his associates, notably Bennett, Milne, Ritt. Professor Bennett devised a method which has a number of points of merit. It is the one now used at the Aberdeen Proving Ground. Professor Bliss gave an inclusive method of computing variations in range, altitude and time due to changes in air density, winds, muzzle velocity. Dr. Gronwall greatly simplified and extended the work by Bliss, and made other important contributions. In short, leaving out of account the question as to the correctness of the law of air resistance, the variation of that resistance with the angle of attack of air and projectile, leaving out the motion of precession and nutation which are dependent upon the transverse and longitudinal moments of inertia of the projectile and its rate of spin—leaving out these factors the mathematical basis for finding the trajectory of a projectile is secure.

But the system of forces under which a projectile moves is not the simple one implied by the equations just given. For a projectile is a body spinning rapidly about an axis probably nearly identical with its geometrical axis. It emerges from the gun either with a small yaw, or with a rate of change of yaw, or both. (By yaw is meant the angle between the axis and the direction of motion of the center of gravity.) As in the case of a top, precessional motion results. If the motion is stable, precession accompanied by nutation continues. If unstable, the axis is driven farther from its original direction until the projectile is "side on" to the air, or "base on" to the air. In short, the projectile tumbles. Loss of range and great dispersion are the results.

The condition for stability may be taken the same as that for a top spinning about an axis nearly vertical, viz.,

$$S = \frac{A^2N^2}{4B\mu} > 1,$$

where

A = moment of inertia about the axis of spin

B = moment of inertia about an axis at right angles

N = frequency of spin in radians per sec.

$\mu \sin \theta$ = moment of force about an axis through the C.G. at right angles to the axis of spin, where θ is the yaw *i. e.*, the angle between the axis of the shell and the direction of motion of the center of gravity.

The rate of orientation of the yaw or the precessional velocity is given by

$$\dot{\varphi} = AN \div B(1 + \cos\theta).$$

The relation given for stability, viz., that

$$\frac{A^2N^2}{4B\mu} > 1,$$

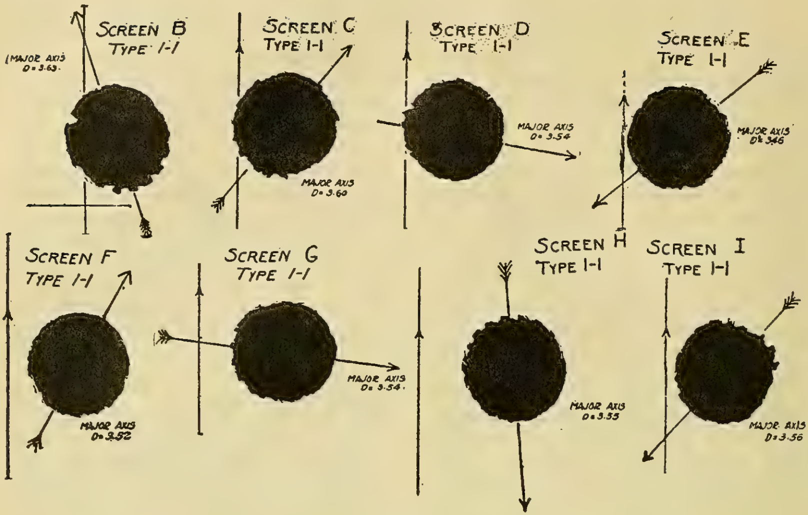

Fig. 2.

is based on the assumption that the torque due to the air is proportional to sin θ. Our air stream experiments throw doubt upon this assumption but the English experimenters, who have made the most complete studies of the rotational motions of projectiles that we know of, seem to confirm it.

These motions of precession and nutation of a projectile can be studied by firing through a number of cardboard screens spaced at equal distances along the line of fire. As has been said, the English have been the foremost investigators in the work. At Aberdeen, under the immediate supervision of Mr. R. H. Kent, a very extended study, following in general the English method, is being made of the stability of projectiles. Cardboard screens are placed at distances of 20 feet from one another for some distance from the gun, then at 100 feet, then at 20 feet again towards the end of the path. A careful study was made of cardboard so as to obtain a kind which would give a clean cut hole. The lantern slide (Fig. 2) shows the variation of the major axis of the hole for eight consecutive 20-foot screens.

It will be seen from Fig. 2 that the major axis of the hole in screens B and C made by the 3.3 inch projectile is about 3.6 inches, and between those screens the angle of the major axis has turned through about 60°. At screens D, E, F, the major axis is about 3.5 inches and it turns rapidly. Here the yaw is a minimum and the rapid motion of the axis is in accord with the theory governing nutation.

If the projectile were moving in a vacuum or if the air forces did not influence the motion, the precessional velocity ϕ' (considered uniform) would be given by

$$\phi' = \frac{AN}{B(1+\cos\theta)} = \frac{AN}{2B}.$$

For the projectile in question $N = 220$ turns per second.

$$\frac{A}{B} = 1/6.$$

Hence $\phi' = 220/12 = 18.3$ turns per second.

Since the muzzle velocity is 2,300 feet per second and the screens are 20 feet apart, this frequency is nearly equal to that of the precessional motion at maximum yaw.

The discussion just given shows what a difficult matter it is to measure the retardation of a projectile by firing through screens. For the retardation must be not only a function of the velocity but also of the yaw. As the latter is periodic there will be a periodic term superimposed on the general term. While the ordinary law may lead one to suppose that the retardation would continually decrease as the velocity dies down it may actually go through the cycle of decrease, increase. For the same reason we may find that the retardation for a shell fired from a gun rifled 1 in 25 may differ from that for the same shell and velocity when the rifling is 1 in 50.

It has been indicated that previous to the introduction of the method of short arc computation by Moulton there had been little change in the field of exterior ballistics in America for several years. In experimental work there had been rather slow progress. That the progress was slow was not so much the fault of the Army as it was due to the non-military policy of the country. When no importance is attached to military affairs by the people we can not expect our army officers to place their service in a position of world prominence.

Recently my attention was called to a letter which may throw light upon one reason for the fact that experimental work was very limited. This letter was written in 1907 from the Ordnance Board to the Chief of Ordnance, requesting that $40 be allowed for experiments in determining the effect on range produced by changing the points or ogives of 50 three-inch projectiles. The experiments were authorized and the money allowed. Trials with only 15 of the 50 projectiles showed that the range was increased from 5,042 to 5,728 yards. It was reported that the coefficient (βc) had been changed from .97272 to .68705. (Note again the extraordinary accuracy in *measuring* this quantity!) The colonel in charge of the experiment deemed further work unnecessary, for he writes (9th indorsement):

> Having established the probable form of the field projectile the board recommends that the remaining 35 experimental shells be made to conform to this design.

However, the Office of the Chief of Ordnance considered that the last word had not yet been said concerning the best form of projectile, and ordered certain other variations to be made in 10 of the remaining 35 projectiles. To provide for this further test it was stated that "a sum of $25 . . . has this day been set aside on the books of this office as a special allotment." (And this was only seven years before the World War started.)

It may be further stated that to this letter authorizing $65 for experimental tests of shells there were 15 indorsements. Those of you who have been in the service will appreciate what this must have meant in the time of stenographers, messengers, filing clerks, and high-salaried officers.

That perfection in the form of projectiles had not been secured was made evident by a series of experiments, rather crude as judged by physical standards, begun at Sandy Hook in 1917, and continued at Aberdeen in 1918. It had been noticed that there was very large dispersion of the shells of the 6-inch gun and the 8-inch howitzer. Various book theories were advanced to account for these dispersions, but finally upon an examination of some recovered shells and as a result of the information obtained by firing through cardboard screens, the true explanation suggested itself. The rotating band on these shells had a raised portion, called a lip, at the rear of the band (Fig. 3). The purpose which this lip was supposed to serve was to act as a choking ring to prevent the escape of the powder blast past the projectile and to seat the projectile at a definite place in the gun. It was seen in the case of the recovered projectiles, and it was evident by the hole formed in the cardboard screen through which the projectile had passed, that these lips were

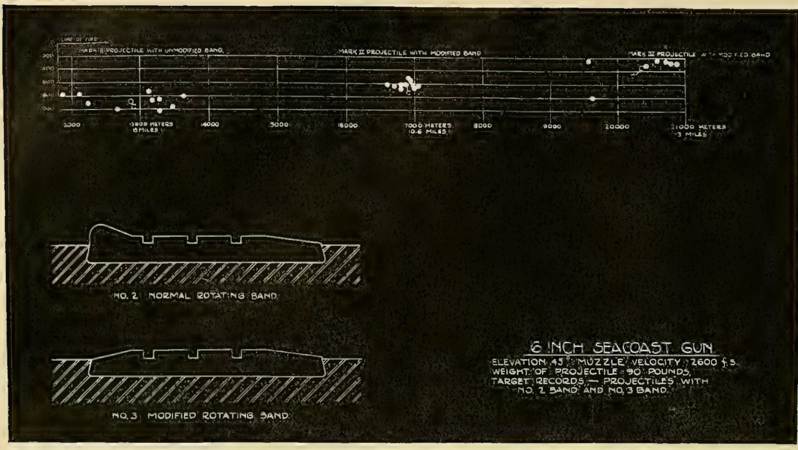

Fig. 3.

partly torn off in the passage of the projectile through the gun. Experiments were then begun in modifying the band. These modifications consisted of machining off the lip as in Fig. 3. The results were very gratifying. The 8-inch howitzer projectile had its range increased by 700 meters and its dispersion decreased in the ratio of 4 to 1, while the 6-inch shell at a muzzle velocity of 2,600 feet per second and elevation of 45° had its range increased from about 12,000 to about 16,000 yards, and its dispersion was divided by four.

A number of experiments of this kind were carried on at Aberdeen, chiefly by Major

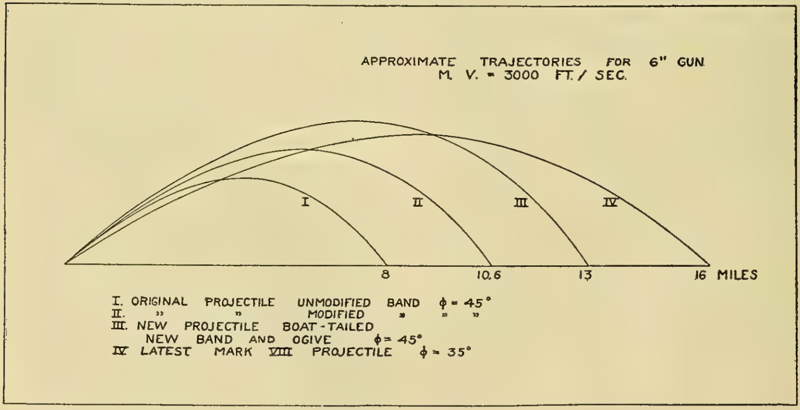

Fig. 4.

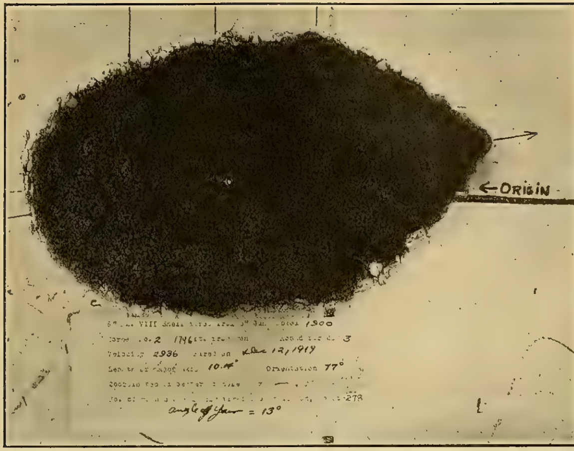

FIG. 5.

Veblen and Lieutenant Alger. In France, similar work was done by Captain R. H. Kent. It is seen that these experiments added greatly to the effectiveness and therefore to the value of the guns in question. The work belongs to physics, notwithstanding the fact that one of these civilian officers was and is a professor of mathematics of the purest quality. That he was able to bring himself temporarily to neglect the fundamental concepts of geometry, in which realm he is one of our foremost thinkers, to enter into the problems of the war with an eagerness for close observation of actualities and a readiness to try out new methods, is very greatly to his credit. He is evidently a physicist by intuition and a mathematician by profession.

It is to be noted (Fig. 4) that between the summers of 1918 and 1919 the range of the 6-inch seacoast gun had been increased from about 14,000 yards to 28,000 yards[2] for a muzzle velocity of 3,000 feet per second, by variations in the form of the projectile suggested by crude experiments. In the case of the last projectile (Mark VIII.) there was rather large dispersion. Had the cardboard test been made it could have been foreseen that there would be this dispersion, for the projectile is evidently not sufficiently stable. In Fig. 5 it is seen that one projectile (6-inch Mark VIII.) has acquired a large yaw not far from the gun. This accounts for the fact that the dispersion for this projectile was large, of the order of 3,000 yards in 28,000.

It may be contended that some of the experiments and tests here recorded are too crude to be classed as belonging to the domain of physics. But let me remind you that Galileo, who may be regarded as the father of our science, climbed the tower of Pisa and let fall two weights, one large and one small, to show that they fell in the same way. We

[2] The range of 14,000 yards for the 6-inch gun is computed for a muzzle velocity of 3,000 feet per second at 45° elevation, basing the computation on the range obtained with a muzzle velocity of 2600 f.s. It ought to be pointed out that the Army had a 6-inch shell which for a muzzle velocity of 2,600 feet per second had a range of 15,000 yards at 15° elevation, but this was a heavy projectile—108 lbs. —while that of the projectile experimented upon was 90 lbs.

have made some progress since Galileo's time. We know that bodies are retarded by the air but we have assumed, on some experimental evidence, in the case of projectiles at any rate except for a constant of proportionality, that they are retarded in the same way. It is evident that in the matter of the laws of air resistance we are not far from the condition that the scientists of Galileo's time were in regard to gravitation.

It is evident from the results of these experiments at Aberdeen that a very slight change in the form of the projectile may make a considerable change in the range obtained. And it is equally clear that those experiments merely touched the matter. The entire subject is still open.

A number of years ago the Ordnance Department made inquiries concerning the possibility of using air streams of high velocity in tests on projectiles. During the war the project was submitted to the National Research Council. It was found that air streams one foot in diameter, with speed of 1,500 feet per second, requiring for their production 5,000 kw., could be furnished by the General Electric Company at their plant at Lynn, Massachusetts. There, with the most loyal support of the Bureau of Standards, and with the effective collaboration of Dr. L. J. Briggs of the bureau the Ordnance Department has conducted experiments[3] which have for their object the determination of the forces of such air streams on projectiles of various forms. Velocities of the air have, so far, varied from 600 up to 1,200 feet per second and temperatures from 0° to 130° C. In these air streams, which are vertical, projectiles of various shapes can be held nose down, and the forces on them and pressures at various points on their surfaces, can be measured. A number of important results have been secured. First, for head-on resistance there is no *one* curve similar to the French B curve which gives the law of air resistance for all projectiles. For example, in that law it will be seen by inspection (Fig. 1) that F/v^2 is multiplied by the factor 3 when the velocity changes from 200 to 380 meters per second. In our curves the corresponding factor varies from 1.3 to 4 for the various forms of projectiles. In other words the force exerted on one projectile may be less at one velocity and more at another than the force for the corresponding velocity in the case of another projectile. It follows that there is no "best form" of projectile unless we specify the approximate velocity with which we are dealing.

Second, the results obtained indicate the resistance introduced by the rotating band and show where this band should be placed to produce the least increase of resistance.

Third, it appears that the rapid rise of the B curve in the neighborhood of $V = 340$ meters per second is not entirely determined by the velocity of the compressional wave, *i. e.*, by the velocity of sound in the air. In some cases the force of air streams at 130° C. are identical with those at 30° C. (It is understood that the density of the air is standardized, *i. e.*, that the forces plotted are those which an air stream of equal speed and of density 0.001206 gms./cm.^{3} would have exerted.) In other cases, however, the results indicate that the velocity of the compressional wave is one of the factors determining the resistance. The temperature relation seems to be a complicated one and our results are not at all complete on this point.

Fourth, though we have not made quantitative measurements of the variation of force with the angle of attack of air and projectile, we have had some experimental evidence of the large forces which are called into play when this angle changes from "nose on" to oblique. In one case, the force of the air on a fifty pound 4-inch projectile was of the order of 44 pounds, so that there was still about six pounds of down force. When the projectile was being removed from the air stream it was accidently tipped slightly. The air stream forced it farther from the vertical, bent off the steel rod holding it to the balance

[3] Without a knowledge on his part of other inquiries, negotiations for these experiments were carried on and pushed to a conclusion by Major Moulton.

arm and blew the projectile up several feet over a railing into the yard. In another case, when the up force due to the air on a two-inch projectile was only about one third of the weight, *i. e.*, about 1.5 pounds, an oblique action at a slight angle drove the projectile farther from the vertical, finally turned its nose up, bending the steel spindle in the process. It is evident that the oblique forces of air streams on projectiles may be many times the "nose-on" force for corresponding velocities. It is clear then that unless a projectile turns "nose-on" to a wind the method now in use for finding wind corrections are greatly in error.

Enough has been said to show that the fundamental problem of the projectile is not one of mathematics. There are various mathematical methods of handling the problem. The English have a method highly analytical and complete. The French have a method rather tedious for computation but they excel in the graphic representation of results. The Italians still cling to the Siacci method. There are at least three methods in use in America, each one claiming points of merit. The problem is one of experimental science. We must first determine the complete law of air resistance for every probable form of projectile, then we must determine the variation of force as the axis of the projectile changes in direction; the torque about the center of gravity; the precessional and nutational motions under these forces, and the consequent effective lift and drag, as these terms are used in aerodynamics. Mathematicians may then find it necessary, using these known facts, to formulate the differential equations of a twisted trajectory and to evolve methods of integration. But it is quite probable that simple physical methods of integration may be devised.

It is evident even from a superficial study of the matter that a gun is an inefficient engine. An appreciable part of the energy of the powder takes the form of heat and kinetic energy of the gas developed. Of the initial energy of the projectile a large part is used in overcoming the resistance of the air. Perhaps in the warfare of the future we shall not need guns, on land at any rate. Rather we may hoist a carload of projectiles on a dirigible, carry them over the enemy's cities or lines and drop them on carefully selected spots. But if we are to drop projectiles or bombs accurately we must know the laws governing the motion of such bodies.

During the war, Drs. A. W. Duff and L. P. Seig carried on a series of experiments at Langley Field, in which the object was to find by photography the path of a bomb dropped from an airplane. By placing an intense light in a bomb they were able to photograph its path, to measure its velocity at any point, to obtain the speed of the airplane, and the wind velocity. These important results were contributed to the Americal Physical Society at the April meeting.

At Aberdeen, Dr. F. C. Brown, then captain later major in the Ordnance Department, while flying over a shallow body of still water observed the image of the airplane in the water. To a casual observer this would have excited no special interest. But, being a physicist, knowing the meaning of a level surface and a line of force, Dr. Brown saw that he had with him a visible vertical line. However the airplane tossed and pitched the vertical direction could be identified. He made use of this fact in a very skillful way. Attaching to the airplane a motion picture camera he was able to photograph a bomb released from the plane at a height of about 3,000 feet during the whole course of the projectile to the earth. Time can be obtained either from the rate of motion of the camera or from the photograph of a watch placed so that its image also falls on the film. The distance that the bomb has fallen and its orientation in space can be determined from the dimensions of its image. Its angle of lag or its distance behind the vertical line from the plane can be found by measuring the distance between the image of the bomb and that of the airplane. Hence not only the complete trajectory can be found but also the relation of the trajectory at any point with the variation in direction of the axis of the bomb.

It is assumed here that the motion of the airplane has been kept constant. The motion picture film which I shall show, which was kindly loaned to us by the Aircraft Armament Section of the Ordnance Department, will bring out clearly the tossing, pitching motion of the bomb in its course to the earth.

INTERIOR BALLISTICS

In interior ballistics, there are a number of unsolved problems. The first is concerned with the pressure produced in a gun by the exploding charge and its time rate of change.

The ordinary method which has been in use has been to measure the so-called maximum pressure by the shortening produced in a copper cylinder. But experiments have shown that the amount which a cylinder of copper is compressed by an applied pressure depends on the amount of the pressure, the time of application, the previous history as regards tempering, annealing, compression, etc. It is known for example that an application of a pressure of say 36,000 pounds per square inch will give an extra shortening to a cylinder previously compressed to 40,000 pounds per square inch. But the ordinary procedure has been to place in the gun a copper cylinder which had been precompressed to an amount nearly that to be expected. Obviously such a cylinder may indicate a pressure in the gun in excess of 40,000 pounds when in reality it was less. Moreover, the copper cylinder need not indicate the maximum. Rather it indicates a summation of the total effect of the gases upon it. A smaller pressure applied for some time may produce a shortening equal to that due to a larger pressure for a shorter time. Notwithstanding this uncertainty in the behavior of a copper cylinder, that is the kind of gage which has been used to standardize all the powder used in guns. It is clear that we may doubt whether these powders have been standardized at all. What is wanted evidently is a gage which will register the pressure accurately at a certain instant and therefore which will give the complete variation of the pressure with time.

Several gages have been devised which have points of excellence as well as defects. In the Petavel gage the compression of a steel spring was registered on a revolving drum by a light pointer. But the mechanical processes were not well worked out. Colonel Somers improved on Petavel's design in the mechanical details but neglected the optical. For small arms, both mechanical and optical details have been worked out by Professor A. G. Webster. In the gage the spring is a single bar of steel about 5 mm. square and 20 mm. long, which is bent by a plunger fitting into a cylindrical opening through the wall of the gun. Its moving parts have small mass and high elasticity, and it seems capable of giving an accurate record of the changes in pressure even when the whole time is of the order of a few thousandths of a second. But its use appears to be limited to the cases of guns which can be rigidly clamped during the explosion.

In the Bureau of Standards, Drs. Curtis and Duncan have been perfecting a gage which has been used in the large naval guns. Here a steel cylinder compresses a steel spring. During the compression a metal point makes electrical contact with conductors equally spaced. Consequently electrical signals can be indicated by an oscillograph for these equal steps. The time pressure curve is then given if the spring can be properly calibrated. There is however some doubt on this point and there is also uncertainty in electrical contacts and in the friction of the system.

What is needed is a method of calibrating accurately any gage by means of a known rapidly changing high pressure. Such a method has been worked out by the technical staff of the Ordnance Department, but the mechanical and experimental work still has to be done.

I have given you here some applications of the older physics to old and new problems of war. The list even in this limited field might be easily increased. By means of the photography of sound waves from a projectile we may determine many facts concerning its motion, the frequency of its precessional and nutational motions, the nature of its stability or instability. By means of motion pictures taken from an airplane we may determine facts of importance concerning the motion of a rapidly rotating projectile dropped from the plane. The recoil, jump and other motions of guns may be studied by photographic methods. By similar methods the times and positions of high angle shell bursts may be obtained from observational balloons. Gyro stabilizers, microphones, string galvanometers, oscillographs, piezo-electric apparatus, vacuum amplifying tubes, Kenetrons, old and new devices in physics—they all may be used to reduce the problems which I have been discussing to those of an exact science.

Gordon F. Hull

Dartmouth College

BOARD OF SURVEYS AND MAPS OF THE FEDERAL GOVERNMENT

On December 30, 1919, the President of the United States by executive order created a Board of Surveys and Maps to be composed of one representative of each of the following organizations of the government:

1. Corps of Engineers, U. S. Army.
2. U. S. Coast and Geodetic Survey, Department of Commerce.
3. U. S. Geological Survey, Department of Interior.
4. General Land Office, Department of Interior.
5. Topography Branch, Post Office Department.
6. Bureau of Soils, Department of Agriculture.
7. U. S. Reclamation Service, Department of Interior.
8. Bureau of Public Roads, Department of Agriculture.
9. Bureau of Indian Affairs, Department of Interior.
10. Mississippi River Commission, War Department.
11. U. S. Lake Survey, War Department.
12. International (Canadian) Boundary Commission, Department of State.
13. Forest Service, Department of Agriculture.
14. U. S. Hydrographic Office, Navy Department.

The individual members of the board were appointed by the chiefs of the several organizations named. The board is directed, by the executive order, to make recommendations to the several departments of the government or to the President for the purpose of coordinating the map-making and surveying activities of the government and to settle all questions at issue between executive departments relating to surveys and maps, in so far as their decisions do not conflict with existing law. The board is also directed to establish a central information office in the U. S. Geological Survey for the purpose of collecting, classifying and furnishing to the public information concerning all mapping and surveying data available in the several government departments and from other sources. The executive order further directs that the board shall hold meetings at stated intervals to which shall be invited representatives of the map-using public for the purpose of conference and advice.

All government departments, according to the executive order, will make full use of the board as an advisory body and will furnish all available information and data called for by the board.

The order of the President rescinds the advisory powers granted to the U. S. Geographic Board by the executive order of August 10, 1906, and transfers those powers to the Board of Surveys and Maps. The executive order of August 10, 1906, reads as follows:

EXECUTIVE ORDER

The official title of the United States Board on Geographic Names is changed to United States Geographic Board.

In addition to its present duties, advisory powers are hereby granted to this board concerning the preparation of maps compiled, or to be compiled, in the various bureaus and offices of the government, with a special view to the avoidance of unnecessary duplications of work; and for the unification and improvement of the scales of maps, of the symbols and conventions used upon them and of the methods representing relief. Hereafter, all such projects as are of importance shall be submitted to this board for advice before being undertaken.

Theodore Roosevelt

The White House,
August 10, 1906

The representatives of the federal organizations mentioned in the executive order of December 30, 1919, met on January 16, 1920, and perfected the organization by the enactment of by-laws for the government of the Board of Surveys and Maps.

The officers of the board are: Chairman, Mr. C. O. Merrill, chief engineer of the Forest Service; vice-chairman, Dr. William Bowie, chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey; secretary, Mr. C. H. Birdseye, chief geographer of the U. S. Geological Survey.

Standing committees have been appointed to care for the various phases of surveying and mapping. Those committees are:

1. On coordination of work among the federal bureaus.
2. On cooperation between federal and other map-making and map-using organizations and agencies.
3. On technical standards.
4. On topographic maps.
5. On highway maps.
6. On general maps.
7. On hydrographic charts.
8. On control surveys.
9. On photographic surveys.
10. On information.

In addition to these committees there was also organized the Map Information Office, with headquarters at the U. S. Geological Survey, which was directed by the Executive Order.

On all except a few of the standing committees of the Board of Surveys and Maps, representatives of outside organizations will also be appointed.

The public meetings of the board will be held in Washington, D. C., on the second Tuesday of January, March, May, September and November of each year and there will be executive meetings held immediately after those public meetings and also on the second Tuesday of February, April, October and December.

It is interesting to know the steps by which the Board of Surveys and Maps came into existence. The National Research Council had its attention called to the desirability of having an organization that would prevent duplication and provide for cooperation among the federal map-making organizations. The matter was discussed by the National Research Council and was then submitted to the Engineering Council for consideration. On July 1, 1919, the chairman of the Engineering Council, Mr. J. Parke Channing, wrote a letter to the President of the United States in which he called attention to the necessity for the completion of the topographic map of the United States at an early date to meet the needs of the country in its commerce, industries, etc. The Engineering Council recommended the creation of a Board of Surveys and Maps to consider the whole question of coordination of the work of the government in those branches of engineering.

On July 27, 1919, the President of the United States directed the Secretary of War to call a conference of representatives of the surveying and map-making organizations of the government for the purpose of considering the recommendation of the Engineering Council.

This conference held a number of meetings in September, 1919, and on the last of that month sent a report to the President, recommending, among other things, that the Board of Surveys and Maps be created. Added to the report of the conference were a number of exhibits which show the surveying and map-making work carried on by each of the several organizations of the government. The executive order of the President and the organization of the board are considered in the early part of this article.

It is believed that the creation of this Board of Surveys and Maps is a step that will have very far reaching consequences in completing the topographic mapping of the country and in planning standard methods for carrying on work connected with the surveys and map making of various kinds employed in both government and other organizations and agencies.

Maps have been made in this country ever since the colonists first landed but there has never been any coordinating agency by which standards of accuracy could be established for the guidance of surveyors and map-makers. In fact, such an organization as the American Society of Civil Engineers, which is vitally interested in surveys and maps, has no committee to consider these important matters.

It is hoped that the engineers and scientists of the country will cooperate with the Board of Surveys and Maps by making their wants known. If they will do this the board will be able to make the maps of the government of even more use to the public than they have been in the past.

William Bowie
U. S. Coast and Geodetic Survey,
Washington, D. C.

THE CINCHONA TROPICAL BOTANICAL STATION AGAIN AVAILABLE

The lease of the Cinchona Station by the Smithsonian Institution on behalf of a group of contributing American botanists was interrupted by conditions existing during the war. It has now been resumed and the laboratory will be available for American botanists during the coming year.

This tropical laboratory in a botanical garden containing scores of exotic trees, shrubs and vines and other scores of herbaceous perennials from all quarters of the earth is located within a half-hour's walk of an undisturbed montane rain forest, on the southern slope of the rugged Blue Mountains of Jamaica. In the well-kept garden of ten acres and on other parts of the Cinchona plantation of six thousand acres, the visiting botanist can find well-developed specimens of many economic or ornamental plants such as cinchona, tea, coffee, rubber trees, silk oaks, ironwoods, several species of eucalyptus and many others. The dry ridges and sunny valleys of the south side of the Blue Mountains offer many types of peculiar ferns, of epiphytic bromeliads, grasses, mistletoes and lianes. In the rain forest are to be found scores of species of ferns ranging from the very diminutive epiphytic polypodiums of but an inch or two in height to the scrambling pteridiums or gleichenias or climbing lomarias of many yards in length, and to great tree ferns, forty feet in height. Mosses and liverworts are present here in like profusion and grow on all sorts of substrata from the damp soil of the forest floor, the trunk of a tree fern, or even to the leathery surface of the leaf of a climbing fig or fern. There are also dozens of interesting native trees, shrubs and vines and many herbaceous forms which together make parts of the forest a practically impenetrable jungle.

As the vegetation of the main ridge of the Blue Mountains differs from that of the southern ridges and valleys, so that of the beclouded northern slope, especially the hot, moist lower slopes differs from both. In the deep valley of the Mabess River, five miles north of Cinchona, many peculiar mosses, ferns and seed plants, including a wealth of interesting epiphytic species are to be found. There are whole square miles of these northern slopes of the Blue Mountains within a day's walk of Cinchona that have never been explored by the botanist, nor even by the collector.

Botanists wishing to work on plants of the lowlands or the sea coast can make their headquarters in Kingston. Such workers have always been granted the privilege of using the library, herbarium and laboratory at Hope Gardens. These gardens also contain a fine collection of native and introduced tropical plants offering much material for morphological and histological study. Cacti, agaves and other xerophytic plants of the sea coast and the algæ of the coral reefs along the shore afford still other types of vegetation of great ecological, developmental and cytological interest. Castleton Garden, the third botanical garden of the island, has a very different climate from either Cinchona or Hope, for it is located in a hot, steaming valley, twenty miles north of Kingston, where cycads, screw pines, palms, orchids, figs, ebonies and the gorgeous amherstias and other tropical trees grow luxuriantly.

All in all Jamaica probably offers the botanist as great a variety of tropical conditions within a day's walk of Cinchona and a day's drive from Kingston as can be found anywhere in an area of equal size. One of our botanists who has collected ferns in many tropical regions of both the old and new world says "none equals Jamaica in either number of species or of individuals." Five hundred pteridophytes are known on the island. Another botanist, a student of the mosses, says "the facilities for the study of these plants at Hope Gardens and at Cinchona are probably unequaled anywhere else in the tropics except at Buitenzorg." It is thus evident that the opportunities for the study of many sorts of botanical problems are abundant at Cinchona, Hope and Castleton. It is also clear that there are many botanical problems of prime importance which can be studied only in such environments. There is then every reason to believe that this American tropical station, which is now available, can be made as notable by the work of our own investigators as the famous Dutch garden at Buitenzorg in Java has become in consequence of the work of the Dutch and other European investigators.

Further details concerning the types of vegetation found and the opportunities for research in Jamaica may be found in SCIENCE, 43: 917, 1916, and in *The Popular Science Monthly* for January, 1915.

Any American botanist wishing to work at Cinchona may be granted this privilege by the Cinchona Committee, consisting of N. L. Britton, J. M. Coulter and D. S. Johnson. Inquiries for this privilege and for information regarding the conditions under which it may be granted should be sent to the writer.

DUNCAN S. JOHNSON
JOHNS HOPKINS UNIVERSITY,
BALTIMORE

ENTOMOLOGY IN THE UNITED STATES NATIONAL MUSEUM

THE day has long passed when American scientific activities can be restricted to a narrow field. Whether we regard the economic needs or the intellectual development, we find ourselves compelled to consider the whole range of science, limited only by our resources and the powers of the human mind. In the field of entomology this involves, among other things, access to adequate collections of insects, including not only those found in North America, but the species of the whole world. The leading European countries have long appreciated such needs, and have built up collections to which Americans have to make pilgrimages when engaged in comprehensive studies of insect groups. There is no reason why we should not possess facilities for work at least equal to those of any other country. We have the greatest material resources of any nation at the present time, and certainly are not lacking in the ability to carry on the work.

The species of insects are far more numerous than those of any other group of animals; in fact the described forms exceed those of all other groups combined. Very many of them are of supreme importance and interest to man, as destroyers of our crops, carriers of the germs of disease, enemies of other injurious insects, or sources of some of our most important economic products. All know the value of the silkworm and the honey bee, but few realize the services of the host of parasitic insects, which keep down the enemies of our crops, and without which agriculture would be impossible. All are aware that numerous insects are injurious to plants, but comparatively few know that many of the most harmful of these have been introduced from abroad. The great danger to our crops, or even to our health, may arise from insects accidentally brought from foreign countries through the operations of commerce. The San José scale, dangerous enemy of many fruits, came from Asia; the cottony cushion scale, which once threatened the extinction of the orange industry in California, came from Australia. The gypsy moth, which has cost this country hundreds of thousands of dollars to fight, is European. The cotton boll weevil, even more to be dreaded, invaded the United States from Mexico and Central America. For urgent practical reasons, therefore, as well as in order to complete and organize our knowledge, we need to know the insects of all countries, and to have them represented in at least one American collection.

This obvious requirement of a great collection representing the insects of all lands, can not be met without Congressional aid. The National Museum, under present conditions, or better, limitations, can not possibly adopt an adequate policy of entomological development. The two prime obstacles are lack of sufficient curators and lack of space. The present force of curators, even with the aid afforded by the members of the Bureau of Entomology, can not arrange and classify the collections already on hand, incomplete as these are. Some of the men work overtime and on holidays, while help is sometimes obtained from those not officially connected with the museum. But all these activities lamentably fail to meet the whole need. The museum should have enough expert curators to keep classified and in order, the available material in every group of insects, and to furnish identifications and other aid to economic entomologists and other workers in every state. Should a sufficient curatorial force be supplied, however, it would be helpless in the present crowded condition of the department. There is hardly room to move around, and almost no space for new cabinets. The only way out seems to be through the erection of a new building of suitable size; fireproof, but not necessarily of any great architectural pretensions.

Granting the building and the curators, with suitable rules and arrangements to ensure the proper care of all the collections, what more should be demanded? Undoubtedly collectors and students would present or bequeath their materials on a scale previously unheard of, because of the great services they had received from the museum and their confidence in it as a repository of types and other priceless specimens. This, however, would not suffice. Funds should be available for explorations within the United States and abroad, to discover insects hitherto unknown or unrepresented in the museum.

With curators, building and adequate collections, we are still confronted by another urgent need. The results of the work done must be made available to scientific men in every part of the country. This can only be brought about through the creation of adequate publishing facilities, insuring the reasonably prompt appearance of each work completed. At the present time authors hesitate to undertake large monographs not knowing when they will see the light of publicity, nor indeed whether they will ever do so.

Prepared by the committees to investigate conditions and needs of the United States National Museum.

ENTOMOLOGICAL SOCIETY OF AMERICA

T. D. A. Cockerell,
Professor of Zoology, University of Colorado,

Herbert Osborn,
Research Professor, Dept. of Zoology and Entomology, Ohio State University,

Wm. Barnes,
Surgeon, Decatur, Illinois,

Wm. M. Wheeler,
Dean, Bussey Institution, Harvard University.

J. G. Needham,
Head, Dept. of Entomology, Cornell University,

AMERICAN ASSOCIATION ECONOMIC ENTOMOLOGISTS

John J. Davis,
In Charge, Japanese Beetle Project, N. J. State Dept. of Agri.,

Vernon L. Kellogg,
Sec'y National Research Council,

E. P. Felt,
State Entomologist, New York,

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State Entomologist, Iowa,

Approved and adopted at St. Louis, Missouri, by the Entomological Society of America on December 30, 1919, and by the American Association of Economic Entomologists on January 2, 1920.

SCIENTIFIC EVENTS

MANGANESE IN COSTA RICA AND PANAMA

Manganese deposits have been known in Panama for many years, and some were extensively worked as early as 1871. None were recorded in Costa Rica, however, until 1915, when American engineers found deposits in western Costo Rica and, under the stimulus of the prevailing high prices, explored many of them. During 1916, 1917, and 1918 about 18,000 tons of ore was exported from Costa Rica to the United States. In October, 1918, the Geological Survey, taking advantage of the presence in Costa Rica of an American geologist, J. D. Sears, had the deposits examined. Dr. Sears afterward visited several new deposits in Panama.

The deposits in Costa Rica are found at several places on the Nicoyan peninsula, in the Province of Guanacaste, which extends along the Pacific coast. Most of the known deposits, and all those which have been the source of the shipments, lie within about 16 miles of Playa Real on the Pacific coast in the northern part of the peninsula. Other isolated deposits occur in the eastern part of the peninsula, near the Gulf of Nicoya. As the central part of the peninsula is covered with dense forest and is difficult to cross, further exploration may bring other deposits to light.

Although deposits of manganese oxides were examined at thirty-six places near Playa Real, most of the ore shipped has been derived from three deposits that lie in an area scarcely 1,000 feet square at Playa Real. These deposits are owned by the Costa Rica Manganese & Mining Co., and American company. At Playa Real, as at many other places in the region, the manganese oxides form very irregular masses, which appear to extend along the crests of hills. The genesis of the deposits is obscure, but sufficient work has been done to show that only a few persist for as much as 100 feet below the surface. Estimates of the size of the known deposits, which, however, are based upon very inadequate data and are therefore probably low, indicate that they might yield 10,000 to 15,000 tons in addition to the 18,000 tons already shipped. The oxides are intimately mixed with silica, so that careful sorting is necessary to produce material containing more than 45 per cent. of manganese. After the oxides are sorted they are carried by lighters to ships anchored near the shore.

The deposits in Panama lie in an inaccessible region along Boqueron River, about 20 miles northeast of Colon. They are about 12 miles southwest of the deposits at Nombre de Dios, which were extensively explored from 1871 to 1902. These deposits are poorly exposed and only a few of them have been explored, but the indications in two small areas warrant an estimate that the deposits there may yield 25,000 to 30,000 tons of high-grade oxides. As there is considerable float along the near-by streams other deposits may be found. In order to export the material, however, roads or tramways must be constructed at considerable expense.

THE CAMBRIDGE NATURAL SCIENCE CLUB[1]

The Cambridge Natural Science Club, founded in 1872, celebrated its 1,000th meeting by a dinner in the combination room of St. John's College, Cambridge, on Saturday, January 24. The president, Mr. J. M. Wordie, was in the chair. There were eighty-three members and guests, and the occasion was taken to bring out a complete list of the members of the club since its inauguration. This shows that of the 330 members 52 are dead, 10 having been killed or died on active service during the war, and that 55, or 16.7 per cent., had received the blue ribbon of science—the F.R.S. Indeed, in returning thanks for the guests, Sir J. J. Thomson, who, although president of the Royal Society and master of Trinity, had never been a member of the club, thought that the proportion of fellowships of the Royal Society was probably higher among members of the club than among fellows of colleges elected on account of their attainments in natural science. He confessed that he had never taken the Natural Science Tripos, though he had often examined others for it, and pleaded in defence that, like Professor W. H. Bragg, also a guest, he had made some vicarious amends by submitting a son to the ordeal. It may be noted that Professor W. H.

[1] From the *British Medical Journal.*

Bragg and his son divided the Nobel Prize in 1915 for work on X-rays. "The Club" was proposed by Dr. J. G. Adami, the recently appointed vice-chancellor of the University of Liverpool, who insisted on the educational value of the club, which, as a past professor, he seemed to rate higher than that of lectures; that ideas struck out in a discussion were often of great value was accepted as true by Professor Marr, who, as one of the senior honorary members, replied to the toast in an amusing speech. On the cover of the menu there was an attractive reproduction of Kneller's portrait of Sir Isaac Newton, painted in 1689, two years after the publication of the Principia, and apparently the only authentic portrait done in his prime. The original portrait is in the collection of the Earl of Portsmouth, but the reproduction was a photograph of the Trinity College engraving executed about 1866 by Oldham Barlow.

FELLOWSHIP OF THE NEW ZEALAND INSTITUTE

AT the annual meeting in 1919 of the board of governors of the New Zealand Institute it was decided to establish a fellowship of the institute, since—apart from Hutton and Hector Memorial Medals, which couuld only be gained by very few—there were no honors attainable in the Dominion for those engaged in scientific research, the number of whom has greatly increased in recent years, while more branches of science are pursued than formerly. This fellowship, which entitles the recipient to place the letters "F.N.Z. Inst." after his name, is limited to forty fellows, and not more than four from now on are to be elected in any one year until the number is complete, after which only such vacancies as occur may be filled.

In order to make a commencement, and as there were many who well deserved recognition for their long and valuable services to science, it was resolved that in the first place twenty original fellows be appointed, these to consist of the living past presidents, together with Hutton and Hector medallists—ten in all, and of ten more members of the institute who were to be elected by the past presidents and medallists from persons nominated by the various affiliated branches of the institute.

The fellowship is to be given only for research or distinction in science, and it is plain that the distinction even now is far from easy of attainment, and that, as time goes on, its value will greatly increase.

The election and appointment of the original fellows took place at the close of 1919, and has resulted as follows:

B. C. Aston, F.I.C., F.C.S.
*‡Professor W. B. Benham, M.A., D.Sc., F.R.S., F.Z.S.
†Elsdon Best.
*†T. F. Cheeseman, F.L.S., F.Z.S.
*†Professor Chas. Chilton, M.A., D.Sc., LL.D., M.B., C.M., F.L.S., C.M.Z.S.
*†‡L. Cockayne, Ph.D., F.R.S., F.L.S.
†Professor T. H. Easterfield, M.A., Ph.D., F.I.C., F.C.S.
Professor C. C. Farr, D.Sc., F.P.S.L., A.M.I.C.E.
G. Hogben, C.M.G., M.A., F.G.S.
G. V. Hudson, F.E.S.
Professor H. B. Kirk, M.A.
†‡P. Marshall, M.A., D.Sc., F.G.S., F.R.G.S., F.E.S.
*D. Petrie, M.A., Ph.D.
†Sir Ernest Rutherford, F.R.S., etc.
Professor H. W. Segar, M.A.
S. Percy Smith, F.R.G.S.
R. Speight, M.A., M.Sc., F.G.S.
Professor A. P. W. Thomas, M.A., F.L.S.
*Honorable G. M. Thomson, M.L.C., F.L.S.
J. Allan Thomson, M.A., D.Sc., A.O.S.M., F.G.S.

*Past President.
†Hector Medallist.
‡Hutton Medallist.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ALBERT A. MICHELSON, of the University of Chicago, has been elected a foreign associate member of the Paris Academy of Sciences to succeed the late Lord Rayleigh.

THE Bruce Gold Medal of the Astronomical Society of the Pacific has been awarded to Professor Ernest W. Brown, of Yale University, for "distinguished services to astronomy." The award was officially announced at the annual meeting of the society on January 31. It is hoped that Professor Brown may be able to go to California to receive the medal in person at the meeting of the society which will be held on March 27. This is the fifteenth award of the Bruce Gold Medal. It will be recalled that nominations for the medal are received each year from the directors of six great observatories of the world: the Cordoba Observatory, Argentina; the Royal Observatory, Greenwich, England; the Paris Observatory, France, and the Harvard, the Lick and the Yerkes Observatories in America. It is on the basis of these nominations that the directors of the society make the annual award.

At a meeting of the Academy of Natural Sciences of Philadelphia held on February 17, the Hayden memorial geological medal for distinguished work in geology or paleontology for 1920 was awarded to Professor T. C. Chamberlin, of the University of Chicago, on the recommendation of a committee consisting of R. A. F. Penrose, Jr., *chairman,* John Mason Clarke, Henry F. Osborn, Charles D. Walcott and Edgar T. Wherry.

The William H. Nichols medal for the year 1919 was presented to Dr. Irving Langmuir by Dr. Nichols at a meeting of the New York Section of the American Chemical Society on March 5. Dr. Langmuir made an address on "Octek theory of valence."

R. H. Hooker has been elected president of the Royal Meteorological Society. The vice-presidents are J. Baxendell, F. Druce, Sir Napier Shaw and F. J. W. Whipple.

Arthur W. Gilbert, Ph.D., who was professor of plant breeding at the New York State College of Agriculture from 1911 to 1917, has been appointed state commissioner of agriculture for Massachusetts.

Dr. W. A. Setchell has a sabbatical year of absence from his work as head of the department of botany at the University of California and is visiting botanical institutions in the eastern states.

Dr. J. W. E. Glattfeld, assistant professor of chemistry of the University of Chicago, has been appointed temporary research associate of the department of botanical research, Carnegie Institution of Washington, and is spending January, February and March at Tucson, in cooperative work with Dr. H. A. Spoehr, of the staff of the Desert Laboratory.

According to a press dispatch from Geneva Burt Wolbach, of Harvard Medical School, and Dr. John Todd, of McGill University, have arrived there to confer with the general medical director of the League of Red Cross Societies concerning inquiries the league will carry on in Poland in connection with the study of typhus fever. Other members of the mission are proceeding to Poland. Professor George C. Whipple, of Harvard University, has arrived there to take up his work as chief of the sanitary department of the Red Cross League.

Dr. Alonzo E. Taylor, of the University of Pennsylvania, sailed for Europe, February 14, to make a study of food conditions on the continent.

The *Journal* of the American Medical Association states that Drs. William J. Mayo, Rochester, Minn., and Franklin H. Martin, Chicago, who have been visiting South America in the interests of a Pan-American College of Surgeons, started for home from Santiago, Chile, on February 14. In the course of their tour they have visited Buenos Aires, Montevido and Valparaiso, Chile.

The Government of South Africa has appointed an advisory committee to carry out and supervise a botanical survey of the territories included in the Union, with Dr. J. B. Pole-Evans, chief of the division of botany in the Department of Agriculture, as director.

The committee on Scientific Research of the American Medical Association has made the following grants for scientific work: Professor G. Carl Huber, University of Michigan, $400, for study of nerve repair. Professor H. M. Evans, University of California, $400, for study of the influence of endocrine glands on ovulation. Professor E. R. LeCount, Rush Medical College, $200, for study of extradural hemorrhage and of the h-ion content of the blood in experimental streptococcus infections. Dr. E. E. Ecker, Western Reserve University, $200, for a study of the specificness of anti-anaphylaxis. Dr. Henrietta Calhoun, Iowa State University, $400, for a study of the effect of protein shock on diptheria intoxication.

THE Cornplanter silver medal, which is awarded biennially by the Cayuga County (N. Y.) Historical Society in recognition of service to the historical study and the present welfare of the Iroquois League or Six Nations Confederacy, has been given this year to Mrs. Frederick Ferris Thompson (Mary Clark Thompson) in acknowledgement of her contributions to the Iroquois collections of the New York State Museum and to the conservation of the historical records of the league. Mrs. Thompson's contrbutions to this object have been made in the name of her father Myron H. Clark, a former governor of New York state.

THE seventh lecture of the Harvey Society series will be given by Dr. Otto Folin, professor of physiological chemistry, Harvard University, on "Blood chemistry" at the New York Academy of Medicine on Saturday evening, March 13.

AT a meeting of the American Philosophical Society held on March 5, the program was: "Across the Andes in search of fossil plants," by Edward W. Berry, assistant professor of paleobotany, Johns Hopkins University, and "Interrelations of the fossil fuels—the Paleozoic coals," by John J. Stevenson, professor emeritus of geology, New York University.

DR. ALFRED J. MOSES, professor of mineralogy in Columbia University, has died at the age of sixty-one years.

DR. FRANCIS C. PHILLIPS, professor of chemistry at the University of Pittsburgh for forty years, died on February 16, at the age of sixty-nine years. Professor Phillips was known for his work in the chemistry of natural gas.

SIR JAMES ALEXANDER GRANT, one of the most distinguished surgeons of Canada, known also for work in paleontology, died on February 6, at his home in Ottawa, aged eighty-nine years.

THE department of geology and geography at the University of Michigan is to have a summer camp in the mountains of Kentucky for field work in geology and geography. This camp will open on August 30, and will continue for four weeks. Professor C. O. Sauer, in charge of geography at the university, will be director of the camp and conduct the work in geography. The work in geology will be directed by Professor E. C. Case. The number of students will be limited to twelve in each course. Students from other universities who have finished an elementary course in geology will be welcome to the camp. Full information can be obtained from Professor Sauer.

DR. JOSEPH GRINNELL, associate professor of zoology and director of the California Museum of Vertebrate Zoology, has presented his entire private collection of scientific study skins of North American birds to the University of California. The specimens number 8,312 and represent collections during the period 1893 to 1907. The total ornithological collections in the California Museum of Vertebrate Zoology now amount to 39,659 specimens. The study skins were secured from Los Angeles county, the Colorado Desert, the Mohave Desert, the San Bernardino Mountains, the Santa Barbara Islands, Mt. Pinos in Ventura, Santa Clara county, Los Coronados Islands, the Stikan District in southeastern Alaska, and the Kotzebue Sound District in arctic Alaska. Twenty-seven types of subspecies newly described, and specimens of at least three species of birds now extinct, are included in the collection. There are also many "record specimens." Large series of such birds as the willow ptarmigan, specially selected to illustrate processes of molt are included. There are also long series of birds gathered from appropriate territory to show facts in geographic variation.

THE American Museum of Natural History has published in its *Bulletin* a full report by Dr. Pilsbry on Land Mollusks of the Belgian Congo, one of a series of reports on the fauna of that region. These reports are based on the collections made by the American Museum Belgian Congo Expedition in cooperation with the Belgian government.

The *Journal* of the American Medical Association states that the Société de Neurologie de Paris has recently decided to inaugurate an international exchange of views on neurologic questions by inviting neurologists and psychiatrists from other countries to attend a special meeting to be held annually at Paris in July. It is planned to have two days of work with two sessions each day, and some subject is to be appointed for discussion. The first meeting it is announced will be organized in July, 1921, and the subject appointed for discussion at that time is the clinical forms and the treatment of syphilis of the nervous system. Professor J. A. Sicard has been appointed to open the discussion.

We learn from the *Journal* of the American Medical Association that a notable gathering of members of the medical profession and other friends of the late Sir William Osler attended services in his honor on January 1, in Old St. Paul's Church, Baltimore. The time was set on receipt by Dr. Henry Barton Jacobs, of a cablegram from Lady Osler, stating that the funeral services in England would be held at that hour. The ceremony at St. Paul's was most impressive. The trustees, faculty and student body of the Johns Hopkins University were represented, as well as the nurses of the training school and officials of Johns Hopkins Hospital. The medical and chirurgical faculty of Maryland and the Baltimore City Medical Society were represented by leading members of the medical profession. A memorial meeting of the staff of Mayo Clinic, Rochester, was held on December 31.

Valuable data and records, covering two years' research in the cause and effect of influenza, made by Dr. Thomas M. Rivers, and the laboratories of Dr. Bayne Jones and Dr. Lloyd D. Felton, containing apparatus and data of value, were destroyed in the fire which recently broke out on the top floor of the pathologic building in the Johns Hopkins group.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board, founded by Mr. John D. Rockefeller, announces an appropriation of $1,000,000 as a contribution toward a building fund of $3,000,000 for the construction and endowment of a new library and class room building for Teachers College, Columbia University.

An emergency grant has been made to the University of Cambridge, by the government, of £30,000, payable in two installments, the first of which has been received. The council of the senate has assigned £5,000 to the university library, £4,100 to increase the stipends of various professorships, £1,400 to increase the stipends of eight readers, and £2,575 for various university lecturers.

Mr. S. B. Joel and his brother, Mr. J. B. Joel, have promised the sum of £20,000 for the endowment of a chair of physics in the Middlesex Hospital Medical School, London.

After thirty years of service in the department of chemistry at the University of Iowa, during the last fifteen of which he has been head of the department, Professor E. W. Rockwood has resigned his administrative duties. He will continue his teaching and research.

Assistant Professor C. N. Mills, of South Dakota State College, has been appointed professor of mathematics at Heidelberg University, Tiffin, Ohio.

Dr. Roger C. Smith, of the Virginia Station, has succeeded Dr. M. C. Tanquary in the Kansas State Agricultural College, entomological department. Dr. Tanquary resigned to accept the post of Texas state entomologist.

Howard M. Turner, a consulting engineer of Boston, who recently has been connected with the Turners Falls Construction Company, has been appointed lecturer on water-power engineering at the Harvard Engineering School.

It is stated in *Nature* that Dr. Samuel Smiles has been appointed to the Daniell chair of chemistry at King's College, London, in succession to Professor A. W. Crossley. Last year Dr. Smiles was appointed professor of organic chemistry at Armstrong College, Newcastle, and since 1913 he has been senior honorary secretary to the Chemical Society.

DR. T. F. SIBLY, at present professor of geology at Armstrong College, Newcastle-upon-Tyne, has been appointed principal of the University College of Swansea.

DISCUSSION AND CORRESPONDENCE

MATHEMATICS AT THE UNIVERSITY OF STRASBOURG

TO THE EDITOR OF SCIENCE: I take pleasure in transmitting to you a note recently received from my friend and old schoolmate at the Ecole Normale Supérieure, Maurice Fréchet, concerning the opening under French auspices of the University of Strasbourg. From the extent of the mathematical curriculum thereto appended it is clear that the whole university will be on a very substantial basis.

Many readers of SCIENCE may recall that in 1914 just prior to the outbreak of the war Professor Fréchet was planning to come to America as lecturer at one of our large universities with a strong department of mathematics. Students who now wish to study with Fréchet that branch of mathematics in which he is eminent by researches internationally known will have to cross the Atlantic. I may add that Dr. Fréchet speaks English fluently and will doubtless make every endeavor to render profitable to any young American mathematician a sojourn at Strasbourg.

EDWIN BIDWELL WILSON

THE UNIVERSITY OF STRASBOURG

It will be perhaps of interest for readers of SCIENCE to hear that notwithstanding many difficulties, the University of Strasbourg was reopened informally last January. It is in course of reorganization and will be in full working order for the formal reopening which will take place next November, 1919.

As "the end of the University of Strasbourg" has been announced in some neutral papers, we give below the full program of its mathematical department for the next academic year, such as it has been decided upon, in the original French, names being only given in full for men already in Strasbourg.

Lectures are, of course, delivered in French. The library has been considerably increased as far as concerns books written in English, as well as French books.

For further particulars, apply to Professor Fréchet, 2 Rue du Canal, Robertsan, Strasbourg.

MAURICE FRÉCHET

The courses in mathematics offered during 1919–20 are: (1) Preparatory and general mathematics, by Dr. Pérès and an instructor. (2) Differential and Integral Calculus (unassigned). (3) Theoretical and applied mechanics, by Professor Villat and Mr. Veronnet. (4) Astronomy by Professor Esclangon and Danjon. (5) Higher Analysis (spaces of ∞ dimensions, approximative functions, functional calculus), by Professor Fréchet. (6) Differential geometry (2d semester), by Dr. Pérès. (7) Theory of functions (integral functions, elliptic functions with applications), by Professor Villat and ——— (2d semester). Furthermore as preparation for the Agrégation a series of courses (Math. spéciales, Math. élementaries, Calcal diff. et int., mécanique rationelle) are given. Dr. Pérès, director of the mathematical laboratory, and an assistant will offer work in that line, and Professor Fréchet will conduct a colloquium to encourage original research.

PROFESSOR PAWLOW

TO THE EDITOR OF SCIENCE: Knowing the keen interest of all American men of science and particularly physiologists in news from Professor Pawlow, I hasten to send herewith a paragraph from a letter recently received from a well-known physiologist in the south of Russia. For obvious reasons the place and name had at this time best not be made public.

In August of 1919 Professor J. P. Pawlow was still alive in Petrograd. He begged his friends [in Kieff] to send him some provisions, as he was starving. At the end of his letter he writes: "Instead of science I am busy peeling potatoes." I know nothing about him at present (January 17, 1920), as the north has been severed from the south by the Bolshevick invasion.

Ever since the false announcement of Professor Pawlow's death a few years ago all his friends have been anxiously awaiting word from him. The above is indeed pitiable but at least indicates that he was living seven months ago.

Francis G. Benedict

ANOPHELES QUADRIMACULATUS AND ANOPHELES PUNCTIPENNIS IN SALT WATER

While it is well known that *Anopheles ludlowi* and *Anopheles chaudoyei* may pass their larval stages in brackish water, the report[1] of Smith (1904) regarding the occurrence of *Anopheles quadrimaculatus* in brackish water has been either ignored or discredited. *Anopheles crucians* has been found in salt water at times.

It seems desirable to record certain cases of the distribution of larvæ of malarial mosquitoes in brackish water which have come to my observation. Although not numerous these cases indicate that the American species of Anophelines may occur in brackish water rather frequently.

During the summer of 1918, while in charge of a malarial mosquito survey of the zone around Camp Abraham Eustis, Lee Hall, Va., the writer secured several imagoes of *Anopheles quadrimaculatus* and *Anopheles punctipennis* from larvæ taken in brackish water. Later, (1919) a single imago of *A. quadrimaculatus* developed from a collection taken in a brackish pond near Hampton, Va.

On August 21, 1918, in company with Mr. T. B. Hayne, a sanitary inspector in the U. S. P. H. S., the writer was surveying the draws leading off one of the tributaries to Skiff's Creek, near Camp Eustis, when a large draw was encountered on which great mats of algæ (*Spirogyra* and *Œdogonium*) were floating. Such algal mats ordinarily afford protection to mosquito larvæ and it was therefore not surprising that we secured two pupæ and several larvæ of the second and third moults of *Anopheles*. Since the water was slightly brackish, the expectation was that the imagoes would be those of *Anopheles crucians*. During the night, however, two females of the species *A. quadrimaculatus* emerged. On the next day a second trip was made to the same draw and temperature and specific gravity readings were taken, a number of larvæ of all ages being secured. The temperature of the water supporting the algal mats was 27° C. and the specific gravity was 1.0048. From the second collection three females of the species *A. quadrimaculatus* emerged and with them two females of the species *A. punctipennis*.

The source of the brackish water was from tidal flow and the tributary from which the draw led, had a temperature of 25° C. and a specific gravity of 1.0058. The seepage was not great. In this case there is no question that the eggs of *Anopheles* furnished larvæ which were able to resist a quite considerable salinity. Except for the presence of salts, the environment was one ordinarily exceedingly likely to furnish malarial mosquitoes.

During the summer of 1919, while the writer was making a survey of territory in the vicinity of Newport News, Va., much of which had been under the control of our sanitary engineers, a collection was made from a pond between Hampton and Newport News, which had been recently cut off by a dike from the tidal water of a large creek. The specific gravity of the pond water was 1.005 while that of the tidal creek was 1.015. One imago of *Anopheles quadrimaculatus* developed from this collection.

It is quite evident from the cases here recorded that future control work in connection with Anopheline mosquitoes must include rather careful study of the slightly saline waters. In all probability the adult females of *Anopheles* select their breeding places with more reference to favorable temperature, light and vegetation than with reference to the chemical conditions. Field

[1] Smith, J. B., 1904, Report of the N. J. Ag. Exp. Sta. upon the mosquitoes occurring within the state, their habits, life history, etc.

observations to be recorded elsewhere indicate that this is the case and that many times, eggs were deposited where they were unable to survive.

F. E. CHIDESTER
U. S. PUBLIC HEALTH SERVICE

A PARAFFINE RULER FOR DRAWING CURVES

SINUOUS lines of almost any form can be drawn with the aid of a ruler constructed in the following manner. Points are plotted on a sheet of paper which is then placed on a smooth board and slender nails somewhat larger than pins are driven into the wood at each point. A strip of any flexible material such as whalebone, metal or bristol board is bent around to fit the uprights and held in place by other nails. The edges of the paper are then turned up and melted paraffine poured in to a depth of about a quarter of an inch. When the paraffine is thoroughly hardened the nails are draw out, their spaces filled up by means of a hot metal point and the sheet of solid paraffine broken in two along the strip which is in the form of the line to be drawn.

Such a ruler, of course, must be made for each curve, although for a symmetrical one only one half need be made. This method gives an evenly modulated curvature which can be trimmed if necessary. When several graphs are to be grouped together as many trials as necessary can be made in a short time until a good arrangement of them is drawn.

A practical point of importance is to have the liquid as cool as possible before pouring otherwise it will penetrate the paper and become fastened to the substratum. After a little experience a mold can be made quickly, although it requires some time for the cast to harden. For those who do not have occasion to draw many arcuations a device of this kind produces fairly satisfactory results and takes the place of rather expensive splines.

D. F. JONES
CONNECTICUT AGRICULTURAL EXPERIMENT STATION

THE HANDWRITING ON THE WALLS OF UNIVERSITIES

A CORRESPONDENT sends us the following extract from Dr. Geoffrey Martin's popular exposition of "Modern Chemistry and its Wonders" (1915), suggesting that as it applies very largely to American universities also, it may be advisable to reprint it in SCIENCE.

The color industry started in England some fifty years ago, flourished immensely for twenty years and then passed away to Germany, where now gigantic factories control the world's markets.

This loss of supremacy in a world-industry is a fact to make Englishmen sad and thoughtful, and those who have lived, as I have lived, in Germany, and have seen her numerous universities and great technical schools filled with eager students, know perfectly well the reason of this disaster. It is not so much the fault of our practical men—who in energy and judgment and general sagacity are, despite all critics, splendid, full of bold enterprise—as the *fault of our universities,* who have *failed entirely* to get into touch with practical men. Instead of encouraging research—and it was this that laid the basis of the German chemical industry—our university senates have done their level best by legislation to keep our best students off it, or to make it so unprofitable that they prefer to enter some other form of activity. Let me give an instance of how the greatest difficulties are placed by the universities before students attempting to undertake scientific research.

When a student enters an English, and still more a Scottish, university, he sees before him a long series of oncoming examinations. Almost every year he has to pass an examination of increasing difficulty, and the only subjects that count are the stereotyped ones, on which questions may be asked at some forthcoming examination. In an atmosphere of examinations he lives, breathes, and has his being. Finally, after some four to six years' hard work, he passes the B.Sc. examination, which is an examination of considerable difficulty. Now mark, up to this point he has only been learning what others have done before him. At no time has he reached the confines of knowledge, or advanced it in any way. His parents now step in. The father says, "My son, we have given you a good education; for four to six years we have maintained you at a university, and you have shown your ability by passing innumerable examinations of a highly complicated nature, and it is now time that you pass into the great world to earn your own living.'' And so the young man passes out of the university without ever being even introduced to methods of research, or ever touching the boundaries of human knowledge. Being a university man, he hardly ever passes into the great world of affairs, but retires into the badly paid and despised teaching profession—and the worst of it is that *it is our very best students who invariably turn to the sheltered ranks of the teachers. It is only students who fail to pass the Chinese-like wall of examinations who join the business world and enter factory or workshop.* Perhaps, however, the young man, in spite of every discouragement meted out to him by the university authorities by means of suppressive legislation, is resolved to remain on in order to do research work. He works hard for two years longer (for research work is difficult and laborious), and at the end of that time has discovered enough to produce a small paper—nothing more can be expected after two years' work. Then as a rule this single little paper is not considered sufficient by the university authorities to merit the highest academic recognition, and so he leaves the university with no reward for his extra work. The highest academic honors involving recognition of research work are thus in this country confined to one class of men—namely, to university teachers, who remain on in the laboratories working out problems in science often for years; and the business world, *where the highest inventive and practical ability is really needed,* never or very seldom receives men trained in methods of research. The heads of factories or workshops, and even the directors of huge industrial undertakings, have never been introduced themselves either to the spirit or practise of research, and so are entirely out of sympathy with it. In Germany, however, a different system prevails, and it *pays* a student to remain on in order to undertake research, as it helps him afterwards in obtaining a good position in the industrial world. Such men gradually rise to the top, become directors of firms, and hence a sympathetic view of scientific work has become a characteristic of the German industrial world. It is all a matter of university legislation, and in Great Britain it is hopeless for the average student to attempt to obtain high academic honors involving research, and so he does not try. If any research work is done in this country research students must be *paid* to do it, the payment taking the form of research scholarships! In Germany a celebrated professor can have as many helping hands as he desires to carry on his investigations, his students forming willing and unpaid assistants, who afterwards pass out into the industrial world, carrying methods of research and influence there also. Here, however, students in any numbers can not be got to undertake or assist research going on in the university, for no good of it will come to them. There is nothing fundamentally different between the natures of German and English students. The difference in the enthusiasm for research, however, is that the legislations of the German and English universities are different, so that in Germany research work helps a student in getting a diploma, and so his living, whereas in this country it is of no practical advantage for a student to undertake research work.

SPECIAL ARTICLES

TWO DESTRUCTIVE RUSTS READY TO INVADE THE UNITED STATES[1]

The application of the adage, "an ounce of prevention is better than a pound of cure," to the spread of crop pests has now became an established procedure for the United States through the activities of the Federal Horticultural Board. One of the difficult factors in securing success is learning about pests before they have been introduced or have attracted much attention. The hollyhock rust did not seem important in the mountainous regions of Chili, but it spread over all the world between 1869 and 1886, reaching the United States last, doubtless due to our "splendid isolation" from South America in transportation facilities. The Colorado potato beetle, as another instance, had to leave its native home and food plants to become a recognized menace to crops. It seems worth while, therefore, to call attention to two rust fungi that seem to possess the possibilities of great harm, but which have not yet invaded the United States proper.

The peanut crop is a large and growing industry of the southern states. There is a rust of peanuts widely distributed in South America, and becoming common in the West India Islands. It is usually designated as

[1] Presented to the American Phytopathological Society at the St. Louis meeting, January 1, 1920.

Uredo Arachidis, although a single collection from Paraguay would indicate that it should be called *Puccinia Arachidis.* It has been known to mycologists since 1884, but only very recently has it attracted attention of the cultivator. Specimens received by the writer from W. Robson, of Montserrat, British West Indies, show every leaf covered with the abundant brownish-yellow powder of the fungus. This was in September, 1916. Mr. Robson reports that some seasons it is a serious menace to the peanut crop in that island. Experiments for its control with Bordeaux mixture did not prove promising.

The life cycle of the rust has not been worked out, but as in the case of the chrysanthemum rust the cultivator will meet only with the uredinial stage, for only one kind of spore is produced on cultivated plants. The rust appears to be working its way northward, having been reported from Porto Rico in 1913, and from Cuba in 1915. It has not yet been reported from any part of the United States proper.

The second rust, to which attention should be called, is one on potatoes and tomatoes (*Puccinia Pittieriana*). Little is yet known about it. It was collected by H. Pittier on the wild potato in 1903 and again in 1904 on the slopes of the volcano Irazú in Costa Rica, at an altitude of about 10,000 feet, and was found again in the same region by E. W. D. Holway in 1916. It is mentioned in Pittier's "Plantas Usuales de Costa Rica" under the name *Uredo Pittieri.* More recently specimens have been examined by the writer sent by A. Pachano from Ambato, Ecuador, where it was found in 1918 in the gardens of the Quinta Normal on both potatoes and tomatoes.

For this rust only one kind of spore, the teliospore, is produced in the life-cycle, and these spores germinate at once upon reaching maturity, requiring no period of rest. The habit of the fungus and its mode of distribution are essentially those of the hollyhock rust. In gross appearance, as well as in other characters, it is very similar to the common rust on cocklebur.

The two rusts, to which attention is particularly called, have not yet demonstrated their full capacity for harm, but from their appearance, and from what we know of the introduction and behavior of similar rusts that are highly destructive, there seems little doubt that if once established in a region where suitable crops are extensively grown, they will prove most unwelcome to the cultivator.

J. C. ARTHUR

PURDUE UNIVERSITY,
LAFAYETTE, IND.

THE FIXATION OF FREE NITROGEN BY GREEN PLANTS

IN spite of a considerable amount of negative evidence, the question of the ability of chlorophyll-containing plants to utilize the uncombined nitrogen of the air is still an open one. A large number of experiments with lower forms, especially the grass-green algæ, tend to disclaim any such ability and it has come to be very generally accepted that members of the Chlorophyceæ are not able to use free nitrogen. However, the number of species which have been investigated is small and the culture methods employed have not always been those which are most favorable for the best growth of these organisms. Accordingly experiments were begun in this laboratory a few years ago for the purpose of extending our knowledge over a larger number of species, under culture conditions which would insure a rapid and vigorous growth. Some of the results of these experiments are presented in this brief preliminary note and a more detailed account will appear elsewhere within a few months.

Seven species of grass-green algæ (Chlorophyceæ) were used in the experiments. With the exception of one (*Protococcus* sp.), all were isolated from soil and all species were used in pure culture, understanding by this term a single species free from all other organisms. The cultures were grown in 500 c.c. Kjeldahl flasks on approximately 150 gr. of accurately weighed mineral nutrient agar. Since previous experiments have shown that these forms will not grow in the complete absence of combined nitrogen, a definite amount of combined nitrogen was supplied in the medium. The full nutrient solution employed contained 0.5 gr. NH_4NO_3 per liter and in the various series this source of nitrogen was replaced by $(NH_4)_2SO_4$, $Ca(NO_3)_2$, asparagine, glycocoll, and urea, the other constituents of the solution remaining unchanged. In all the culture media nitrogen as such was present in approximately equal quantities and each nitrogen source was set up in duplicate series, with and without 1 per cent. glucose. NH_4NO_3, $Ca(NO_3)_2$, and $(NH_4)_2SO_4$ were also used in the presence of mannite. The culture flasks were arranged in series according to the medium and connected by glass and rubber tubing for aeration with ammonia-free air. Three flasks of each series remained uninoculated as checks and two or three flasks in each series were inoculated with the same organism.

At the end of a growing period of from five to seven months the cultures were analyzed for total nitrogen. The Gunning-Kjeldahl method was used for media free from nitrates and where nitrates were present the Förster modification was employed. The average of the determinations of the three checks of a series was taken as the nitrogen content of that medium per unit weight, and any increase in total nitrogen in the culture flasks of that series was regarded as "free nitrogen fixation." In the urea, glycocoll, asparagine, and $(NH_4)_2SO_4$ series no marked increase or decrease occurred either in the presence or absence of glucose or mannite. Marked increases were found, however, in both NH_4NO_3 and $Ca(NO_3)_2$ media in the presence of glucose, the amount of fixation ranging from 6 to 10 mg. per culture in the 1917–18 experiments and from 4 to 13 mg. in the 1919 experiments. Since the initial nitrogen content of the medium was but 22 or 23 mg. per culture, as shown by the checks, this fixation represents an increase in total nitrogen ranging from 17 to 55 per cent. Where mannite replaced glucose in the nitrate media, there was no indication of fixation; and in the absence of both glucose and mannite, there were only slight increases over the checks. Fixation was not confined to any one species, apparently all seven species showing ability to use free nitrogen. The amount of fixation, however, varied somewhat with the different species and seemed to be related to the intensity of growth.

One species of the 1919 experiment exhibited what is apparently a "denitrification" when grown on nitrate media in the presence of mannite. The total nitrogen content of these flasks was from 2 to 9 mg. below that of the checks. However, the same species in the presence of glucose increased the total nitrogen content of the culture. There was also a slight indication of denitrification with this species on nitrate media in the absence of both glucose and mannite.

F. B. Wann

Department of Botany,
N. Y. State College of Agriculture

AMERICAN PHYSIOLOGICAL SOCIETY

REPORT OF THE THIRTY-SECOND ANNUAL MEETING

The American Physiological Society held its thirty-second annual session during the holidays at Cincinnati, Ohio. The scientific and business sessions were called at the school of medicine of the University of Cincinnati. Six half-day sessions were held on December 29, 30 and 31, 1919, for the reading and discussion of scientific papers. In the two business sessions a number of important measures were considered and voted, the most notable of which was the establishment of a new journal for the publication of periodical reviews of physiological progress in subjects of dominant scientific interest.

The important business acts of the council and of the society at the several sessions during the meeting are here enumerated:

1. The annual assessment was fixed at $1.00 for the year 1920.

2. A grant of $125 was made in aid of the publication of the journal, *Physiological Abstracts,* edited by the English Physiological Society in which the American Physiological Society is a collaborator.

3. Professor Donald R. Hooker, of Johns Hopkins University, was appointed managing editor of

The American Journal of Physiology for the year 1920. The society passed a vote of appreciation to Dr. Hooker in recognition of his successful management of the *Journal* since the administration of the *Journal* has been under the control of the society.

4. Professor William H. Howell, of Johns Hopkins University, was nominated as representative of the society on the Medical Division of the National Research Council for the three-year term beginning July 1, 1920.

5. The society at its thirty-first annual meeting at Baltimore, April, 1919, voted approval of a proposition by the council to establish a new journal under the auspices of the society for the publication of reviews of timely topics in the physiological sciences. At the present meeting the perfected plan was announced. It was voted to launch the new journal under the control of the American Physiological Society. A tentative board of seven editors was chosen to represent the biological field of the different societies constituting the American Federation of Biological Societies. Dr. Donald R. Hooker was appointed managing editor for the year 1920, and the sum of $3,000 was set aside from the surplus funds of the *American Journal of Physiology* to guarantee the initial expenses of the new journal. The board of editors announced by the council include four members from the Physiological Society and one each from the Biochemical, Pharmacological and Pathological Societies. The list follows:

Wm. H. Howell, The Physiological Society, Johns Hopkins University.

J. J. R. Macleod, The Physiological Society, University of Toronto.

Frederic S. Lee, The Physiological Society, Columbia University.

Donald R. Hooker, The Physiological Society, Johns Hopkins University.

L. B. Mendel, The Society of Biological Chemists, Yale University.

Reed Hunt, The Society of Pharmacologists and Experimental Therapeutics, Harvard University.

H. Gideon Wells, The Society for Experimental Pathology, University of Chicago.

6. The following new members were nominated by the council and elected by the society at the two business sessions:

Joseph C. Aub, A.B., M.D., instructor in physiology, Harvard Medical School, Boston, Mass.

Francis M. Baldwin, A.B., A.M., Ph.D., associate professor of zoology, Iowa State College, Ames, Iowa.

Stanley R. Benedict, A.B., Ph.D., professor of chemistry, Cornell Medical College, New York City.

Felix Chillingworth, M.D., assistant professor of physiology and pharmacology, Yale University, New Haven, Conn.

Isabelo Conception, M.D., assistant professor of physiology, University of the Philippines, P. I. Care War Department, Insular Bureau, Washington, D. C., for 1920.

Chas. H. O'Donoghue, B.Sc., D.Sc., professor of zoology, University of Manitoba, Winnipeg, Canada.

Nathan B. Eddy, M.D., lecturer in physiology, McGill University, Montreal, Canada.

Andrew C. Ivy, Ph.D., professor in physiology, Loyola University, Chicago, Ill.

Merkel Henry Jacobs, A.B., Ph.D., assistant professor of zoology, University of Pennsylvania, Philadelphia, Pa.

Theophile K. Kruse, A.B., A.M., Ph.D., assistant professor of pharmacology, University of Pittsburgh, Pa.

Spencer Melvin, M.D., professor of physiology, Queen's University, Kingston, Ontario, Canada.

Walter R. Miles, A.B., A.M., Ph.D., research psychologist, Nutrition Laboratory, Carnegie Institution, Boston, Mass.

Lillian Mary Moore, B.S., M.S., Ph.D., instructor in physiology, University of California, Berkeley, Calif.

Andrew Theodore Rasmussen, A.B., Ph.D., associate professor of neurology, University of Minnesota, Minneapolis, Minn.

John Tait, M.D., D.Sc., professor of physiology, McGill University, Montreal, Canada.

Geo. A. Talbert, B.S., assistant in physiology, University of Chicago, Chicago, Ill.

Homer Wheelon, A.B., M.S., M.D., assistant professor of physiology, St. Louis University School of Medicine, St. Louis, Mo.

7. The officers elected by the society for the year 1920 are:

President, Warren P. Lombard, University of Michigan.

Secretary, Charles W. Greene, University of Missouri.

Treasurer, Joseph Erlanger, Washington University.

Councillor for the 1920–23 term, Carl J. Wiggers, Western Reserve University.

8. Article IX. of the Constitution was amended to enable the society to control and publish jour-

nals other than the *American Journal of Physiology*. The amended article reads:

Article 1, Section 1. The official organs of the society shall be the *American Journal of Physiology* and such other journals as the society shall from time to time establish. These the society shall own and manage.

Section 2. The management of the journals shall be vested in the council. The council shall make a full report to the society at each annual meeting on the financial condition and the publication policy of the journals.

9. The following resolutions were passed:

(1) That this society concurs in the opinion that the present multiplicity and duplication of work in respect to abstracts of the literature in its field is unsatisfactory.

That we are in general sympathy with the effort along the general lines suggested by the Concilium Bibliographicum to simplify and coordinate such work on an international basis in respect to lists of titles and brief abstracts, while retaining to each national society complete freedom in respect to publications in the fields of review and critique.

(2) That the Council of the American Physiological Society extends its very great appreciation of the hospitality of the Daniel Drake Society which contributed so largely to the pleasures and convenience of the members at the council meetings.

(3) That the cordial thanks of this society be extended to the authorities of the University of Toronto and to its local committee for their invitation to meet at Toronto at the present time and for their preparations for such meeting, which unforeseen circumstances prevented; that it is the hope of this society that another and early opportunity may be given to meet at the University of Toronto.

(4) That the American Physiological Society hereby expresses its very great appreciation of the courtesy and hospitality extended to its members and guests by the officers and faculty, and particularly by the local committee, of the college of medicine of the University of Cincinnati which have gone far to make this meeting an unusual success.

SCIENTIFIC PAPERS

The society met in joint session with the American Federation of Biological Societies for two of its six scientific meetings and one very profitable demonstration session was held on the second afternoon. The program which follows contains 58 papers that were read and discussed beside 19 papers announced by title only.

SCIENTIFIC PAPERS

Observations on the physical efficiency tests used by the Royal Air Force of England: Edward C. Schneider, Wesleyan University.

Observations on the distribution of glycogen in some invertebrates and fishes: J. J. R. Macleod, L. Kilborn and R. S. Lang, University of Toronto.

Further observations on ether hyperglycemia in the absence of the adrenals: G. N. Stewart and J. M. Rogoff, Lakeside Hospital, Cleveland.

Further observations on the relation of the central nervous system to epinephrin secretion: G. N. Stewart and J. M. Rogoff.

The etiology of ricketts: E. V. McCollum.

The rôle of fat soluble vitamine in human nutrition. Its suggested relationships to rickets: A. F. Hess.

Preliminary observations on the relation of bacteria to experimental scurvy in guinea-pigs: M. H. Givens and G. L. Hoffman, Western Pennsylvania Hospital, Pittsburgh.

Further studies on the use of water soluble B in the treatment of infant malnutrition: Walter H. Eddy, New York City.

Is fibrinogen formed in the liver? A. P. Mathews, University of Cincinnati.

Anaphylactoid phenomena: Paul J. Hanzlik and Howard T. Karsner, Western Reserve University.

Further studies in experimental excitation of infections of the throat by chilling the body surface: Stuart Mudd, Samuel B. Grant and Alfred Goldman, Harvard Medical School.

Some observations on dark adaptation of the peripheral retina: M. Dresbach, John E. Sutton, Jr. and S. R. Burlage, Albany Medical College.

Paradoxical pupil dilation following lesions of afferent paths: Joseph Bryne, Fordham University.

The interpretation of certain muscle phenomena in terms of "all or none": T. K. T. Krause, University of Pittsburgh.

Heat production in the Cardia Sphincter of the turtle: C. D. Snyder, Johns Hopkins Medical School.

Some remarks on catalase: Thos. C. Burnett, University of California.

Adrenal secretion in pain and asphyxia: W. B. Cannon, Harvard Medical School.

The cardio-respiratory metabolic function: R. G. Pearce, Akron, Ohio.

Character of the sympathetic innervation of the retractor muscle in the dog: C. W. Edmunds, University of Michigan.

A comparison of the physiological effects of Alpha and Beta rays: Alfred C. Redfield, University of Toronto.

On the origin of the muscular tremors, clonic and tonic spasms, in parathyroid tetany: A. B. LUCKHARDT, M. SHERMAN and W. B. SERBIN, University of Chicago.

The rôle of catalase in the organism: W. E. BURGE, University of Illinois.

Significance of concentration as applied to substances in the blood plasma: R. T. WOODYATT.

Alkaloid diffusion in physical and biological systems: G. H. A. CLOWES and A. L. WALTERS.

The adjustment to the barometer of the hemato-respiratory functions in man: YANDELL HENDERSON and H. W. HAGGARD.

A convenient permanent urease preparation: OTTO FOLIN.

Relation of anesthesia to respiration: SHIRO TASHIRO.

New methods for the study of blood pressure in man and in the dog. a. Continuous systolic tracings in man. b. Indirect determination of blood pressure in the unanesthetized dog: ALFRED C. KOLLS, Washington University, St. Louis.

Determination of the circulation time in man and animals: A. S. LOEVENHART, BENJ. H. SCHLOMOVITZ and E. G. SEYBOLD, University of Wisconsin.

The critical level as blood pressure falls: WALTER B. CANNON and MCKEEN CATTELL, Harvard Medical School.

Basal metabolism during traumatic shock: JOSEPH C. AUB and DONALD CUNNINGHAM, Harvard Medical School.

The effects of some anesthetics in shock: MCKEEN CATTELL, Harvard Medical School.

Acidosis as a criterion of shock: B. RAYMOND, University of Chicago.

The blood in clinical shock: G. C. WEIL and C. C. GUTHRIE, University of Pittsburgh.

The rôle of the vagi and the splanchnic nerves in the genesis of shock from abdominal operations: A. C. IVY, Loyola University.

Microdissection studies on the fertilization of the star fish egg: ROBERT CHAMBERS, Cornell University Medical College.

Further studies on the action of Acacia and associated colloids: T. K. T. KRUSE, University of Pittsburgh.

Studies on the responses of the circulation to low oxygen tension. II. The electrocardiogram during extreme oxygen want: CHAS. W. GREENE and NEWTON C. GILBERT, Medical Research Laboratory, Air Service.

The influence of low oxygen tensions on venous blood pressure in man: EDWARD C. SCHNEIDER, Wesleyan University.

Observations on the pathological physiology of chronic pulmonary emphysema: R. W. SCOTT, Western Reserve Medical School.

Electron tube amplification with the string galvanometer: ALEXANDER FORBES and CATHERINE THACHER, Harvard Medical School.

Observations on the capillary blood pressure in man with demonstration of apparatus: D. R. HOOKER and C. S. DANZER, Johns Hopkins Medical School.

Some cardiac and vascular reactions to small hemorrhages: WALTER J. MEEK and J. A. E. EYSTER, University of Wisconsin.

Time relations of the heart cycle as shown by the carotid pulse: W. P. LOMBARD and OTIS M. COPE, University of Michigan.

Further experiments on the effect of warming and cooling the sino-auricular node in the mammalian heart: BENJ. H. SCHLOMOVITZ, University of Wisconsin.

Studies on catalase: R. J. SEYMOUR, Ohio State University, Columbus.

Further results on the physics of sphygmography: A. M. BLEILE and CLYDE BROOKS, Ohio State University.

Effects of breathing dry and moist air: E. P. LYON and ESTHER GREISHEIMER, University of Minnesota.

Vascular reactions to epinephrine in solutions of various concentrations of hydrogen ions: C. D. SNYDER and W. A. CAMPBELL, JR.

The effect of the subcutaneous injection of adrenalin chloride on blood pressure, pulse rate and the basal metabolic rate in man: WALTER M. BOOTHBY and IRENE SANDIFORD, Mayo Clinic.

Removal of the duodenum: F. C. MANN, The Mayo Clinic.

The experimental production of edema as related to protein deficiency: EMMA KOHMAN, University of Chicago.

Susceptible and resistant phases of the dividing sea-urchin egg when subjected to various lipoid-solvents especially the higher alcohols: F. M. BALDWIN, Iowa State College.

Effect of glutamine production on urinary nitrogen: CARL P. SHERWIN, M. WOLF and W. WOLF, Fordham University.

The excretion of a red pigment in the sweat by man: M. H. GIVENS, V. L. ANDREWS and H. B. MCCLUGAGE, Western Pennsylvania Hospital, Pittsburgh, Pa.

Urochrome excretion as influenced by diet: Carl Pelkan, University of California.

The chemistry of gar roe: Chas. W. Greene and Erwin E. Nelson, University of Missouri.

On the protection against eosin hemolysis afforded by certain substances: C. L. A. Schmidt and C. F. Norman.

PAPERS READ BY TITLE

The regeneration of the vagus nerve in the dog: F. T. Rogers, Marquette School of Medicine.

The action of prostatic extracts on the tonicity and contractions of isolated genitourinary organs: D. I. Macht and S. Matsumoto, Johns Hopkins Medical School.

Nervous regulation of respiration: F. H. Scott and C. C. Gault, University of Minnesota.

Recent developments in the field of industrial hygiene: A. H. Ryan, Waterbury, Conn.

The influence of internal secretions on blood pressure and the formation of bile: Ardrey W. Downs, McGill University.

The physiology of reproduction in the opossum: Carl Hartman, University of Texas.

A study of the effect of massage and electrical treatment on denervated mammalian muscle: F. A. Hartman and W. E. Blatz, University of Buffalo.

Function of the Coxal plates of amphipoda: John Tait, University of Toronto.

Keratin: John Tait, University of Toronto.

The effect of pituitary extracts on the absorption of water from the intestine: M. H. Rees, University of South Dakota.

Observations on the thyroid: Walter B. Cannon and Phillip E. Smith, Harvard Medical School.

The effect of pituitary feeding on egg production in chickens: Sutherland Simpson, Cornell University.

The theory of physiological overstrain of the pancreas as the cause of diabetes: A. J. Carlson and V. W. Jensen, University of Chicago.

The nature of the light producing reaction of luminous animals: E. Newton Harvey.

Observations on volume-flow of blood: Robert Gesell, University of California.

Blood flow measurements through the hands: N. B. Taylor, University of Toronto.

On the reality of nerve energy: D. Fraser Harris, University of Toronto.

The respiratory quotient and its uncertainties: J. A. Fries, State College, Pennsylvania.

The subcortical tract for masticatory rhythm: F. R. Miller, Western University.

DEMONSTRATIONS

Apparatus for gas analysis, etc.: J. J. R. Macleod, University of Toronto.

A method for determining the rate of oxygen absorption by blood: W. S. McEllroy and C. C. Guthrie, University of Pittsburgh.

A non-leakable and quantitative volume change recorder: Robert Gesell, University of California.

Foods and food substitutes used in western Russia, and in parts of Poland during the winter 1918–1919: A. J. Carlson, University of Chicago.

A convenient stop cock needle cannula: Paul J. Hanzlik, Western Reserve University.

Demonstration of method for determining the circulation time: A. S. Loevenhart, Benj. H. Schlomovitz and E. G. Seybold, University of Wisconsin.

Blood pressure apparatus. (*a*) For continuous systolic tracing in man; (*b*) for indirect determinations of pressure in the unanesthetized dog: Alfred C. Kolls, Washington University, St. Louis.

The scientific papers called forth spirited discussion, especially the papers on the secretion of epinephrin by Drs. Stewart and Rogoff, on the one hand, and Dr. Cannon, on the other; and the papers by Dr. McCollum and by Dr. Hess, on the problem of nutritional diseases.

The program, as a whole, was very strong and general satisfaction was expressed at the evidence of promptness with which American physiologists have returned to their scientific investigations.

The executive committee of the federation voted, the Council of the Physiological Society concurring, to hold the next annual meeting at Chicago, in conjunction with the American Association for the Advancement of Science.

Chas. W. Greene,
Secretary

SCIENCE

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CONTENTS

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EINSTEIN'S LAW OF GRAVITATION[1]

The by-laws of our society make it one of the duties of its president to deliver an address before its members. This fact renders it necessary for the president to select a subject; and this year the selection is to a certain degree forced by the public press. When a daily newspaper considers Einstein's work on gravitation a topic of sufficiently general interest to devote to it valuable space and cable funds, surely here is justification for my selection of this as the subject of my presidential address.

Einstein's original memoirs upon gravitation appeared in the years 1916 to 1918; and there are two excellent papers in English expounding and explaining his method, one by Professor deSitter, of Leyden, and one by Professor Eddington, of Cambridge. While Einstein's work may be known to many of you either in its original form or in one of the two papers mentioned, I fear that the attention of most of us was first directed seriously to the matter by the articles in the newspapers to which I have referred. I confess that I was one of those who had postponed any serious study of the subject, until its immense importance was borne in upon me by the results of the recent eclipse expedition. I have all the enthusiasm of the discoverer of a new land, and feel compelled to describe to you what I have learned.

Albert Einstein, although now a resident of Berlin and holder of a research professorship of the Kaiser Wilhelm Institute, is legally a Swiss. He is forty-five years old and was for some time a professor in the Zurich Technical School, and later in the University of Prague. He is a man of liberal tendencies, and apparently one whom any of

[1] Presidential address delivered at the St. Louis meeting of the Physical Society, December 30, 1919.

us would be glad to welcome for personal reasons in our international meetings of the future. He protested against the famous manifesto of the German professors in 1914 and was one of the eager supporters of the German Republic when it arose from the wreck of the Empire.

But, in presenting the subject of Einstein's study of the law of gravitation, I must begin many years ago. In the treatment of Maxwell's equations of the electromagnetic field, several investigators realized the importance of deducing the form of the equations when applied to a system moving with a uniform velocity. One object of such an investigation would be to determine such a set of transformation formulæ as would leave the mathematical form of the equations unaltered. The necessary relations between the new space-coordinates, those applying to the moving system, and the original set were of course obvious; and elementary methods led to the deduction of a new variable which should replace the time coordinate. This step was taken by Lorentz and also, I believe, by Larmor and by Voigt. The mathematical deductions and applications in the hands of these men were extremely beautiful, and are probably well known to you all.

Lorentz' paper on this subject appeared in the Proceedings of the Amsterdam Academy in 1904. In the following year there was published in the *Annalen der Physik* a paper by Einstein, written without any knowledge of the work of Lorentz, in which he arrived at the same transformation equations as did the latter, but with an entirely different and fundamentally new interpretation. Einstein called attention in his paper to the lack of definiteness in the concepts of time and space, as ordinarily stated and used. He analyzed clearly the definitions and postulates which were necessary before one could speak with exactness of a length or of an interval of time. He disposed forever of the propriety of speaking of the "true" length of a rod or of the "true" duration of time, showing, in fact, that the numerical values which we attach to lengths or intervals of time depend upon the definitions and postulates which we adopt. The words "absolute" space or time intervals are devoid of meaning. As an illustration of what is meant Einstein discussed two possible ways of measuring the length of a rod when it is moving in the direction of its own length with a uniform velocity, that is, after having adopted a scale of length, two ways of assigning a number to the length of the rod concerned. One method is to imagine the observer moving with the rod, applying along its length the measuring scale, and reading off the positions of the ends of the rod. Another method would be to have two observers at rest on the body with reference to which the rod has the uniform velocity, so stationed along the line of motion of the rod that as the rod moves past them they can note simultaneously on a stationary measuring scale the positions of the two ends of the rod. Einstein showed that, accepting two postulates which need no defense at this time, the two methods of measurements would lead to different numerical values, and, further, that the divergence of the two results would increase as the velocity of the rod was increased. In assigning a number, therefore, to the length of a moving rod, one must make a choice of the method to be used in measuring it. Obviously the preferable method is to agree that the observer shall move with the rod, carrying his measuring instrument with him. This disposes of the problem of measuring space relations. The observed fact that, if we measure the length of the rod on different days, or when the rod is lying in different positions, we always obtain the same value offers no information concerning the "real" length of the rod. It may have changed, or it may not. It must always be remembered that measurement of the length of a rod is simply a process of comparison between it and an arbitrary standard, *e. g.*, a meter-rod or yard-stick. In regard to the problem of assigning numbers to intervals of time, it must be borne in mind that, strictly speaking, we do not "measure" such intervals, *i. e.*, that we do not select a unit interval of time and find how many times it is contained in the interval in question. (Similarly, we do not "measure" the pitch of a sound or the temperature of a room.) Our practical instruments for assigning numbers to time-intervals depend in the main upon our agreeing to believe that a pendulum swings in a perfectly uniform manner, each vibration taking the same time as the next one. Of course we can not *prove* that this is true, it is, strictly speaking, a definition of what we mean by equal intervals of time; and it is not a particularly good definition at that. Its limitations are sufficiently obvious. The best way to proceed is to consider the concept of uniform velocity, and then, using the idea of some entity having such a uniform velocity, to define equal intervals of time as such intervals as are required for the entity to traverse equal lengths. These last we have already defined. What is required in addition is to adopt some moving entity as giving our definition of uniform velocity. Considering our known universe it is self-evident that we should choose in our definition of uniform velocity the velocity of light, since this selection could be made by an observer anywhere in our universe. Having agreed then to illustrate by the words "uniform velocity" that of light, our definition of equal intervals of time is complete. This implies, of course, that there is no uncertainty on our part as to the fact that the velocity of light always has the same value at any one point in the universe to any observer, quite regardless of the source of light. In other words, the postulate that this is true underlies our definition. Following this method Einstein developed a system of measuring both space and time intervals. As a matter of fact his system is identically that which we use in daily life with reference to events here on the earth. He further showed that if a man were to measure the length of a rod, for instance, on the earth and then were able to carry the rod and his measuring apparatus to Mars, the sun, or to Arcturus he would obtain the same numerical value for the length in all places and at all times. This doesn't mean that any statement is implied as to whether the length of the rod has remained unchanged or not; such words do not have any meaning—remember that we can not speak of true length. It is thus clear that an observer living on the earth would have a definite system of units in terms of which to express space and time intervals, *i. e.*, he would have a definite system of space coordinates (x, y, z) and a definite time coordinate (t); and similarly an observer living on Mars would have his system of coordinates (x', y', z', t'). Provided that one observer has a definite uniform velocity with reference to the other, it is a comparatively simple matter to deduce the mathematical relations between the two sets of coordinates. When Einstein did this, he arrived at the same transformation formulæ as those used by Lorentz in his development of Maxwell's equations. The latter had shown that, using these formulæ, the form of the laws for all electromagnetic phenomena maintained the same form; so Einstein's method proves that using his system of measurement an observer, anywhere in the universe, would as the result of his own investigation of electromagnetic phenomena arrive at the same mathematical statement of them as any other observer, provided only that the relative velocity of the two observers was uniform.

Einstein discussed many other most important questions at this time; but it is not necessary to refer to them in connection with the present subject. So far as this is concerned, the next important step to note is that taken in the famous address of Minkowski, in 1908, on the subject of "Space and Time." It would be difficult to overstate the importance of the concepts advanced by Minkowski. They marked the begining of a new period in the philosophy of physics. I shall not attempt to explain his ideas in detail, but shall confine myself to a few general statements. His point of view and his line of development of the theme are absolutely different from those of Lorentz or of Einstein; but in the end he makes use of the same transformation formulæ. His great contribution consists in giving us a new geometrical picture of their meaning. It is scarcely fair to call Minkowski's development a picture; for to us a picture can never have more than three dimensions, our senses limit us; while his picture calls for perception of four dimensions. It is this fact that renders any even semi-popular discussion of Minkowski's work so impossible. We can all see that for us to describe any event a knowledge of four coordinates is necessary, three for the space specification and one for the time. A complete picture could be given then by a point in four dimensions. All four coordinates are necessary: we never observe an event except at a certain time, and we never observe an instant of time except with reference to space. Discussing the laws of electromagnetic phenomena, Minkowski showed how in a space of four dimensions, by a suitable definition of axes, the mathematical transformation of Lorentz and Einstein could be described by a rotation of the set of axes. We are all accustomed to a rotation of our ordinary cartesian set of axes describing the position of a point. We ordinarily choose our axes at any location on the earth as follows: one vertical, one east and west, one north and south. So if we move from any one laboratory to another, we change our axes; they are always orthogonal, but in moving from place to place there is a rotation. Similarly, Minkowski showed that if we choose four orthogonal axes at any point on the earth, according to his method, to represent a space-time point using the method of measuring space and time intervals as outlined by Einstein; and, if an observer on Arcturus used a similar set of axes and the method of measurement which he naturally would, the set of axes of the latter could be obtained from those of the observer on the earth by a pure rotation (and naturally a transfer of the origin). This is a beautiful geometrical result. To complete my statement of the method, I must add that instead of using as his fourth axis one along which numerical values of time are laid off, Minkowski defined his fourth coordinate as the product of time and the imaginary constant, the square root of minus one. This introduction of imaginary quantities might be expected, possibly, to introduce difficulties; but, in reality, it is the very essence of the simplicity of the geometrical description just given of the rotation of the sets of axes. It thus appears that different observers situated at different points in the universe would each have their own set of axes, all different, yet all connected by the fact that any one can be rotated so as to coincide with any other. This means that there is no one direction in the four dimensional space that corresponds to time for all observers. Just as with reference to the earth there is no direction which can be called vertical for all observers living on the earth. In the sense of an *absolute* meaning the words "up and down," "before and after," "sooner or later," are entirely meaningless.

This concept of Minkowski's may be made clearer, perhaps, by the following process of thought. If we take a section through our three dimensional space, we have a plane, *i. e.*, a two-dimensional space. Similarly, if a section is made through a four-dimensional space, one of three dimensions is obtained. Thus, for an observer on the earth a definite section of Minkowski's four dimensional space will give us our ordinary three-dimensional one; so that this section will, as it were, break up Minkowski's space into our space and give us our ordinary time. Similarly, a different section would have to be used for the observer on Arcturus; but by a suitable selection he would get his own familiar three-dimensional space and his own time. Thus the space defined by Minkowski is completely isotropic in reference to measured lengths and times, there is absolutely no difference between any two directions in an absolute sense; for any particular observer, of course, a particular section will cause the space to fall apart so as to suit his habits of measurement; any section, however, taken at random will do the same thing for some observer somewhere. From another point of view, that of Lorentz and Einstein, it is obvious that, since this four dimensional space is isotropic, the expression of the laws of electromagnetic phenomena take identical mathematical forms when expressed by any observer.

The question of course must be raised as to what can be said in regard to phenomena which so far as we know do not have an electromagnetic origin. In particular what can be done with respect to gravitational phenomena? Before, however, showing how this problem was attacked by Einstein; and the fact that the subject of my address is Einstein's work on gravitation shows that ultimately I shall explain this, I must emphasize another feature of Minkowski's geometry. To describe the space-time characteristics of any event a point, defined by its four coordinates, is sufficient; so, if one observes the life-history of any entity, *e. g.*, a particle of matter, a light-wave, etc., he observes a sequence of points in the space-time continuum; that is, the life-history of any entity is described fully by a line in this space. Such a line was called by Minkowski a "world-line." Further, from a different point of view, all of our observations of nature are in reality observations of coincidences, *e. g.*, if one reads a thermometer, what he does is to note the coincidence of the end of the column of mercury with a certain scale division on the thermometer tube. In other words, thinking of the world-line of the end of the mercury column and the world-line of the scale division, what we have observed was the intersection or crossing of these lines. In a similar manner any observation may be analyzed; and remembering that light rays, a point on the retina of the eye, etc., all have their world lines, it will be recognized that it is a perfectly accurate statement to say that every observation is the perception of the intersection of world-lines. Further, since all we know of a world-line is the result of observations, it is evident that we do not know a world-line as a continuous series of points, but simply as a series of discontinuous points, each point being where the particular world-line in question is crossed by another world-line.

It is clear, moreover, that for the description of a world-line we are not limited to the particular set of four orthogonal axes adopted by Minkowski. We can choose any set of four-dimensional axes we wish. It is further evident that the mathematical expression for the coincidence of two points is absolutely independent of our selection of reference axes. If we change our axes, we will change the coordinates of both points simultaneously, so that the question of axes ceases to be of interest. But our so-called laws of nature are nothing but descriptions in mathematical language of our observations; we observe only coincidences; a sequence of coincidences when put in mathematical terms takes a form which is independent of the selection of reference axes; therefore the mathematical expression of our laws of nature, of every character, must be such that their form does not change if we make a transformation of axes. This is a simple but far-reaching deduction.

There is a geometrical method of picturing the effect of a change of axes of reference, *i. e.*, of a mathematical transformation. To a man in a railway coach the path of a drop of water does not appear vertical, *i. e.*, it is not parallel to the edge of the window; still less so does it appear vertical to a man performing manœvres in an airplane. This means that whereas with reference to axes fixed to the earth the path of the drop is vertical; with reference to other axes, the path is not. Or, stating the conclusion in general language, changing the axes of reference (or effecting a mathematical transformation) in general changes the shape of any line. If one imagines the line forming a part of the space, it is evident that if the space is deformed by compression or expansion the shape of the line is changed, and if sufficient care is taken it is clearly possible, by deforming the space, to make the line take any shape desired, or better stated, any shape specified by the previous change of axes. It is thus possible to picture a mathematical transformation as a deformation of space. Thus I can draw a line on a sheet of paper or of rubber and by bending and stretching the sheet, I can make the line assume a great variety of shapes; each of these new shapes is a picture of a suitable transformation.

Now, consider world-lines in our four dimensional space. The complete record of all our knowledge is a series of sequences of intersections of such lines. By analogy I can draw in ordinary space a great number of intersecting lines on a sheet of rubber; I can then bend and deform the sheet to please myself; by so doing I do not introduce any new intersections nor do I alter in the least the sequence of intersections. So in the space of our world-lines, the space may be deformed in any imaginable manner without introducing any new intersections or changing the sequence of the existing intersections. It is this sequence which gives us the mathematical expression of our so-called experimental laws; a deformation of our space is equivalent mathematically to a transformation of axes, consequently we see why it is that the form of our laws must be the same when referred to any and all sets of axes, that is, must remain unaltered by any mathematical transformation.

Now, at last we come to gravitation. We can not imagine any world-line simpler than that of a particle of matter left to itself; we shall therefore call it a "straight" line. Our experience is that two particles of matter attract one another. Expressed in terms of world-lines, this means that, if the world-lines of two isolated particles come near each other, the lines, instead of being straight, will be deflected or bent in towards each other. The world-line of any one particle is therefore deformed; and we have just seen that a deformation is the equivalent of a mathematical transformation. In other words, for any one particle it is possible to replace the effect of a gravitational field at any instant by a mathematical transformation of axes. The statement that this is always possible for any particle at any instant is Einstein's famous "Principle of Equivalence."

Let us rest for a moment, while I call attention to a most interesting coincidence, not to be thought of as an intersection of world-lines. It is said that Newton's thoughts were directed to the observation of gravitational phenomena by an apple falling on his head; from this striking event he passed by natural steps to a consideration of the universality of gravitation. Einstein in describing his mental process in the evolution of his law of gravitation says that his attention was called to a new point of view by discussing his experiences with a man whose fall from a high building he had just witnessed. The man fortunately suffered no serious injuries and assured Einstein that in the course of his fall he had not been conscious in the least of any pull downward on his body. In mathematical language, with reference to axes moving with the man the force of gravity had disappeared. This is a case where by the transfer of the axes from the earth itself to the man, the force of the gravitational field is annulled. The converse change of axes from the falling man to a point on the earth could be considered as introducing the force of gravity into the equations of motion. Another illustration of the introduction into our equations of a force by means of a change of axes is furnished by the ordinary treatment of a body in uniform rotation about an axis. For instance, in the case of a so-called conical pendulum, that is, the motion of a bob suspended from a fixed point by a string, which is so set in motion that the bob describes a horizontal circle and the string therefore describes a circular cone, if we transfer our axes from the earth and have them rotate around the vertical line through the fixed point with the same angular velocity as the bob, it is necessary to introduce into our equations of motion a fictitious "force" called the centrifugal force. No one ever thinks of this force other than as a mathematical quantity introduced into the equations for the sake of simplicity of treatment; no physical meaning is attached to it. Why should there be to any other so-called "force," which, like centrifugal force, is independent of the nature of the matter? Again, here on the earth our sensation of weight is interpreted mathematically by combining expressions for centrifugal force and gravity; we have no distinct sensation for either separately. Why then is there any difference in the essence of the two? Why not consider them both as brought into our equations by the agency of mathematical transformations? This is Einstein's point of view.

Granting, then, the principle of equivalence, we can so choose axes at any point at any instant that the gravitational field will disappear; these axes are therefore of what Eddington calls the "Galilean" type, the simplest possible. Consider, that is, an observer in a box, or compartment, which is falling with the acceleration of the gravitational field at that point. He would not be conscious of the field. If there were a projectile fired off in this compartment, the observer would describe its path as being straight. In this space the infinitesimal interval between two space-time points would then be given by the formula

$$ds^2 = dx^2_1 + dx^2_2 + dx^2_3 + dx^2_4,$$

where ds is the interval and x_1, x_2, x_3, x_4, are coordinates. If we make a mathematical transformation, *i. e.*, use another set of axes, this interval would obviously take the form

$$ds^2 = g_{11}dx^2_1 + g_{22}dx^2_2 + g_{33}dx^2_3 + g_{44}dx^2_4 + 2g_{12}dx_1dx_2 + \text{etc.},$$

where x_1, x_2, x_3 and x_4 are now coordinates referring to the new axes. This relation involves ten coefficients, the coefficients defining the transformation.

But of course a certain dynamical value is also attached to the g's, because by the transfer of our axes from the Galilean type we have made a change which is equivalent to the introduction of a gravitational field; and the g's must specify the field. That is, these g's are the expressions of our experiences, and hence their values can not depend upon the use of any special axes; the values must be the same for all selections. In other words, whatever function of the coordinates any one g is for one set of axes, if other axes are chosen, this g must still be the same function of the new coordinates. There are ten g's defined by differential equations; so we have ten covariant equations. Einstein showed how these g's could be regarded as generalized potentials of the field. Our own experiments and observations upon gravitation have given us a certain knowledge concerning its potential; that is, we know a value for it which must be so near the truth that we can properly call it at least a first approximation. Or, stated differently, if Einstein succeeds in deducing the rigid value for the gravitational potential in any field, it must degenerate to the Newtonian value for the great majority of cases with which we have actual experience. Einstein's method, then, was to investigate the functions (or equations) which would satisfy the mathematical conditions just described. A transformation from the axes used by the observer in the following box may be made so as to introduce into the equations the gravitational field recognized by an observer on the earth near the box; but this, obviously, would not be the general gravitational field, because the field changes as one moves over the surface of the earth. A solution found, therefore, as just indicated, would not be the one sought for the general field; and another must be found which is less stringent than the former but reduces to it as a special case. He found himself at liberty to make a selection from among several possibilities, and for several reasons chose the simplest solution. He then tested this decision by seeing if his formulæ would degenerate to Newton's law for the limiting case of velocities small when compared with that of light, because this condition is satisfied in those cases to which Newton's law applies. His formulæ satisfied this test, and he therefore was able to announce a "law of gravitation," of which Newton's was a special form for a simple case.

To the ordinary scholar the difficulties surmounted by Einstein in his investigations appear stupendous. It is not improbable that the statement which he is alleged to have made to his editor, that only ten men in the world could understand his treatment of the subject, is true. I am fully prepared to believe it, and wish to add that I certainly am not one of the ten. But I can also say that, after a careful and serious study of his papers, I feel confident that there is nothing in them which I can not understand, given the time to become familiar with the special mathematical processes used. The more I work over Einstein's papers, the more impressed I am, not simply by his genius in viewing the problem, but also by his great technical skill.

Following the path outlined, Einstein, as just said, arrived at certain mathematical laws for a gravitational field, laws which reduced to Newton's form in most cases where observations are possible, but which led to different conclusions in a few cases, knowledge concerning which we might obtain by careful observations. I shall mention a few deductions from Einstein's formulæ.

1. If a heavy particle is put at the center of a circle, and, if the length of the circumference and the length of the diameter are measured, it will be found that their ratio is not π (3.14159). In other words the geometrical properties of space in such a gravitational field are not those discussed by Euclid; the space is, then, non-Euclidean. There is no way by which this deduction can be verified, the difference between the predicted ratio and π is too minute for us to hope to make our measurements with sufficient exactness to determine the difference.

2. All the lines in the solar spectrum should with reference to lines obtained by terrestrial sources be displaced slightly towards longer wave-lengths. The amount of displacement predicted for lines in the blue end of the spectrum is about one hundredth of an Angstrom unit, a quantity well within experimental limits. Unfortunately, as far as the testing of this prediction is concerned, there are several physical causes which are also operating to cause displacement of the spectrum-lines; and so at present a decision can not be rendered as to the verification. St. John and other workers at the Mount Wilson Observatory have the question under investigation.

3. According to Newton's law an isolated planet in its motion around a central sun would describe, period after period, the same elliptical orbit; whereas Einstein's laws lead to the prediction that the successive orbits traversed would not be identically the same. Each revolution would start the planet off on an orbit very approximately elliptical, but with the major axis of the ellipse rotated slightly in the plane of the orbit. When calculations were made for the various planets in our solar system, it was found that the only one which was of interest from the standpoint of verification of Einstein's formulæ was Mercury. It has been known for a long time that there was actually such a change as just described in the orbit of Mercury, amounting to 574″ of arc per century; and it has been shown that of this a rotation of 532″ was due to the direct action of other planets, thus leaving an unexplained rotation of 42″ per century. Einstein's formulæ predicted a rotation of 43″, a striking agreement.

4. In accordance with Einstein's formulæ a ray of light passing close to a heavy piece of matter, the sun, for instance, should experience a sensible deflection in towards the sun. This might be expected from "general" considerations. A light ray is, of course, an illustration of energy in motion; energy and mass are generally considered to be identical in the sense that an amount of energy E has the mass E/c^2 where c is the velocity of light; and consequently a ray of light might fall within the province of gravitation and the amount of deflection to be expected could be calculated by the ordinary formula for gravitation. Another point of view is to consider again the observer inside the compartment falling with the acceleration of the gravitational field. To him the path of a projectile and a ray of light would both appear straight; so that, if the projectile had a velocity equal to that of light, it and the light wave would travel side by side. To an observer outside the compartment, *e. g.*, to one on the earth, both would then appear to have the same deflection owing to the sun. But how much would the path of the projectile be bent? What would be the shape of its parabola? One might apply Newton's law; but, according to Einstein's formulæ, Newton's law should be used only for small velocities. In the case of a ray passing close to the sun it was decided that according to Einstein's formula there should be a deflection of 1″.75 whereas Newton's law of gravitation predicted half this amount. Careful plans were made by various astronomers to investigate this question at the solar eclipse last May, and the result announced by Dyson, Eddington and Crommelin, the leaders of astronomy in England, was that there was a de-

flection of 1″.9. Of course the detection of such a minute deflection was an extraordinarily difficult matter, so many corrections had to be applied to the original observations; but the names of the men who record the conclusions are such as to inspire confidence. Certainly any effect of refraction seems to be excluded.

It is thus seen that the formulæ deduced by Einstein have been confirmed in a variety of ways and in a most brilliant manner. In connection with these formulæ one question must arise in the minds of everyone: by what process, where in the course of the mathematical development, does the idea of mass reveal itself? It was not in the equations at the beginning and yet here it is at the end. How does it appear? As a matter of fact it is first seen as a constant of integration in the discussion of the problem of the gravitational field due to a single particle; and the identity of this constant with mass is proved when one compares Einstein's formulæ with Newton's law which is simply its degenerated form. This mass, though, is the mass of which we become aware through our experiences with weight; and Einstein proceeded to prove that this quantity which entered as a constant of integration in his ideally simple problem also obeyed the laws of conservation of mass and conservation of momentum when he investigated the problems of two and more particles. Therefore Einstein deduced from his study of gravitational fields the well-known properties of matter which form the basis of theoretical mechanics. A further logical consequence of Einstein's development is to show that energy has mass, a concept with which every one nowadays is familiar.

The description of Einstein's method which I have given so far is simply the story of one success after another; and it is certainly fair to ask if we have at last reached finality in our investigation of nature, if we have attained to truth. Are there no outstanding difficulties? Is there no possibility of error? Certainly, not until all the predictions made from Einstein's formulæ have been investigated can much be said; and further, it must be seen whether any other lines of argument will lead to the same conclusions. But without waiting for all this there is at least one difficulty which is apparent at this time. We have discussed the laws of nature as independent in their form of reference axes, a concept which appeals strongly to our philosophy; yet it is not at all clear, at first sight, that we can be justified in our belief. We can not imagine any way by which we can become conscious of the translation of the earth in space; but by means of gyroscopes we can learn a great deal about its rotation on its axis. We could locate the positions of its two poles, and by watching a Foucault pendulum or a gyroscope we can obtain a number which we interpret as the angular velocity of rotation of axes fixed in the earth; angular velocity with reference to what? Where is the fundamental set of axes? This is a real difficulty. It can be surmounted in several ways. Einstein himself has outlined a method which in the end amounts to assuming the existence on the confines of space of vast quantities of matter, a proposition which is not attractive. deSitter has suggested a peculiar quality of the space to which we refer our space-time coordinates. The consequences of this are most interesting, but no decision can as yet be made as to the justification of the hypothesis. In any case we can say that the difficulty raised is not one that destroys the real value of Einstein's work.

In conclusion I wish to emphasize the fact, which should be obvious, that Einstein has not attempted any explanation of gravitation; he has been occupied with the deduction of its laws. These laws, together with those of electromagnetic phenomena, comprise our store of knowledge. There is not the slightest indication of a mechanism, meaning by that a picture in terms of our senses. In fact what we have learned has been to realize that our desire to use such mechanisms is futile.

J. S. Ames

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LEARNED SOCIETIES, OLD AND NEW[1]

It would tax the younger men of science beyond the compass of their imagination, if

[1] President's address at the fourth meeting of the Annual Conference of Biological Chemists, held

for a moment they should stop other activities in order that they might weigh the magnitude of their indebtedness to the scientific societies of the past. It would reduce them below any level of humility if they compared the service of the contemporary societies with those of their ancestors, from whom they are separated by many centuries.

What a glorious record of devotion, sacrifice, and heroism is the history of the early days of the Accademie del Cimento of Italy, of the Royal Society of England, of the Académie des Sciences of France, of the Scientific Societies of Germany.

Somewhere remote in your memory, vaguely and hazily, perhaps, there still lingers a recollection that the bearers of the illustrious names of Copernicus, Gallileo, Toricelli, nay even of Newton, were viewed by their contemporaries with profound suspicion, as dangerous troublemakers; and if the vocabulary of the sixteenth and seventeenth centuries had been as luxuriant as is ours today, those illustrious men might have been disposed of as Bolsheviki.

In the days when those societies came to life, experimentation was a dangerous business. Scholasticism, philosophy, and all classes of organized society, nobility, gentry, clergy were hostile to experimental science. And in spite of these obstacles the result of the efforts of the great pioneers of the seventeenth and of the early eighteenth centuries were preserved and further developed, and made the foundation of our present civilization. In a great measure the success was attained through the activities of the learned societies of those days.

One is filled with astonishment and admiration reading about the great vision of the founders of those academies. They saw clearly all the needs of the new science and of the new times and they grouped together by joint effort to accomplish what they could not do individually. Indeed, so much were they permeated by their desire to serve science, rather than the individual scientist, that often the personalities of the investigators were completely submerged in that of the institution as a whole. In the Accademia del Cimento, as an instance, all the work was published anonymously in the name of the academy. This is perhaps the most sublime example of self-obliteration in the service of an ideal ever known in the history of science.

in affiliation with the American Biochemical Society, in the lecture room of the department of biochemistry in the medical school of the University of Cincinnati, December 30, 1919.

This oldest of all European societies more than any other emphasized the preeminence of experiment, of creation of instruments, establishment of standards of measurements, over theory and hypotheses. "Probando et Reprobando" was their motto. And indeed the academicians have discharged their task admirably. The number of instruments they constructed is endless, the scientific facts they discovered still stand among the foundations of our present sciences. And Poggendorf, referring to the Accademia del Cimento, says: "Few bodies have so well fulfilled their aims . . . ," and further, "we stand to-day on their shoulders."

The aims of the Accademia del Cimento were adopted by the younger European Society which later received its charter from Charles II. as the Royal Society of England.

This society furthered all the ambitions of its Italian forerunner and amplified on it by its program of social activities. As the Cimento, the members of this society were encouraged through cooperation to improve the tools of the scientists. Thus their members perfected the telescope, devised a spring for watches, improved the microscope. They were constructing laboratories, organizing collections, and by every means were improving the equipment and facilitating the task of the investigator. In a letter to Boyle, Hooke writes:

> We are now undertaking several good things, such as the collection of a repository, the setting up of a chemical laboratory, a mechanical operatory, an astronomical observatory, and an optic chamber.

The great effort made by the society to furnish the English workers with the information acquired outside of England is demonstrated by the creating of the office of a special secretary whose aim it was to maintain correspondence with the scientific men of other lands, to collect foreign publications, to translate them, etc.

In those days when bringing out a book was quite an enterprise the society often undertook the publication of the important works of its members and of other scientists. Indeed through the activity of the Royal Society the world became acquainted with the work of Newton. Writes Newton to Oldenburg, one of the secretaries of the society:

> At reading your letter I was surprised to see so much care taken about securing an invention to me of which I have hitherto had so little value. And therefore, since the Royal Society is pleased to think it worth patronizing, I must acknowledge it deserves much more of them for that than of me, who, had not the communication of it been desired, might have let it still remain in private as it hath already some years.

Indeed to such an extent was the society concerned with the interests of investigators that Secretary Oldenburg devised a way of securing rights of priority even in unfinished investigations.

The emphasis of the Royal Society on social and practical service is seen from the following lines taken from the writings of Sprot, one of the historians of the Royal Society.

> They have propounded the composing of a catalogue of all trades, works and manufactures, taking notice of all physical receipts or secrets, instruments, tools and engines. . . . They have recommended advancing the manufacture of tapestry, silk making. . . . They have compared soils and clays for making better bricks and tiles. . . . They started the propagation of potatoes and experiments with tobacco oil.

Indeed one could continue for hours if he made it his task to enumerate all the important functions undertaken by the Royal Society of England. The history of the French "Académie des Sciences" is only a repetition with variations of the histories of the two forerunners, and very much the same may be said of the early history of the German learned societies, though they came to life many decades later.

And now let us pass decades and centuries and let us make an attempt to write the current history of our own learned societies. What is their social function? What is their contribution to the end of facilitating the task of individual workers? What initiative do they take in introducing scientific methods in the practical activities of our social life?

I fail to find the data on which to write this current history. True, the high specialization of science of to-day makes modern presentations less comprehensive and less thrilling than in the times of Newton and of Leibnitz. True, all the activities of the old scientific societies have been appropriated by special institutions: the university, the technical institution, the research institution, the government bureaus, by the laboratories in the industries, and true it is that present societies can not resume the activities of the old academies. Should the societies of to-day then hibernate 362 or 363 days a year and awaken only for the remaining two or three days in order that the members may be bored by listening to communications which they comprehend not, nor are desirous to comprehend? No, hibernate they need not unless they choose to do so by preference.

The great emergency of the past war has demonstrated how capable of initiative, of achievement, of inventiveness the modern American scientist is, once his interest is aroused, when he is called to join hands with his fellow workers.

The old problems are gone, but new ones are coming up every day. Ours is a large country with great natural resources. It is customary to refer to them as endless. The word is a misnomer, an invention of those in whose interest it is to use the resources recklessly. Human energy is needed to exploit these resources; and human energy is not boundless. Who shall devise methods to preserve our natural resources from devastation? Why not a scientific body, and particularly one composed of biochemists? Nearly two years ago the American Chemical Society initiated a campaign for the establishment of a research institute of chemotherapy. For the last year the propaganda has painlessly died. Why this lack of perseverance? I can see the need of another institute which would embrace the study of all the materials employed in the industries engaged in the manufacture of agricultural and natural products. True, the industries have undertaken a considerable share of this work, but industries work for the profit of to-day and not for the preservation of national wealth of the future.

Referring again to the biological chemist who interests us particularly, I see his need for better laboratories, of better methods, of better standards; I see the needs that have been pointed out by several members of this conference, and which are placed on the program for discussion, and of a great many more needs. Surely the biological chemist is not the most favored son of society, of the university, or of the medical school.

I am glad that Dr. Gies brought you all together[2] and gave you the opportunity to inaugurate a new type of society, the aim of which is to enhance the social usefulness of the biological chemist, on the one hand, and, on the other, to improve his facilities for work, whether his work be teaching or investigating. Will this new society live to record important service, or will it vegetate a pale, colorless existence? This will depend on the spirit in which you join it. The prospect for service is before you. Once more I wish to compliment Dr. Gies on his vision.

P. A. Levene

The Rockefeller Institute for Medical Research

A BUST OF THE LATE PROFESSOR E. D. COPE

A bust in plaster of the late Edward Drinker Cope, who, at the time of his death in Philadelphia, on April 12, 1897, was professor of zoology and comparative anatomy in the University of Pennsylvania, has been purchased by the subscriptions of some twenty-seven of his former colleagues, associates and students and presented to the zoological laboratory of the university.

This bust is the work of Mr. Eugene Castello, of Philadelphia, and is the one represented in half tone in the number of *The American Naturalist* for May, 1897. Mr. Castello writes:

> I had been engaged on portrait busts, of Dr. Matthew Woods, president of the Browning Society, and of Dr. William Mountain, author of "Saint Cecilia." The study of individual character in these portraits, followed by the production of a number of heads of racial types: American Indians, Russian moujiks, Arabs and Frenchmen, directed my attention to the very unusual features of Professor Cope's head. That he was quite aware of the interesting subject he was for a sculptor was soon evident, for he humorously described himself as "gimber-jawed," that is, he meant that the lower jaw was slightly undershot, having much the form of a skate runner extending from ear to chin.
>
> In reference to the circumstances connected with the modelling of the bust, now the property of the university, I consulted a diary that I kept at that time and find that he gave me six sittings for it, beginning October 22, 1896, and the last one on January 6, 1897. At the final sitting he expressed himself as satisfied that I had succeeded in obtaining a good likeness. After Professor Cope passed away, his friend, Dr. Persifor Frazer, saw the bust and invited me to place it in the hall of the American Philosophical Society, May 7, 1897, where it remained for some time. Later it was again exposed there on the occasion of the Cope Memorial meeting [November 12, 1897], where it received favorable criticism from Professor Osborn of the American Museum of Natural History, Dr. Minis Hays and others. . . . Dr. Nolan, of the Academy of Natural Sciences, of this city, also has taken occasion to express his appreciation.
>
> The work of constructive modelling of the head was aided to a considerable extent by the sitter himself, who seemed to be familiar with the anatomical points that differentiated it from any others and which attracted my attention when I met him for the first time. Artists delight in individual character, such as was evident in his head, and upon my expression of interest Professor Cope consented to give me some sittings, although suffering at the time with an incurable

[2] An allusion to the fact that the conference was organized at Dr. Gies's suggestion.

malady. He collapsed on one occasion during a sitting and I was obliged to administer stimulants to revive him. He was a very patient sitter, although I knew he was suffering from disease, and had never before given a sitting to a sculptor.

I think the university is to be congratulated on obtaining possession of the work and I can assure you and the other subscribers that nothing could be more pleasing to me. It is an exact duplicate of the head even in measurement, every feature being transferred and reproduced in the clay by means of calipers, such as are used by sculptors, so that the work has a sort of scientific value as a human document. I used calipers with points especially protected with little cork balls. This seemed to amuse Professor Cope and yet he showed considerable fear that I might do some damage to his features with the instrument. The plaster bust was made from the clay by myself in a matrix of plaster which was destroyed in the process known to sculptors as the "waste mould process."

As far as known, this bust of Professor Cope is the only one in existence modelled from life, although a death-mask was taken and is preserved in the University Museum. Although he never saw the present zoological laboratory of the University of Pennsylvania, it seems fitting that this building, which houses his osteological collection and many of his books, should also be enriched by this bust.

PHILIP P. CALVERT

THE UNIVERSITY OF PENNSYLVANIA

SCIENTIFIC EVENTS

THE HENRY PHIPPS INSTITUTE

THE Henry Phipps Institute for the study and prevention of tuberculosis, a part of the University of Pennsylvania, is engaged in a campaign to raise $3,000,000 to enable it to continue its work. Dr. Charles J. Hatfield is executive director; Dr. H. R. M. Landis, director of the clinical and sociological departments, and Dr. Paul A. Lewis, director of the pathological department. The text of the institute's appeal is in part as follows:

WHEREAS, The support which has been so generously contributed during the past 16 years by Mr. Henry Phipps can no longer be extended;

WHEREAS, The board of trustees of the University of Pennsylvania see no prospect of being able to support the work of the Henry Phipps Institute from the funds at present available;

WHEREAS, It is deemed important that the work of the Henry Phipps Institute be continued upon an even larger scale:

The directors of the departments of the Henry Phipps Institute announce a campaign to raise a Foundation Fund of $3,000,000.

It is confidently expected that America will rally to the support of this enterprise which has already accomplished so much for the betterment of humanity in so difficult a field of endeavor.

The Henry Phipps Institute was the first organization brought into existence for the express purpose of eradicating tuberculosis through intensive and scientific research.

The institute was conceived when Dr. Lawrence F. Flick, about to start a tuberculosis clinic with a total backing of $1,000, met Mr. Henry Phipps by appointment and discussed the venture with him. Mr. Phipps at once offered to underwrite a much more extensive enterprise aimed at the extermination of tuberculosis.

On February 1, 1903, the institute began work in an old remodeled building equipped with 52 beds, a small laboratory and facilities for operating a large dispensary.

During the ten years that followed, its work was so successful that Mr. Phipps not only agreed to continue his support over another stipulated period of time, but also supplied funds for the purchase of land and the erection of the splendid property in which the institute is now housed.

In order that the standing of the institute might be assured and the integrity of the enterprise guaranteed, it was on July 1, 1910, placed in charge of the trustees of the University of Pennsylvania, with the contractual understanding that Mr. Phipps would be responsible for its support over a stipulated period of time.

The new building erected at Mr. Phipps' expense provided adequate facilities for every branch of medical and sociological research bearing upon the problem of tuberculosis.

The period for which Mr. Henry Phipps had agreed by contract to support the work of the institute came to an end in May, 1919. Because of ill health Mr. Phipps is not able to continue his interest and support. Other means of maintenance must be found or the institute must close. In this event one of man's strongest defenses in the battle against tuberculosis will be abandoned.

THE AWARD OF THE BOYLE MEDAL

The presentation of the Boyle Medal to H. H. Dixon on January 23, 1917, by Lord Rathdonnell is now a matter of somewhat ancient history to his colleagues of the Royal Dublin Society. Due to delay in transmission of periodicals, however, the account of the presentation and the bibliography of Dr. Dixon's more than three score contributions to science have only just reached America in printed form.[1] Because of the widespread interest in Dixon's work on the rise of water in trees, the writer is hastening at this late hour to do honor to a brilliant career and a gentleman of scientific vision.

The tension theory of the ascent of sap in trees was published in 1894 in collaboration with Dr. John Joly. The latter, also, is favorably known in America as a physical geologist and mineralogist and a graceful writer of essays on scientific topics, ranging all the way from the "Birth-Time of the World" to "Skating" and "Pleochroic Halos." He also visited the United States as a member of the British Education Commission two years ago. Many of Dr. Dixon's earlier researches were undertaken with Dr. Joly. Dr. Dixon's principal scientific labors may be classed under three main heads: Cytology and genetics, the path of the transpiration current, and cryoscopy and thermo-electric methods.

Contributions to cytology include fertilization of *Pinus sylvestris* and some significant work on reduction division and mitosis which aided about a decade later in the rediscovery of Mendel's law. However, transpiration soon began to be Dixon's chief topic of experiment and research and his results will doubtless remain one of the great contributions to botanical science. During the interval between 1894 and 1914 investigations concerning the resistance experienced by the transpiration stream and theories to account rationally for the upward movement of water were developed. Most of the methods employed in these researches were devised by Dr. Dixon and only a few were in collaboration with students. It is, then almost entirely due to his genius and patient effort that the epochal discoveries come into being. His records of this work are contained in the monograph "Transpiration and the Ascent of Sap," published about 1914. Previously he had been invited to contribute to *Progressus Rei Botanicæ* on the same subject. The third line of investigation has been largely in collaboration with Dr. W. R. G. Atkins. Osmotic pressure changes and cryoscopic and conductivity measurements on saps have been particularly dealt with. These researches are still continuing and have been amplified recently by new attacks on the many problems of photosynthesis, especially the increase of sucrose rather than the hexoses following insolation. There is no doubt but that much valuable information will result from this field of investigation.

The closing sentences of the biographical note (*loc. cit.*) seem to indicate that Professor Dixon has been accomplishing this magnificent amount of experimental work at the same time that he was teaching "large classes" of medical students. The more honor to him. One can not help feeling, however, the stupidity of university organization which permitted his time to be occupied during the best years of his life in work which was relatively unproductive for the science of botany. If such an inspired worker can not impress the governing board of the school with the importance of fundamental research, the outlook for most of us is indeed dark.

A. E. Waller

The Ohio State University

[1] Award of the Boyle Medal to Professor Henry Horatio Dixon, Sc.D., F.R.S., *Sci. Proc. Roy. Dublin Soc.*, 15: 179–184. Anon.

IN HONOR OF WILLIAM H. WELCH

On April 8 Dr. Welch reaches his seventieth birthday. Such an occasion ought not to pass without some new expression of affection and admiration on the part of the medical profession of America to one who has long stood as its leader. To many of his friends it has seemed that an expression worthy the master would be the preservation in suitable form of the chief contributions from his pen.

Dr. Welch's writings are scattered through a great variety of publications and are more or less inaccessible. It has accordingly been decided to bring together and to publish in three volumes his papers and addresses which strikingly reveal the great part he has played in the development of medical science and medical education.

In order that the project may be assured it has been decided to invite his friends and former pupils to unite in making possible the publication of his work.

The volumes will be issued by the Johns Hopkins Press under the editorial supervision of the undersigned committee. The set of three volumes, bound in linen, is offered to the subscribers at $16.50, which is less than the estimated cost. Each copy will be numbered, and assigned in the order of subscription. The edition will be restricted to the number subscribed.

Committee: John J. Abel, Lewellys F. Barker, Frank Billings, Walter C. Burket, William T. Councilman, Harvey Cushing, John M. T. Finney, Simon Flexner, William S. Halsted, William H. Howell, John Howland, Henry M. Hurd, Henry Barton Jacobs, William W. Keen, Howard A. Kelly, William G. MacCallum, William J. Mayo, Ralph B. Seem, Winford H. Smith, William S. Thayer, J. Whitridge Williams, Hugh H. Young.

SCIENTIFIC NOTES AND NEWS

SIR AUCKLAND GEDDES, who was formerly professor of anatomy in McGill University, and is now a member of the British cabinet as president of the board of trade, has been named as British ambassador to the United States.

DR. W. S. HALSTED, of the Johns Hopkins University, has been elected to honorary foreign membership in the Royal Academy of Medicine of Belgium.

THE following are the officers of the Association of American Geographers for the year 1920: *President,* Herbert E. Gregory; *Vice-presidents,* Harlan H. Barrows and Charles F. Brooks; *Treasurer,* George B. Roorback; *Councilors,* Walter S. Tower, Eliot Blackwelder and Ray H. Whitbeck; *Secretary and Editor,* Richard E. Dodge.

MAJOR H. E. WIMPERIS has been transferred from the office of the British Crown Agents for the Colonies to the Air Ministry, to take up the position of head of the air navigation research section.

MR. ALFRED SMETHAM, chemist to the Royal Lancashire Agricultural Society, has been elected president of the British Society of Public Analysts in succession to Dr. Samuel Rideal.

DR. LÉON BERNARD, professor of hygiene in the faculty of medicine, Paris, a well-known writer on tuberculosis, has been elected a member of the Academy of Medicine. Dr. Lesbre, of Lyons, and Dr. Lignières, of Buenos Aires, have been elected correspondents.

THE Christian Fenger fellowship for 1920 has been awarded to Dr. Harry Culver, of the University of Illinois Medical School, Chicago. He will continue his studies on Infections of the Kidney.

DR. ALBERT ERNEST JENKS, professor of anthropology and director of the four-year Americanization training course at the University of Minnesota, has been made president of the newly organized National Council of Americanization Workers.

JOHN WAGNER, JR., civil engineer, eldest son of Samuel Tobias Wagner, chief engineer of the Philadelphia and Reading Railway Co., has been elected a member of the board of trustees of the Wagner Free Institute of Science, to fill the vacancy caused by the death of Joseph Willcox.

DR. NATHANIEL L. BRITTON, director of the New York Botanical Garden, is engaged in botanical work in Trinidad.

DR. J. PERCY MOORE, professor of zoology in the University of Pennsylvania, has been given leave of absence for one year to study abroad.

PROFESSOR EMILIO ODDONE, an Italian seismologist, arrived recently in New York from

Naples on his way to Mexico to study recent earthquakes there for his government.

Frederic H. Lahee, formerly professor of geology at the Massachusetts Institute of Technology, and since the latter part of 1918 associate geologist for the Sun Oil Co., of Dallas, Tex., will take charge of the geological department of the Twin State Oil Co., at Tulsa, Okla., while still maintaining his connection with the Sun Co.

Mr. Rollin C. Dean, who for the last eight years has represented the Bausch and Lomb Optical Co. among the universities and colleges of the east, will become connected with The Rockefeller Foundation.

Dr. Mary J. Erickson has arrived at the University of Iowa to take charge of the research work in the state board of health under the recent appropriation from the federal government for investigation in the field of venereal diseases.

Professor C. E. Seashore, of the psychology department of the State University of Iowa, lectured on the "Psychology of Musical Talent" at the University of Kansas on March 1.

Dr. Christine Ladd-Franklin lectured recently before the Research Club of the Harvard Medical School on the theory of color sensation.

Professor Edward J. Moore, of the department of physics of the University of Buffalo, spoke before the Buffalo Society of Natural Sciences on February 3, on "The Einstein Gravitation Theory."

Professor Douglas W. Johnson, of Columbia University, addressed the faculty and students of Mount Holyoke College on February 18, on "The Work of the Geographer and the Geologist in the War."

Dr. W. H. R. Rivers, of the University of Cambridge, will lecture on "Ethnology: its Aims and Needs" at Columbia University on the evening of March 15. It will be a general meeting of the New York Academy of Sciences arranged by the Section of Anthropology and Psychology and the American Ethnological Society.

Herbert Ralph Werner, assistant professor of zoology in the Iowa State College, died on February 14, at the age of thirty-one years, of pneumonia following influenza.

Dr. Charles Gordon Hewitt, Dominion entomologist and consulting zoologist, died at Ottawa on March 1. He had resided in Canada since 1909, having been born in Scotland in 1886.

Sir Thomas Anderson Stuart, professor of physiology and dean of the faculty of medicine in the University of Sydney, died on April 3. He was born in Scotland in 1856.

The U. S. Civil Service Commission announces an examination for assistant fuel engineer. A vacancy in the Bureau of Mines, Department of Interior, at Pittsburgh, Pa., at $4,200 a year, will be filled from this examination.

House tariff measures fixing duties on optical glass, laboratory apparatus, surgical instruments and glass and porcelain articles for laboratory use have been ordered favorably reported by the Senate Finance Committee.

Through the courtesy of the American Geographical Society the spring meeting of the Association of American Geographers will be reinaugurated this year. The meeting will be held in New York City at the American Geographical Society's hall, April 16 and 17, 1920. All interested are most cordially invited to attend.

The Iowa Academy of Science will hold its thirty-fourth annual meeting at the University of Iowa on April 30 and May 1, under the presidency of Professor T. C. Stephens, of Morningside College. It is expected that fully one hundred papers on scientific subjects will be presented.

The next annual meeting of the British Medical Association will be held in the University of Cambridge at the end of June under the presidency of Sir Clifford Allbutt. It was intended to hold the 1915 meeting at Cambridge under his presidency, but the war intervened and he has remained president of the association.

YALE UNIVERSITY has recently received from Bayard Dominick, of the class of 1894, Yale College, gifts amounting to $40,000 for scientific exploration in the Southern Pacific Ocean. Professor Herbert E. Gregory, of Yale, is the active head of the expedition, and the funds will be disbursed by the Bishop Museum of Honolulu. It is expected that the work of the expedition will extend over a period of two years and that it will be carried on by a group of distinguished men of science. Professor Gregory has been granted leave of absence for the balance of the year by Yale and is now in Honolulu.

A NEW museum has been opened at Yellowstone Park, Wyoming, for the preservation and exhibition of natural history specimens of the region.

THE fortieth annual report of the United States Geological Survey, made public, compares the present scope of the work with that of the work done during the first year of this organization. The growth of the survey is suggested by a comparison of the appropriations for the present year, which comprise items amounting to $1,437,745, with the total appropriation of $106,000 for the first year, 1879-80. During the 40 years the number of employees has been increased from 39 to 967.

THE arrangements for the amalgamation of the four existing British meteorological services are practically completed, and it is expected that at an early date the reorganization, which will combine the Meteorological Office with the weather services of the Air Ministry, the Navy, and the Royal Engineers, will be effected under the Department of the Controller-General of Civil Aviation, and will be directed by Sir Napier-Shaw, the present Director of the Meteorological Office at South Kensington. The headquarters of the amalgamated services will be at the Air Ministry, Canada House, Kingsway. It is understood that the forecasting department and other departments of the Meteorological Office will be transferred from South Kensington to the Air Ministry, while the statistical department and the library will remain at the present office in Exhibition Road. The British Rainfall Association, which was founded in 1860, and which has been a very successful private enterprise, will come under the director of the Meteorological Office, but it is expected that its special work will continue to be carried on at Camden-square. The combined services will be in close touch with all the colonial and foreign observatories and the Air Minister will assume Parliamentary responsibility for the new combined department.

THE Advisory Committee at the American Chemical Society, on recommendation of Editor E. J. Crane, has passed the following vote:

> That *Chemical Abstracts* be empowered to loan to members in good standing of the American Chemical Society, copies of current publications upon request; that each such request must be accompanied by twenty-five (25) cents for each issue requested to cover cost of packing, mailing and correspondence, and must further be accompanied by an undertaking on the part of the requesting member to replace such issue or issues, should they not be returned to *Chemical Abstracts* in good order, less reasonable wear and tear; *Chemical Abstracts* to notify the loaning member of receipt in good or bad order, as the case may be, of the loaned issue and then to close the transaction accordingly.

THE Oberlin College Research Committee, affiliated with the National Research Council, met recently for dinner and the transaction of business at the Faculty Club. The present committee consists of men engaged in experimental scientific work, but a recommendation was adopted to include those from the mathematics department. Discussion centered around possible methods of stimulating and financing research in those departments which care to do such work, and also the development of research spirit as a definite college policy. It was definitely expressed as the opinion of those present that a college of the standing of Oberlin must abandon the policy that teaching is the sole business of the faculty members, and that productive work must be given the prominence it merits.

THE United States Committee on the Ramsay Memorial Fund has transmitted

£3,500 which it has collected; £263 have been sent direct by contributors; approximately £100 yet remain in the hands of the treasurer, Mr. W. J. Matheson. Professor Baskerville, the chairman, hopes that the total American contribution which is £3,863, may be raised to £4,000, and that the American subscriptions may then be closed. The total fund now amounts to £51,274. Professor H. Kamerlingh Onnes reports contributions of £1,571 given or promised by donors in Holland.

Robert W. Lawson writes to *Nature* from the Physics Laboratory, the University of Sheffield, quoting a letter of Professor Einstein as follows: "Zwei junge Physiker in Bonn haben nun die Rot-Verschiebung der Spektral-Linien bei der Sonne so gut wie sicher nachgewiesen und die Gründe des bisherigen Misslingens aufgeklärt."

Mr. Theodore W. Robinson, of Chicago, has given $500 to be used in purchasing museum material for the Oriental Institute of the University of Chicago; and a donor whose name is withheld gives $25,000 for the same purposes. These funds will be used by Professor James Henry Breasted, who is now in Egypt on his way to Mesopotamia.

The National Research Council has received a gift from the Southern Pine Association of $10,000 to pay for the incidental expenses of a coordinated scientific study by a number of investigators of the re-growth of trees or cut-over forest lands with the aim of determining the best forestry methods for obtaining the highest productivity. The investigation will be conducted under the advice of the Research Council's special committee on forestry and will not duplicate any present government or other undertakings along similar lines.

On the invitation of the council of the senate of the University of Cambridge, the chancellor, the vice-chancellor, Mr. Rawlinson, Professor Sir Joseph Larmor, Professor Sir J. J. Thomson (master of Trinity), Dr. Hobson, and Professor Sir Ernest Rutherford, have consented to serve as representatives of the university on a joint committee of the Royal Society and university for the purpose of taking steps to secure an appropriate memorial to the late Lord Rayleigh.

UNIVERSITY AND EDUCATIONAL NEWS

Professor William H. Walker, chairman of the administrative committee of the Massachusetts Institute of Technology, since the death of President Maclaurin, has resigned to devote his time to the division of industrial cooperation and research. The new chairman is Professor H. P. Talbot, chairman of the faculty. Professor E. B. Wilson, of the physics department has been appointed a member of the committee, on which is also Professor Edward Miller, of the department of mechanical engineering. Professor Walker is succeeded as head of the course of chemical engineering by Professor Warren K. Lewis. As has been already noted here, Professor Arthur A. Noyes, head of the research department, has handed in his resignation as of January 1, to go to the California Institute of Technology.

After thirteen years of service as professor of medicine and ten years as dean of the Yale School of Medicine, Dr. George Blumer has resigned to resume consultation practise, but he will not wholly sever his connection with the school and the hospital.

Dr. Arthur B. Lamb has been promoted to a professorship of chemistry at Harvard University.

Dr. Adolph Knopf, of the U. S. Geological Survey, has been appointed lecturer in geology in Yale University for the second term of the present academic year. He has in charge the undergraduate and graduate courses in petrology formerly taught by the late Professor Pirsson. Additional appointments in the geological department are those of Dr. Carl O. Dunbar (B.A. Kansas 1913, Ph.D. Yale 1917) as assistant professor of historical geology, and Mr. Chester R. Longwell (B.A. Missouri 1915, M.A. 1916) as assistant professor of geology.

THE trustees of Cooper Union, New York City, have authorized the organization of a four-year day course in industrial chemistry to be started in September of the present year. This course will aim to train men as analysts, research chemists, foremen and superintendents in manufacturing plants, and sales agents. Mr. Maximilian Toch, has been appointed adjunct professor of industrial chemistry.

DR. H. E. ROAF has been appointed to the university chair of physiology tenable at the London Hospital Medical College, and Professor T. Swale Vincent to the university chair of physiology tenable at the Middlesex Hospital Medical School.

DISCUSSION AND CORRESPONDENCE

AN ODD PROBLEM IN MECHANICS

TO THE EDITOR OF SCIENCE: The following statements are intended to throw light on the questions raised by Dr. Hering in his letter entitled "An odd problem in mechanics" in SCIENCE for January 9, 1920.

The statements in the second paragraph of the letter are correct: a body travelling eastward on the ground along the equator will exert less pressure on the ground than one at rest relative to the earth's surface, and still less pressure than a body travelling westward. The correctness of this statement was verified experimentally in connection with observations to determine the intensity of gravity at sea by determinations of the boiling point compared with readings of the mercury barometer. In the spring of 1909 the Russian government placed a war ship at the disposal of Professor Hecker, who was engaged in this work, and tests were made in the Black Sea by comparing the gravity obtained when the ship was running east with gravity at the same point when the ship was running west. The correction in question is of the order of 0.100 dyne for a vessel of fair speed, and the reality of the expected effect and the necessity of applying a correction for it were, of course, verified. It should be mentioned that the rolling, pitching and lifting of the ship, which occur on all courses, were such that the total effect of the ship's motion did not necessarily reverse in sign when the ship's course was reversed.

In the third paragraph it is assumed that the "gyroscopic tendency (of a rotating horizontal flywheel) to get into the vertical plane has been counteracted and may be neglected." But the forces Dr. Hering has been describing in this paragraph are exactly the gyroscopic forces themselves that tend to make the axis of the flywheel parallel to the earth's axis. At the equator, since the celestial pole is in horizon, the plane of the flywheel would tend to become vertical. If the gyroscopic tendency is counteracted, there is, of course, no shifting of the axis of rotation.

In the cases supposed in the fourth paragraph, there are gyroscopic forces arising from the earth's rotation that Dr. Hering has not considered. When the plane of rotation is north and south, that side of the disk which is descending will tend to move eastward, and the side that is ascending will tend to move westward, thus tending to turn the plane of the disk out of the meridian into the prime vertical, so that its axis shall be parallel to the axis of the earth. The apparatus will therefore not be dynamically balanced as Dr. Hering states. At the equator there is no twisting effect due to the horizontal motion of the particles on the edge of the disk, for this effect varies as the sine of the latitude. At the equator, when the plane of the disk is east and west, its axis is parallel to the earth's axis, and the apparatus is dynamically balanced.

The nature of the general question raised may be stated in a few words as follows. For a body at rest on the earth, it is sufficient to consider only the attraction of the earth and the centrifugal force due to the earth's rotation. For a body in motion relative to the earth, there are additional apparent forces to be considered, the so-called gyroscopic forces, or compound centrifugal forces. These apparent forces arise from the fact that our axes of reference are not fixed in direction in space, but are rotating. These forces are all proportional to the product of the earth's angular velocity of rotation by a component velocity along one of the moving axes; furthermore, all components of relative velocity, northward, eastward, or upward (and their opposites) give rise to these forces. Dr. Hering's argument from the varying centrifugal force due to the east and west motion of a particle brings to light the gyroscopic forces due to the east-and-west components of velocity, but it does not tell the whole story. Vertical components, and horizontal components in the meridian must also be allowed for.

There is nothing very new in the results stated above. Problems of moving axes and the effect of the earth's rotation are treated in much detail in advanced treatises like Routh's "Rigid Dynamics." The equations of motion for these cases can be conveniently ground out by Lagrange's method, but it is always interesting and instructive to obtain each term in the result directly, and to examine its geometrical and mechanical meaning.

Walter D. Lambert
U. S. Coast and Geodetic Survey

QUOTATIONS

FEDERATIONS OF BRAIN WORKERS

In the discussion on the better adjustment of the relations between employers and employed which have occupied so much space in the public press during the last year or so attention has been almost exclusively directed to the relations of industrial employers and manual workers. The interests of other classes of persons whose work is essential to industry have been almost ignored, although the Labor Party has declared its willingness to accept recruits from among brain workers. At the industrial conference summoned by the Prime Minister last April employers' associations and trade unions considered a proposal for a joint industrial council, and the Society of Technical Engineers at this conference moved an instruction to the council, when it should come into existence, to consider the position of unions composed exclusively of members of technical, management, and administrative grades, and to determine how such unions should be represented on the council. The industrial council has not yet come into existence, but meanwhile the Labor Research Department has been making inquiries into the position of professional classes in relation to the labor movement, and at a meeting in London on February 7, a National Federation of Professional, Technical, Administrative, and Supervisory Workers was formed. The bodies represented at this conference included the Civil Servants Union, the Association of Local Government Board Officers, the National Union of Clerks, the National Federation of Law Clerks, the National Union of Journalists, representatives of scientific, technical, engineering, and chemical workers, together with the Actors' Association and the National Orchestral Association. A representative of the Labor Research Department said that it was not proposed that the Federation should affiliate with the Labor Party or the Trade Union Congress. Among the professions invited to join the new Federation medicine and the law are not included. It appears, however, that for some months past certain technical and scientific professional workers have been taking steps to form themselves into a confederation, and that representatives of these bodies and several others, after full discussion, have prepared a memorandum proposing that the various societies concerned should be formed into an industrial group, a financial group, a group for the public services, and a group for the other professions. Each group would form a federation, and the four would be combined into a confederation for which draft rules are being prepared. The General Secretary of the Society of Technical Engineers last week published a long letter on the subject in *The Times*, in the course of which he observed that the assumption that a salaried official must ally himself either with the employers or with the work-people ought not to be accepted without further investigation. The position of medicine and the law are similar to each other and differ fundamentally from that of the intellectual workers represented by such bodies as the Society of Technical Engineers. The medical profession will be disposed to watch with sympathetic interest the movement for a federation of scientific and technical workers; but until their plans are more fully known it will be premature to say that medicine should have any direct concern.—*British Medical Journal.*

SCIENTIFIC BOOKS

The Productivity of Invertebrate Fish Food on the Bottom of Oneida Lake, with Special Reference to Mollusks. By FRANK COLLINS BAKER. Technical Publication No. 9, New York State College of Forestry at Syracuse University, Syracuse, N. Y. 1918. Pp. 233, Figs. 44.

This valuable contribution to the general subject of limnology is based upon a numerical study of the bottom fauna of a portion of Oneida Lake, New York, which was made during the month of July, 1916. Lower South Bay and two smaller areas, all at the southwestern corner of the lake, were covered in the survey; they constitute an area of 1,164 acres, or a little less than two square miles out of a total lake surface of about 80 square miles. The maximum depth of the water in the area under consideration is about 19 feet as compared with a maximum of 55 feet for the entire lake.

In the area covered by this survey the greatest development of plant and animal life was found in the zone extending from the shoreline out to the six-foot contour line. Numerically, about 88 per cent. of the invertebrate animals were obtained in this area. The second zone lay between the six-foot and the twelve-foot contour lines and the population of this belt was very much smaller than in the first zone. A still further decline in the density of the population was noted between the twelve-foot and the eighteen-foot contour lines, which constituted the third zone.

Various types of bottom were found in the area studied, ranging from boulders to clay and mud. Of those represented, the sand bottom was richest in animal life while the boulder bottom was poorest.

A classification of the animals on the basis of their feeding habits showed that herbivorous and detritus feeders greatly predominated over the carnivorous forms; the latter, in fact, constituted only 0.29 per cent. of the total population. Of the various groups of animals represented, the mollusks yielded a much larger number of individuals than any other group; they even exceeded in numbers all of the associated animals combined.

CHANCEY JUDAY

MADISON, WISCONSIN

SPECIAL ARTICLES

THE ANTISCORBUTIC PROPERTY OF DEHYDRATED MEAT

THE present conception of a perfect diet demands that the intake contain adequate proteins, sufficient fats, carbohydrates, inorganic salts, bulk, and the three vitamines designated as water-soluble B, fat-soluble A, and antiscorbutic. For some time we have used to produce experimental scurvy in guinea-pigs a combination which meets all of these requirements except that of the antiscorbutic vitamine. A mixture of soy bean flour, whole milk, dried yeast, paper pulp, sodium chloride and calcium lactate is dried down into a cake.[1] This is fed as the basal ration supplemented with a definite amount of the product whose antiscorbutic potency it is desired to determine. By this procedure we have demonstrated that dried cabbage,[1] dehydrated tomatoes[2] and desiccated orange juice[3] retain some of their original content of antiscrobutic vitamine.

The indications are that each foodstuff ought to be studied individually. Meat being one of the most staple articles of our dietaries it has therefore seemed highly important to determine if it retains any antiscorbutic potency after drying.

Stefansson[4] states that "the strongest anti-

1 Givens, M. H., and Cohen, B., *J. Biol. Chem.*, 1918, 36, 127.

2 Givens, M. H., and McClugage, H. B., *J. Biol. Chem.*, 1918, 37, 253.

3 Givens, M. H., and McClugage, H. B., *Am. J. Dis. Chil.*, 1919, 18, 30.

4 Stefansson, V., *J. A. M. A.*, 1918, 71, 1715.

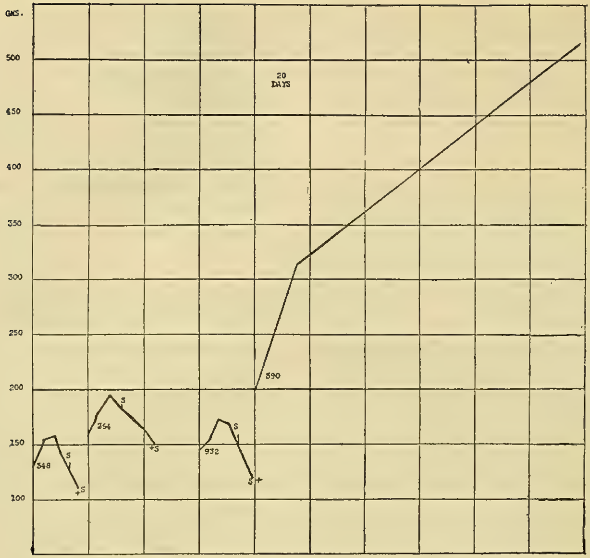

FIG. 1. Growth curves of guinea-pigs on different diets.

Animal No. 932 is representative of a number of guinea-pigs receiving the soy cake diet without any supplement. Clinical signs of scurvy were first noted on the 14th day; death from scurvy occurred on the 19th day. Animal No. 390 receiving soy cake plus 30 gms. of raw cabbage daily never showed any signs of scurvy up to the 120th day, when it was transferred to other experiments. These two groups serve as controls to show that the soy cake diet *alone* will not prevent scurvy but that it is satisfactory if supplemented with a good antiscorbutic agent as, in this case, raw cabbage.

Animal No. 348 is typical of a group on the soy diet plus a daily supplement of dehydrated beef. Animal No. 354 is one of a number of guinea-pigs receiving the soy cake diet plus an allotment of desiccated beef cooked for 15 minutes at 100° C. In these two groups the development of scurvy has not been prevented nor death from the disease delayed.

S signifies first appearance of scurvy.

S + death from scurvy.

scorbutic qualities reside in certain fresh foods and diminish or disappear with storage by any of the common methods of preservation —canning, pickling, drying, etc. Meat and fish slightly or well advanced in the process of ordinary putrefaction seems to be as good an antiscorbutic as fresh flesh or nearly so." Notwithstanding the above statements Stefansson used some dried meat on one of his polar expeditions. However, circumstances were such as not to permit a long usage of the dried products and therefore no direct evidence is available in his cases as to the antiscorbutic value of this material.

Chick, Hume and Skelton[5] found that 10 c.c. of raw fresh beef juice daily did not prevent scurvy in a guinea-pig on a diet of oats and bran ad lib.

Pitz[6] has offered experiments to show that

[5] Chick, H., Hume, E. M., and Skelton, R. F., *Biochm. J.*, 1918, 12, 131.

[6] Pitz, W., *J. Biol. Chem.*, 1918, 36, 439.

5 per cent. of dried meat does not delay the onset of scurvy but does greatly prolong the life of the animals, while 10 per cent. of this meat delays the onset of the disease and greatly prolongs the life of the animals. He also thinks that calcium and chloride cause delay in the development of scurvy.

Dutcher[7] and his associates claim that raw lean beef does not possess antiscorbutic properties. They think the favorable influence from dried meat claimed by Pitz is in reality due to the fact that the animals in those experiments were consuming milk ad lib.

The dried meat used in our experiments was lean beef freed of fat and dehydrated in vacuo at a temperature never higher than 65° C. for a period of twelve hours.[8] The meat was then air dried for several days, during which time it gave up a little more moisture. This dried product was ground to a powder and offered as such to the animals. The guinea-pigs did not care for the food in this form and the only satisfactory consumption obtained was through intimately blending the meat with the soy cake food by grinding the two together. By this manipulation an average consumption of fifty per cent. or better of the 3 gm. of meat offered daily, was obtained from all animals. The actual daily amount of dried meat eaten was about 1.5 gm. per guinea-pig; representing approximately 15 per cent. of the total solids ingested.

The dried meat was fed uncooked and cooked for fifteen minutes at 100° C. In neither case was there any protection against the onset of scurvy nor was death therefrom delayed. A graphic presentation of the above results is given in the chart by a curve of growth of a typical animal from each group.

The findings in these animal experiments are in accord with those of Chick, Hume and Skelton and of Dutcher and associates on the value of raw meat juice and raw meat and a watery extract of raw meat. The results support Stefansson's contention, in so fas as meat is concerned, that foodstuffs preserved by desiccation are deficient in their antiscorbutic property.

The meat used by Pitz in his experiments was dried over steam coils. Our results are in direct opposition to his. The explanation of this is undoubtedly due, as Dutcher believes, to the amount of milk consumed by the guinea-pigs in Pitz's experiments. His results in all likelihood would have been the same as ours had the intake of milk been controlled quantitatively.

MAURICE H. GIVENS,
HARRY B. MCCLUGAGE
UNIVERSITY OF ROCHESTER

[7] Dutcher, R. A., Pierson, E. M., and Biester, A., SCI., N. S., 1918, 50, 184.

[8] Our thanks are due Dr. K. Geo. Falk, of the Harriman Laboratories, Roosevelt Hospital, New York City, for kindly supplying us with the meat used in these experiments.

THE AMERICAN METEOROLOGICAL SOCIETY

THE American Meteorological Society was organized in St. Louis, on December 29, 1919 (*cf.* preliminary announcements, SCIENCE, August 22, 1919, pp. 180–181, and December 12, 1919, pp. 546–547). Following the organization, the Council of the American Association for the Advancement of Science granted affiliation. The officers elected for 1920 are: R. DeC. Ward, president; W. J. Humphreys, vice-president; Robert E. Horton, treasurer, and Charles F. Brooks, secretary. Fifteen councilors representing the various phases of theoretical and applied meteorology were also elected. They are: Lieutenant Colonel W. R. Blair, Meteorological Service, Signal Corps, Washington; E. H. Bowie, Weather Bureau, Washington, D. C.; Professor H. J. Cox, Weather Bureau, Chicago, Ill.; A. W. Douglas, Simmons Hardware Co., St. Louis, Mo.; Professor Ellsworth Huntington, Yale University, New Haven, Conn.; Lieutenant C. N. Keyser, Aerology Division, U. S. Navy, Washington, D. C.; Professor C. F. Marvin, Weather Bureau, Washington, D. C.; Major General C. T. Menoher, Air Service, Washington, D. C.; J. C. Millas, Meteorological Service, Habana, Cuba; James H. Scarr, Weather Bureau, New York, N. Y.; Professor J. Warren Smith, Weather Bureau, Washington, D. C.; Sir F. Stupart, Meteorological Office, Toronto, Canada; Professor C. F. Talman, Weather Bureau, Washington, D. C.; Dr. F. L. West, Utah Agricultural College, Logan, Utah; Professor W. M. Wilson, Cornell University, and Weather Bureau, Ithaca, N. Y. Eleven committees were formed to carry out the objects of the society. These with their chairman are: Research, C. F. Marvin; Public Information, C. F. Talman; Metrological Instruction, W. M. Wilson; Membership, C. F. Brooks; Physiological Meteorology, Ellsworth Huntington; Agricultural Meteorology, J. Warren Smith; Hydrological Meteorology, R. E. Horton; Business Meteorology, A. W. Douglas; Commercial Meteorology, H. J. Cox; Marine Meteorology, J. H. Scarr; Aeronautical Meteorology, Major General C. T. Menoher.

On December 30 and 31, in St. Louis, and on January 3, in New York, 29 papers were presented in five sessions. There was one joint session with the American Physical Society, and one with the Association of American Geographers and National Council of Geography Teachers. Since brief abstracts of each paper are published in the January issue of the *Bulletin* of the American Meteorological Society, and more extensive abstracts, excerpts, or the papers in full, covering all but nine, in the December *Monthly Weather Review*, only the titles and authors will be given here:

Progress of American meteorology in 1919: C. F. Brooks.

Some meteorological paradoxes: W. J. Humphreys.

How the American Meteorological Society can serve geography teachers: C. F. Brooks.

Use of laws in teaching climatology: S. S. Visher.

Motion pictures of weather maps: a report of progress: J. Warren Smith.

The work of the Weather Bureau in the West Indies: O. L. Fassig.

Aims and achievements of the Blue Hill Observatory: A. McAdie.

Aerological work in the U. S. Navy: C. N. Keyser.

Plans for establishing a network of meteorological stations in Palestine: P. W. Etkes.

Determination of the normal temperature by means of the equation of the seasonal temperature variation and of a modified thermograph record: F. L. West, N. E. Edlefsen and S. P. Ewing.

The roaring of the mountain: W. J. Humphreys.

Some applications of radio-telegraphy to meteorology: J. C. Jensen.

Sunshine in the United States: R. DeC. Ward.

Cloudiness in the United States: R. DeC. Ward.

Weather conditions in the orchard regions of the North Carolina mountain slopes: H. J. Cox.

The effect of a "lid" on the temperature and transparency of the lower air: J. W. Redway.

Preliminary steps in making free-air pressure and wind charts: C. L. Meisinger.

The prevailing winds of the north Pacific coast: A. E. Caswell.

Evaporative capacity: R. E. Horton.

A device for measuring maximum and minimum temperatures of reservoir surfaces: R. E. Horton.

Clouds and their significance: C. F. Brooks.

Difficulties in the theory of rain formation: W. J. Humphreys.

Cultivation does not increase rainfall: J. Warren Smith.

Predicting minimum temperatures: J. Warren Smith.

Seasonal distribution of maximum floods in the United States: A. J. Henry.

Weather and business: A. W. Douglas.

Explanation of peculiarities in flying in the wind: J. G. Coffin.

Determination of meteorological corrections on the ranges of guns: W. Noll.

Evidence of climatic effect in the annual rings of trees: A. E. Douglass.

On January 21, the society was incorporated in the District of Columbia. The membership of the society, elected up to the end of January, was 586.

The next meeting of the American Meteorological Society will be held in Washington, D. C., probably, Thursday, April 22, immediately preceding that of the American Physical Society, on Friday and Saturday, April 23 and 24. Plans are being made for meetings with the Pacific Section of the American Association for the Advancement of Science next summer and with the American Association for the Advancement of Science in Chicago next December.

Charles F. Brooks,
Secretary

Weather Bureau,
Washington, D. C.

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CONSTRUCTIVE SCIENTIFIC RESEARCH BY COOPERATION[1]

IT has been occasionally suggested that one of the reasons for the slow advance of science lies in the fact that scientific research problems are still generally attacked by individuals or by small, local groups of workers influenced by a single individual, rather than by planned cooperation among a number of workers in different institutions. Individualistic research has been characterized, by the late Professor C. E. Bessey, as a kind of guerilla warfare upon the unknown. As in other lines of human activity, it seems highly desirable to outgrow this kind of attack, just as rapidly as the appeal of well-planned campaigns and the desire for a maximum of service to race advancement makes itself felt by scientific workers. Commercial research is now frequently carried on in this way, different individuals being actually paid for studying certain aspects of a broad problem and for bringing their minds to bear upon it in a cooperative way. The more fundamental aspects of scientific investigation and the clearing up of the broader, general principles of science have not usually been approached in this manner; the extremely individualistic methods of the Middle Ages seem still to be in vogue.

This state of affairs in science is sometimes thought to be due to the supposed fact that an investigator can not confine himself to what he starts out to study, but that he is constrained, by the nature of investigation itself, to follow his evanescent interests and caprices wherever they may lead. But the scientific researches undertaken and carried out by large commercial establishments and also, especially, those that were so remarkable furthered by preliminary planning and a division of work,

[1] Prepared by request of the chairman of the Division of Biology and Agriculture of the National Research Council.

under the governmental auspices of the nations recently at war, seem to furnish convincing argument against this view. When workers have been paid for solving a specific problem that fits itself into a general scheme of scientific progress—whether payment has been in money or in the approval of their contemporaries or in their own satisfaction in worthy service—it appears that they have been able to perform their separate parts of a broad plan and that they have often accomplished the almost impossible. One prime reason for the medieval methods followed by fundamental research seems to be that significant money rewards are not generally offered for this sort of work and that popular approval still goes to the guerilla rather than to the unit of an organization. The motive of worthy and constructive service to nation and race seems often to be thrust into the background, excepting in so far as the "bias of happy exercise"—with the satisfaction of doing just what one likes to do from day to day, unhampered by previously made plans—gives a person to feel that his own activities must be greatly worthy and outstandingly constructive. It seems, however, that all of us are strongly moved at times by the idea of communal service; for the most part we are glad to consider ourselves as doing our best to be worthy parts of a worthy whole, and therein lies the substratum out of which the morale of an army's research division or of an industrial laboratory is organized.

The cooperative instinct is strong in most scientists, as in other people, but the practical lack of means whereby constructive cooperation might be planned and arranged makes it very difficult indeed for any single worker to break away from medieval individualism in research. To cooperate, it is necessary to find several others with whom to plan and work and with whom the detailed operations may be divided and shared; in short, to organize a cooperation or to find one already organized. If an individual feels the impulse for cooperative service so strongly as to lead him to act, he must first give up his actual investigations for a time, until the needed organization may be created; he does not generally find it in existence. He may approach his colleagues in either of two ways, both of which are apt to lead to bitter disappointment, as things are today. First, he may seek workers who will join with him in attacking a fundamental problem already partly planned in his own mind. Without some money to expend on the work, or some position to offer, he may be met with the suspicion that his motives are ordinarily selfish, that he desires someone else to "pull his chestnuts from the fire." Second, he may offer his services to those who have plans for constructive research problems in mind, but here also he may often be suspected of ulterior motives of low-grade selfishness, and his offers may be responded to by increased secretiveness, so that he may not receive the encouragement he sought. The whole idea of cooperation in such things is so novel that to propose it without money payment seems almost to argue an idealism that verges toward insanity. And yet the conception of cooperation among human beings forms the central strand about which has been braided the cable of most forms of human faith.

It appears that the democratic cooperation that is obviously needed requires an organization that shall not depend on the autocratic leadership of some individual enthusiast, who might soon get looked upon by his followers as a "super-man" or as possessing some sort of divine right (even though he himself might lay no claim to such attributes) and against whom opposition might grow ever stronger because of this very fact. A suitable motto for the organization needed might be that of the French republic, there being as much liberty and equality as is possible with true fraternity (which is cooperation). If such organizations as are here suggested are to be formed they should be cooperative from the very start and should center around several individuals. They should be democratic in nature. It must be clearly understood that the original group have merely tried to plan the work so as to bring about the greatest advancement, and that the original plan is but a temporary scaffold, to be modified from time to time and finally replaced by other plans, as the work progresses and as new ideas are brought to light. This feature apparently requires repeated emphasis, to offset the mistaken thought that any free thinker is to be hampered in his scientific progress if he joins in with a group of others who already have in mind a broad, although always tentative, plan. On the other hand, it is especially essential that any organization for cooperation should exhibit a strong *esprit du corps,* and if a prospective cooperator feels that his entrance into the organization may result in too great modification of his own ideas of what he should do, if he does not respond to the general aims and motives of the group, he should consider carefully before he joins.

Given the needed organization, safeguarded against autocracy or bureaucracy, around which and in which cooperative research might develop—more as a coagulation due to the internal conditions of an emulsion than as a precipitate forced by a reagent from without—it really seems possible for beginnings to be made, even without considerable financial support. According to the writer's experience with his colleagues it is not true that scientific research workers do not generally wish to cooperate. A number of able workers can be found who will gladly join hands in the prosecution of almost any problem that may be mentioned. It is of course not to be expected that all workers will unite on any particular portion of the vast realm of science; if the project in question is concrete enough to be ready for actual attack there will, of necessity, be only relatively few who will take part. Furthermore, the more fundamental is the nature of the problem, the fewer will be the number of possible cooperators; many would join together to find ways of reducing the cost of living, while only a few could be found to work conjointly on the ultimate nature of life itself! Clearly, the function of the original organizations for cooperative scientific research must be to find the cooperators and to prepare a way by which these may cooperate. To accomplish this, the preliminary organization will of course require time and thought from several persons, and some funds must be available for assistance and for travel. Scientists are not generally able to command even such small funds as will be needed; they will rightly feel that, if they devote time and serious thought to this matter of organization (thus temporarily setting aside their own investigations), the small amounts of money needed should come from elsewhere. It is not necessary, however, to pay for the time and thought of the cooperators themselves, these may be had for the asking; but mechanical and clerical assistance must be furnished to the preliminary organizations if they are to be successful. Without funds for this (and for travel, also, in many cases) such organizations ought not to be started, for without such funds they can do little more than distract the attention of their members from their own researches. An active guerilla warfare seems much better than mere social gatherings that would be unable to act upon a decision even if they should reach one, as to what is needed and what ought to be done. This consideration assumes special importance when it is remembered that the individualistic and non-cooperative method, poor as it confessedly is, is the only one that has been really tested in fundamental research, and that discussions within groups that are without adequate power to act are apt to detract from the volume of individual research, while they may add but little to true accomplishment.

To determine whether cooperators may be found for a given project it seems desirable to begin the organization in an experimental way. The preliminary organization will need widespread publicity among the proper public. Tentative plans for the problem in hand will need to be submitted to many minds, will need to be repeatedly modified or remade, until a sufficient group of workers are willing to enter into the proposed cooperation. Diversity of geographical location and of temperament and interest among scientists, make the preliminary testing of any cooperative project an operation that must necessarily consume much time; several years may generally elapse before a true decision can be reached as to whether the project itself is really fitted for cooperation. It is clear that men who are busy with other matters will not generally be able to perform this sort of preliminary service unless adequate funds for assistance and travel are available.

In the preceding paragraphs the need and the apparent possibility for cooperation in productive fundamental research has been emphasized, but it is not to be forgotten that there are other lines of cooperative endeavor to which the attention of scientists might turn, lines along which larger numbers of cooperators might be willing to unite. Practical research, for example, which always holds forth hopes of financial return, is more generally attractive than fundamental research. Applied science readily finds financial support, either from individuals or from commercial organizations, while fundamental science is not so generally and practically appreciated. Another field of cooperation in which large numbers of scientists would surely cooperate is that in which lies the problem of suitable publication and dissemination of the results of research. This field also commands considerable support, partly on account of the fact that publications frequently pay their way in the commercial sense and partly because research institutions of various kinds (especially governmental ones) may hope to gain prestige through the publication and distribution, of good scientific contributions. Still another example may be mentioned, in the field of bibliography, with which the writer has dealt to some degree in other places.[2] A great cooperation of this kind, involving hundreds of workers, has recently been inaugurated in the new botanical abstract journal. Finally, there are possibilities for valuable cooperation in making the facilities for experimental research available to more workers than is now the case. Thus a number of workers might unite to find the needed buildings and apparatus for a research laboratory in which any scientist might work; this has been done in several instances. These and many other lines of cooperative endeavor that might be mentioned are all surely worthy of the best that we find in us, and it is not the intention of the writer to maintain that constructive, fundamental research is more important than any other line. This paper, however, is planned to deal especially with cooperation in fundamental scientific research itself, in the solving of the actual problems of science, and so other fields for cooperation are not here dwelt upon. The following paragraphs will set forth some of the apparently possible ways by which the organization of actual cooperative research might be attempted under the auspices of the National Research Council; there is no doubt that such activity lies within the prerogative of the council or of any of its divisions, should they see fit to undertake it.

[2] See Science, 49: 199–207. 1919. The remark in the text refers also to some unpublished memoranda presented to the Division of Biology and Agriculture of the National Research Council.

POSSIBLE ORGANIZATIONS FOR COOPERATIVE PROJECTS

Since actual research deals with somewhat definite and concrete things, it is clear that a separate organization is required for each project and that a project must be relatively narrow in order to be suitable. A committee on the general subject of cooperation in research, without a specific problem, might be valuable in other ways—mainly educational—but it could not further research cooperation unless it narrowed its purview. General committees might be formed (some are already in existence) to canvass the various scientific fields and prepare, from time to time, lists of projects that seem promising for cooperation.

Before it can be decided whether or not a given project for research cooperation is to be undertaken, that project must of course be presented in a rather complete, though preliminary, way. Scientists might be encouraged to present plans for projects. These plans should show clearly what sort of work is contemplated, how it may be divided up among the cooperators, how the results may be handled so as to bring them into the permanent structure of fundamental science, what funds will be required for assistance, travel, etc., and such other essential features as might enable an executive committee, or other similar board, to make a rational decision. After a set of preliminary plans had received the approval of a division of the council, the most promising course to follow might be to establish a special preliminary committee on the given project. This committee might be instructed to proceed to get the work started if funds are already available, or to attempt to procure these if they are not. It can not be too strongly emphasized that some funds are necessary, even for the activities of such a preliminary committee, for it is neither safe nor desirable to ask research workers to donate money, as well as time and energy, to this sort of endeavor. After the needed funds have become available the preliminary committee may proceed to consult or correspond with all probable cooperators, asking first their aid in completing and elaborating the details of the preliminary plan in such a way that it may be feasible. As this work goes on it should gradually become apparent how many cooperators may be hoped for, and when the preliminary committee judges that the project has reached a feasible stage the committee may enlarge itself so as to include all those of its correspondents who are willing to cooperate. This enlarged committee (which would be the organization mentioned above, as needed before a cooperative project may be actually started) may then reconsider the detailed plan and divide the work up among its members. A project may fail at any stage, even after the enlarged committee has been formed, but it seems probable that a good measure of success may be regarded as fairly assured when this stage shall have been reached. Haste is not desirable, to do good work much time must be allowed, but the preliminary committee would report the project as impossible at present, if it were found impracticable to obtain a reasonable number of cooperators, or the necessary funds for its work.

A cooperative organization started in some such way as this would almost surely be successful, but the contemplated measure of its success must not be too large. It must be remembered that this sort of cooperation, if begun, would tread on new ground and would surely encounter unexpected difficulties. No considerable concrete results need be looked for at the end of a single year and the financial support available at the start ought to give promise of remaining available for several years at least. Nevertheless, the very idea of such cooperative endeavor in research fields is so extremely novel that much discussion and publicity in the proper circles would be needed before it might be realized, and each preliminary plan submitted, each preliminary committee appointed and each letter or publication or conference produced by such a committee, would help to build up the spirit of cooperation. It should be recognized that the fact of cooperation itself is vastly more important than cooperation on any special project; if one project should fail others should be attempted, the work must be regarded as experimental. It would make little difference just what particular problems were undertaken in this way, but it seems highly desirable that *some* problems might be so attacked. Once applied in a concrete case or two, the general idea would surely spread more rapidly than ever could be the case if it were held indefinitely in the phase of *a priori* discussion. As in the prosecution of experimental research itself, it is only by actual trials that it can be found out what degree of success might attend such cooperative organizations as are here suggested.

SOME SPECIAL FEATURES OF COOPERATION IN EXPERIMENTAL RESEARCH

Several features of cooperative research have been impressed on the writer during a number of years' experience with this sort of attempt. First, there appear to be a large number of good experimenters who do not have well-selected problems in mind, who work on that which lies close to them rather than on that which seems to be most fundamental, most far-reaching or most imperatively needed for the growing structure of knowledge. These workers are generally the younger men, and they almost always prove to be glad to join a cooperation that appeals to them as well planned. Of course they can not usually afford to finance such work and they are not always able to obtain financial support from their institutions, but they are generally very willing to work with great enthusiasm on a cooperative project if the actual expenses can be met. For example, about forty workers joined heartily in an experimental study of evaporation in the United States in 1907 and 1908, and all that was needed was that the requisite apparatus and materials should be furnished, together with postage for their reports. Similarly, about eight persons, none of them professional scientists, cooperated very successfully in an experimental study of the climatic conditions of Maryland in 1914. In this case all apparatus was furnished, and each station was visited fortnightly by the scientist who had the work in hand. For the most part, those who have been cooperating in the project on the Salt Requirements of Plants (Division of Biology and Agriculture, National Research Council) have provided their own apparatus, but it has been necessary to supply some equipment in a few cases and to furnish report blanks, seed, etc. Experience seems to indicate that many people are glad to cooperate if a project is well presented and if it has promise of being continued long enough to produce results. In the cooperations with which the writer has previously had to do, a definite time limit was set from the start and enthusiastic cooperation lasted through the period; indeed, in one case the work was continued by many cooperators for more than a year after the agreement came to an end, but it was possible to find the small amount of needed funds for this extension from sources other than the original one.

To maintain enthusiasm among a group of cooperators it would of course be necessary for the committee to see to it that an active correspondence should be kept up. Every one appreciates being written to about his work, being told of what others of the organization are accomplishing, being able to ask for suggestions and advice when difficulties arise, etc. This means that a central office for each cooperative organization should be maintained, and that some competent person should act as secretary and custodian of records. Here is the main limit placed, by the nature of the work, upon the extent of cooperation in actual, concrete research. The number of cooperators would be limited by the amount of time and the amount of assistance that were available to the person acting as secretary. For obvious reasons formal letters would not be satisfactory, and each cooperator should be treated individually. In actual experimentation of an intricate kind it appears that a single individual, with adequate assistance, can care in this way for not more than perhaps a dozen cooperators. With a much larger group the work of the central office would have to be divided and the personal nature of the correspondence would be largely sacrificed. Of course a larger cooperative organization might be arranged in sections, each with its central office, but where all the work interlocks intimately with all the other work such subdivision would probably introduce difficulties requiring much special study. Furthermore, the experimental results obtained by the various cooperators would require very thorough study, tabulation and presentation in other ways, before they might take their place in the planned whole. This work can not generally be accomplished by the cooperators themselves, though each worker would always make his own interpretations as he proceeds. The central office would carry on the work of correlation and would keep the cooperators informed as to new developments coming from the work of others and from combinations of results from several sources. This feature of productive cooperation in research also sets a limit to the number of cooperators that may profitably work together on a concrete problem. Finally, it needs to be emphasized that the work as a whole would require adequate presentation in some suitable form of publication and that individual publications of the cooperators—although these might form a basis for this treatment of the whole problem—would not suffice. What seems most needed are constructive and progressive contributions toward the solution of definite problems that are ready for experimental attack, and the central office of such an organization as is here considered would plan to undertake these. Preliminary presentations might be prepared and submitted to all cooperators. Out of the correspondence thus developed would eventually come a presentation that might measurably approach a truthful one, whereas single individuals could not hope to do more than make incomplete and more or less one-sided contributions in the desired direction, their papers being similar to most of those that now appear in the scientific publications.

From the last paragraph it will be appreciated that the writer's idea of cooperation in research involves the union of a number of minds in planning the attack on a problem, in working out the different parts, and in bringing the several component results together into a well-considered presentation that might really mark a tangible advance in scientific knowledge. Cooperations of this sort would bring it about that many of the experimental mistakes that cause so much discussion in scientific literature might be avoided at the start (through cooperative planning) and that most of the adverse criticism that leads to such wasteful polemics in many scientific fields might be already past before the main publication occurred, for each cooperator—and perhaps others also—would act as critic regarding the general presentation while it was still in manuscript form.

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SUGGESTIONS FOR ECOLOGIC INVESTIGATIONS IN VERTEBRATE ZOOLOGY[1]

In a recent message transmitted to local administrators throughout the country praising them for their efforts during the war Food Administrator Hoover declared that the American people now "are summoned to a still larger task—to provision the Allies and the liberated nations of Europe, which face not their civilization together unless a steady stream of food supplies can be kept flowing to hunger alone, but the collapse of all that holds them to repair their gravest deficiencies, and in far greater volume than by utmost stress was sent last year."

As is well known to everyone, under the continuous and effective stimulus of the United States Department of Agriculture there has taken place a speeding-up process on the farms throughout the nation, a process which must apparently be continued and even augmented if we are to succeed in our wrestlings with the problem of world food shortage.

It is obvious that one very practical way in which to increase food production is to cut down the losses due to plant or animal pests. The department has addressed itself with extraordinary vigor to this problem and a comprehensive program in pest control is being administered by the different bureaus. That portion of the program concerned with reduction of losses due to rodents and other mammalian or bird pests devolves upon the Bureau of Biological Survey.

Current estimates place damage done to the carrying capacity of the open range and to cultivated crops generally by rodents in the western states at $300,000,000 annually. Add to this the destruction of live stock by predatory mammals, estimated at some $20,000,000 every year, and the damage done to goods in warehouses and stores throughout the United States by rats and mice, an additional $200,000,000, and we have an impressive total. Particular interest attaches to these figures at this time in view of the comprehensive plans for the reclamation of arid and other lands in behalf of returned soldiers recommended by the Secretary of the Interior and given favorable mention by the President of the United States in his latest address to Congress. Potential or actual rodent pests exist on nearly every acre of the arid land which it is proposed to reclaim. In some sections effective

[1] Read before the Ecological Society of America, Johns Hopkins University, Baltimore, December 28, 1918.

rodent control will be an absolute prerequisite to successful dry land agriculture.

Important as this side of the work undoubtedly is, the destructive or pest-control aspect of the work is not the only one to which attention is given. Constructive measures under consideration include such items as game protection, with its multitudinous perplexities, biological and legislative; further domestications of wild species, as ducks and other game birds, deer, elk, buffalo and furbearing mammals; possible use for food of available wild animals not now so utilized; artificial stimulation and increase of beneficial wild species of birds and mammals; introduction and acclimatization of birds and mammals; administration of bird and mammalian resources of zoological parks, national forests, game preserves, bird reservations and national parks.

It will be readily realized that problems of extreme difficulty arise in connection with both the program of pest eradication and that of the development and increase of beneficial species, problems the solution of which depends upon a much more adequate knowledge of and control of the balance of nature than man has yet been able to acquire.

Years ago Spencer F. Baird called attention to the fact that the only rational basis for fisheries administration is the complete knowledge of aquatic creatures to be acquired by intimate investigation. He emphasized the fact that it would be of doubtful value to study only the major forms which supported fisheries and that "useful conclusions must needs rest upon a broad foundation of investigations purely scientific in character." This generalization applies with at least as much force to the terrestrial vertebrate fauna as it does to fishes. With this thought in mind, the Biological Survey has for more than thirty years been carrying forward investigations in North America dealing primarily with the geographical distribution and habits of birds and mammals.

It seems to be clear that this work should not only be continued but should be expanded; and that expansion may well take place in the direction of a more intensive investigation of the relation of animal to environment on a dynamic as well as static basis.

The expansion of ecologic activities by the Biological Survey and other agencies engaged in biologic researches does not, of course, exclude the prosecution of the faunal natural history investigations. On the other hand work in ecology implies a fairly thorough knowledge of faunas and floras. It is not unlikely that new methods of the ecological type may be utilized profitably in connection with natural history surveys. In addition to this the ecologic point of view should be tried out in the interpretation of distributional data.

As compared with the plant ecologist, the animal ecologist is working at a considerable advantage. Though many problems of method and approach peculiar to the animal side of the work are bound to present themselves, much of the way over which the animal ecologist must go has been traversed already by his botanical colleague; and by virtue of this fact it should be possible for him to avoid many missteps and false leads. Instrumental studies of the environment have been carried forward to a very considerable extent by the botanist, thus relieving the zoologist of some, at least, of this fundamental labor. Furthermore, many of the guiding principles for research work in plant ecology, already enunciated by the botanist, can be adapted to the field of animal ecology.

Of course, with animals, the factor of mentality introduces a host of new problems into the study which are almost wholly lacking with plants. To a certain extent the new difficulties resulting from this factor neutralize the advantages derived from the fact that the botanists have done pioneer work.

The comprehensive demands of the ecologic program peculiarly emphasize the desirability of cooperative effort. The association of individual investigators who are specialists in botany, chemistry, geology and meteorology, as well as in zoology, will often be necessary to the adequate organization of the work; and it may often be advantageous for institutions as well as individuals to work together. It is obvious that many universities and colleges, by virtue of their locations and resources, have abundant opportunity to perform valuable work in the ecology of vertebrates.

Although for some of the more detailed researches in the physiology, chemistry, habitat relations and psychology of animals a considerable amount of apparatus is necessary, investigations of the highest importance may be carried forward with relatively simple equipment. The field is sufficiently comprehensive to afford promising opportunities to any sincere and resourceful student with proper training.

Suggestions as to equipment needed in the different lines of work indicate the wide latitude of choice open to the prospective investigator. For the prosecution of field work there should be provided camp outfit, traps and collecting materials, photographic apparatus, balances and if possible, equipment for field study of habits, such as shovel, axe, trowel or large spoon, brush cutter, tape-line, sketch pad, coordinate paper, and writing materials. For more detailed study of the habitat apparatus such as thermometers and thermographs, wet-bulb thermometers and psychrographs, rain gauges, geotomes, etc., are required. Investigations of the chemistry and physiology of the animals in question call, of course, for special equipment; and in connection with many of the studies it is necessary to provide some cages, pens, yards or other enclosures for breeding and keeping terrestrial vertebrates under close observation.

The richness and attractiveness of the field may be amply demonstrated through the simple device of a tentative program of work.[2] It is fully realized, I may add, that a program of research may be outlined with comparative ease, but that it is often relatively difficult to get results. But the drawing up of this program, embracing, as it does, material for many investigations, is doubtless justified in that it indicates the immensity of the field, implies the necessity for widespread cooperation in the exploration of its resources, and points out some comparatively neglected fields of research in vertebrate zoology which are full of promise.

I. Close analysis of the animal community.
  1. Community reactions.
    (*a*) Origin.
    (*b*) Migration.
    (*c*) Invasion and reinvasion.
    (*d*) Establishment.
    (*e*) Competition.
    (*f*) Dominance.
    (*g*) Extinction.
  2. Primary and secondary succession in the animal community.
    (*a*) Primary succession as illustrated by zonation in selected localities.
      (1) In deserts.
      (2) In areas of moderate humidity.
      (3) In regions of excessive humidity.
    (*b*) Secondary succession as illustrated by results of interference with the natural balance by man.
      (1) Permanent changes in animal population.
      (2) Reinvasions of abandoned areas.
      (3) The animal assemblages of over-grazed areas; of areas denuded by deforestation; of forest burns; of flooded areas; of drained areas; of reclaimed areas in general.
    (*c*) Climax assemblages of animals.
      (1) Significance for game protection.
      (2) Significance in animal control.
    (*d*) Factor control of distribution and succession among animals.
      (1) Physical factors.
      (2) Biotic factors.
  3. The animal community and climatic cycles.
    (1) Interrelations with forest reproduction.

[2] I am indebted to Dr. Frederic E. Clements, of the Carnegie Institution of Washington, for helpful suggestions in this connection.

(2) Interrelations with forage production on the open range.
(3) Interrelations with crop production.
(4) Climate and fluctuations in animal populations.

II. Analysis of relation of individual animal to its environment.
1. Breeding habits.
2. Migration.
3. Hibernation and estivation.
4. Nests, shelters and other structures.
5. Interrelationships of species.
6. Adaptation of particular life forms to the environment.
7. Controlled investigations.
(1) In the laboratory.
(*a*) Behavior.
(*b*) Food.
(*c*) Adaptation and response.
(*d*) Domestication.
(2) In the field.
(*a*) Fenced areas for special study, *e. g.*, of damage done to forage.
(*a*) Rodent inclosures; exclosures.
(*b*) Eradication plots; reinvasion plots.
(*c*) Census and burrow investigation areas.
(*d*) Reseeding plots.
(*b*) Comparison of animal responses in different measured habitats.

III. Analysis of broad movements of animal populations through time.
(1) The paleontologic record.
(2) Present distribution.
(3) Relationships of animals to the envirments of the past.
(4) Successional communities of animals.

IV. Analysis of data of geographical distribution of higher vertebrates.
1. Realms, regions, life zones, faunal areas, formations, associations, animal communities in general.

V. Economic aspects of analysis of the animal community.
1. Animals and products of the farm.
(1) Rodents and crops.
(2) Relation of birds to agriculture.
(3) Predatory animals and the stock industry.
(4) Economics of fur bearing animals.
2. Animals and reforestation.
(1) Effect of rodents on natural or artificial seeding.
(2) Big game and the forest.
(3) Birds and insect tree enemies.
(4) Animals and forest burns.
(5) Animals and logged over areas.
3. Animals as related to the grazing problem.
(1) Effects of rodents on carrying capacity of the range.
(2) Elucidation of the relations of cattle, sheep, goats, big game, predatory animals, rodents and plants in the disturbed conditions now prevailing on the open ranges of the West.
(*a*) Comparison with conditions in northern Africa, Europe, Asia, Australia.
(3) Permanent vegetative changes produced by the unrestricted grazing of cattle and rodents, and their significance from the standpoint of range maintenance and the future maximum productivity of the land.
4. Further domestications of wild species of animals.
(1) Ducks and other game birds.
(2) Deer and elk.
(3) Fur bearing mammals.
5. Statistics of animal economics.
(1) Estimates of numbers of rodents and other mammals and birds of economic significance in different types of country.
(2) Estimates and determinations of extent of different types of country in the United States.
(3) Estimates of benefits or losses conferred by different species of vertebrates.
(*a*) As individual animals.
(*b*) Aggregate for species as a whole.
(4) Estimates of total losses from rodents and other harmful mammals in the United States.

(5) Estimates of cost of complete control of noxious species, together with amount of probable saving that would result.

6. Beneficial animals and their preservation.
   (1) What animals are beneficial?
   (2) Relation of age of species to problem of its preservation.
   (3) Effect of occupation by man on animal community.
   (4) Essentials for conservation.
      (*a*) Maintenance of seed-stock; determination of annual toll permissible; unfair methods of destruction; effect of legislation on game conservation.

7. Noxious animals and their destruction.
   (1) What animals are noxious?
   (2) Methods of control; rodents, predatory animals, other groups.
   (3) Effects of extirpation of wild species on the natural balance.

By way of summary, may I repeat that present day world politics emphasize in unmistakable terms the vital necessity of increase in food production. For permanent increase in the productivity of the land further study is called for of the scientific fundamentals on which agricultural practise is based. The ecologic method of approach promises much of value. The problems are vast and lead inevitably to the stressing of the strategy of cooperation as an essential to their successful solution.[3]

Walter P. Taylor
Biological Survey

[3] The symposium on the relations between government and laboratory zoologists held in connection with the meeting of Section F at the sessions of the American Association for the Advancement of Science, Johns Hopkins University, Baltimore, December 28, 1918, emphasized the desirability of better coordination and cooperation between these two large and active bodies of scientific investigators. In this connection the Bureau of Biological Survey solicits correspondence from all who contemplate researches in the ecology of the higher vertebrates, and will be glad to assist with suggestions, advice, or otherwise as opportunity may be given.

THE ATTAINMENT OF HIGH LEVELS IN THE ATMOSPHERE

It is a far cry from January 7, 1785, to February 27, 1920. On the earlier date Dr. John Jeffries ascending from the cliffs at Dover, made his way through the air over the English Channel to France, landing after an eventful three hours, on the French coast in the forest of Guines.

During the flight his barometer ranged from 1,006 kilobars (29.70 inches) to 789 kilobars (23.30 inches) indicating at the lower reading a height of nearly 2,012 meters (6,600 feet).

On Friday, February 27, this year, Major R. W. Schroeder, chief test pilot of the Air Service, rose from McCook Field at Dayton, Ohio and reached an elevation of 10,979 meters (36,020 feet).

Jeffries of course used a balloon; Schroeder an airplane designed for climbing, and with a supercharger, *i. e.*, a gas turbine centrifugal compresser to offset the loss at the carbureter due to diminished density of the air at such heights.

The history of the attack upon the high levels of the atmosphere may then be said to extend over a period of one hundred and thirty-five years. Various methods and agencies have been employed. Within twenty years from the time of the first ascension, heights of 4,000 meters had been attained. Indeed Gay-Lussac made certain scientific observations at a height of 7,400 meters in 1804.

On September 5, 1862, Glaisher and Coxwell reached a height of 11,200 meters or practically the same level as that reached by Schroeder with an airplane. Three other noteworthy records by manned balloons are those of Tissandier, Spinelli and Sivel, acting for the French Academy, who reached a height of 8,530 meters, on April 15, 1875; Dr. A. Berson who on December 4, 1894, reached 9,600 meters; and later (1901) Berson and Süring to a known elevation of 10,500 meters and probably 10,800 meters, both men being unconscious at the higher level. In all of these high balloon flights, the observers became unconscious, and this even in the later attempts when recourse to oxygen inhalation was had. In the airplane and Zeppelin ascensions to be referred to later, the observers were provided with oxygen, and what is equally important, body heating devices to enable them to withstand extremely low temperatures.

While not, strictly speaking, a manned balloon, it must be noted that in the famous Zeppelin raid of October 19, 1917, the barographs of the flagship L 49, superdreadnaught, indicated that at least for a short period the airship had attained a height of 6,200 meters. The crew were provided with oxygen tubes and wore electrically heated mittens and boots. There is some doubt, however, concerning the height, owing to the speed of wind and ship.

A brief summation[1] of the extreme elevations attained, up to 1917 is:

By kites, 7,044 meters, Mt. Weather, Va., Oct. 3, 1907.

By manned balloons 10,800 meters, Berson and Süring, July 31, 1901.

By Zeppelin, rigid dirigible, 6,200 meters, October 20, 1917.

By airplane, 7,950 meters, G. Guidi, Nov. 7, 1916.

By sounding balloons, 37,000 meters, 1912.

By pilot balloons, height determined by theodolite, 39,000 meters.

The airplane record has been steadily developed. In 1909 Latham made 161 meters; which was soon surpassed. Drexel in 1910 made 1,829 meters and then in rapid succession Macrane 2,582 meters, Wynmalen 2,800 meters, Drexel 2,880, Johnston 3,193, Loudan 3,280, Parmelee 3,304, Brindley 3,585, and Legagneux, 5,718, a noteworthy jump.

Perreyou on March 11, 1913, attained a height of 6,000 meters.

The war gave a tremendous impetus to the development of the plane; and the necessity of quick and high climbing was fully appreciated by all the belligerents.

Major (then Captain) Schroeder on September 18, 1919, reached a height of 8,809 meters (28,000 feet) at Wilbur Wright Field.

1 From "Principles of Aerography," p. 19.

Captain Lang and Lieutenant Blowers of the Royal Air Service, in the brief space of 66 minutes, reached an elevation of 9,295 meters (30,500 feet); to be in turn surpassed by Roland Rohlfs at Roosevelt Field, Mineola, who made 9,357 meters (30,700 feet) on July 30, 1919, and again on September 18, of the same year when in the short space of 78 minutes he rose 10,516 meters (34,500 feet) and fluttered back to earth as gently as a snowflake drops.

Mention should also be made of the flights of Adjutant Casales on May 22, 1919, to 9,449 meters, June 8, 9,495 meters, and on June 14, to 10,100 meters (33,136 feet).

The record now stands Schroeder, February 27, 1920, 10,979 meters. Thus in a period of ten years the heavier than air machine has been so improved that elevations have increased from 500 to practically 11,000 meters. We are told that the goal of American aviators is 12,000 meters or approximately 40,000 feet, but it is of course, possible that this ceiling shall be lifted still higher, and that a height of 15 or even 16 kilometers (10 miles) may be reached, provided suitable protection (so-called diving suits) for the airman is available.

In Schroeder's latest ascent, the oxygen supply was exhausted and the results were tragic but fortunately not fatal.

The fact that heavier than air machines can be driven to the 10-km. level means much to the aerographer, particularly in connection with forecasting weather changes at the surface. This is the most important level for studying not only pressure, temperature and water vapor content, but the air flow and structure of cyclone and anticyclone. The 10-kilometer level is the bottom of the stratosphere or isothermal region and at the same time the top of the troposphere or convectional region. As a postulate to Dines's statistical studies we know that in the stratosphere or region above 10 kms. it is colder in an anticyclone than in a cyclone at the same level, while on the other hand in the troposphere, *i. e.*, from 9 kms. down to 1 or 2 kms.

it is warmer in the anticyclone than in the low. This holds for Europe but is not entirely confirmed for the United States. The height of the base of the stratosphere varies in Europe with cyclonic and anticyclonic weather from about 8 to 13 kms. It also varies with latitude, averaging 9.6 at Petrograd; 10.6 in England; 11 in Italy; and 11.7 in Canada.

Thus it can readily be predicted that at a height of 10 kms. in the latitude of New York an airman rising on an afternoon in the early fall will experience a temperature lapse or vertical decrease amounting in all to 200 kilograds, *i. e.,* from 1,050 to 850 kilograds, using a scale on which the absence of all molecular heat is represented by 0 and the ordinary freezing point by 1,000. On the Centigrade scale this would be from 14° above freezing to 41 degrees below freezing.

If our atmosphere were homogeneous, we should reach its top at a height of 8,000 meters. There would then be no need of superchargers; and oxygen tanks would be advantageous but not absolutely indispensable. But this does not occur in nature and the density of our aerial envelope at 8,000 meters is actually 40 per cent. of what it is at the surface. At 10,000 meters it is just 33 per cent. of the surface density.

Km.	Kk.	Kb.	*gm/m*³.
20	783	55	87
19	787	63	102
18	783	74	121
17	772	87	144
16	772	102	169
15	772	120	198
14	776	142	233
13	783	167	268
12	790	195	314
11	802	228	365
10	816	266	415
9	838	309	470
8	864	358	528
7	890	413	592
6	920	475	662
5	945	543	733
4	967	618	815
3	989	703	905
2	1,008	798	1,011
1	1,018	903	1,134
0	1,033	1,017	1,258

The preceding table somewhat modified from the data given by Dines in his recent paper on the "Characteristics of the Free Atmosphere" indicates the average temperature, pressure, and density of the air at various heights. The height is in kilometers, temperature in kilograds, pressure in kilobars and density in grams per cubic meter.

Schroeder's thermograph indicated a minimum temperature of —55 degrees C. (or 99 degrees below freezing on the Fahrenheit scale). This on the new temperature scale is 799. It will be seen that this temperature indicates a height of about 11,000 meters.

In one of Rohlf's ascents he went beyond the top of the troposphere or above what might be called the temperature lid. On that date, the base of the stratosphere was below 10 kilometers and, therefore, he passed into a somewhat warmer level even though at a greater elevation.

Alexander McAdie
Blue Hill Observatory,

THE SEPARATION OF THE ELEMENT CHLORINE INTO CHLORINE AND META-CHLORINE

Although many attempts have been made to separate an element into two or more different atomic species, in no case have the experiments met with success. In my opinion this has been due largely to the fact that in all cases where it is *known* that isotopes exist, as in the element lead, the conditions imposed upon the experiments by the relative atomic weights of the different atomic species are such as to be extremely difficult to meet. For this reason, when five years ago I decided to make a separation of an element into isotopes, it seemed that it would be easier to separate the isotopes in an element where isotopes were not known to exist, than to meet the extremely arduous conditions of the known cases.

In 1915 I gave conclusive evidence that chlorine, magnesium, and silicon (in addition to neon as discovered by Thomson), among the light elements, are mixtures of isotopes, and that the atomic weight of the lighter isotope is 35.0 for chlorine, 24.0 for magnesium, and 28.0 for silicon. Among the heavier elements there are probably few elements which are not mixtures of isotopes. Thus there is excellent evidence in the atomic weights that the following elements are mixtures: nickel, copper, zinc, and practically all of the other elements form atomic number 28 to atomic number 80. The radio-elements from thallium (No. 81) to uranium (92) were at that time known to be mixtures of isotopes.

Experiments on the diffusion of chlorine gas were begun by Dr. W. D. Turner and myself in 1916, and early in 1917 slight differences in density were detected, but the chlorine was not entirely pure. Chlorine was used because it could be obtained in cylinders, and its flow was therefore very easy to control. However if chlorine consists of two isotopes, chlorine (Cl) and meta-chlorine (*Cl*), there are three forms of molecular chlorine: Cl-Cl, Cl-*Cl*, and *Cl-Cl*, and this is unfavorable to the diffusion. For this reason we have carried out most of our work by the use of hydrogen chloride gas, which, while unfortunately not obtainable in this country compressed in cylinders, at least has the advantage that its molecules contain only one atom of chlorine each, and that the hydrogen of the molecule has little effect in increasing the molecular weight.

This work was interrupted by the war, but by the summer of 1919 about ten thousand liters of gas had been diffused, a part of this diffusion being done by T. H. Liggett. In October, 1919, I interested Mr. C. E. Broeker in this problem. He has diffused about eight thousand liters of this gas and we hope soon to have an enlarged apparatus capable of diffusing a thousand liters per day, in the first section. At present we have five large units in operation or ready for operation.

The separation by diffusion of gases whose molecular weights lie close together is, according to the diffusion theory of Lord Rayleigh, an extremely slow process. Up to the present time we have concentrated our efforts upon the diffusion itself, and have spent little time in analytical work. The preliminary analyses indicate that the density of the fraction which remains inside the diffusion tubes, is increasing at about the rate predicted by the Rayleigh theory of diffusion, if we consider 35.0 as the atomic weight of chlorine, and 37.0 as the atomic weight of meta-chlorine. We have tested for most of the impurities which might be present except arsenic trichloride. The hydrogen chloride gas is generated from C. P. hydrochloric acid by the action of C. P. sulphuric acid. The next step in our work of proving that a separation has been effected is to secure larger quantities of diffused material, since our final fractions are still small, so that we may be more certain of our purification of the material, and then to make precise atomic weight determinations. If on such further purification we obtain an atomic weight for the heavy fraction as high as that already obtained in our preliminary analyses, we will have definite evidence that we have separated chlorine into a heavier and a lighter isotope. This will be of importance in two ways, first, it will be the *first experimental separation of an element into parts,* and second, it will be one of the strongest links in the proof that *the nucleus of the hydrogen atom is actually the positive electron.*

As stated above, I gave in a series of papers published five years ago[1] a system of atomic structure which gave very strong indications that chlorine, magnesium, silicon, and the other elements specified, are mixtures of isotopes. In fact this system of structure, for which there was much evidence, depended for its validity upon the existence of these isotopes, and in 1916 I published a preliminary notice[2] stating that we were working, on the separation of chlorine into isotopes. It is of great interest that Aston in a preliminary note written to *Nature* in December, 1919, states that his results obtained by positive rays indicate that both chlorine and mercury are mixtures of isotopes, with atomic

[1] *Journal of the American Chemical Society,* 37, 1367–96, especially pages 1390, 1391, 1387.

[2] *Ibid.,* 38, p. 19.

weights 35 and 37 for chlorine, thus confirming to this extent my theory with respect to the light elements and also for the heavy elements. Also in accord with the theory presented in my papers on atomic weights, he finds that the atomic weights on the oxygen basis are practically whole numbers.

The details of our experimental work on the separation of chlorine will be published as soon as we have collected enough material to enable us to make a more careful purification of our material, and when in addition the accurate atomic weight determinations have been completed. We expect to make the final separations by thermal diffusion. The theory of this method has been worked out by Chapman. Mr. Broeker and I are also beginning preparations for an extensive attempt to separate hydrogen into hydrogen and meta-hydrogen, the latter with an atomic weight of 3.0. While there was sufficient evidence for the existence of a meta-chlorine in ordinary chlorine to be found already in the atomic weights, there is no such evidence that ordinary hydrogen contains meta-hydrogen. However, there is evidence that the meta-hydrogen nucleus of a formula $h_3e_2^+$, where h is the hydrogen nucleus and e is the negative electron, is the most important unit in the building of atomic nuclei, with the exception of the alpha particle ($h_4e_2^{++}$). The nucleus of an isotopic atom of higher atomic weight differs from the nucleus of the normal atom by the presence of a mu group (h_2e_2) which carries no *net* charge, and which, if it were alone, would have an atomic number zero. Isotopes of higher atomic weight are also formed by the addition of alpha groups ($h_4e_2^{++}$), each alpha group being attached by two cementing electrons. This is equivalent to the addition of an h_4e_4 group. The details of this system will be found in a paper now in print in the *Physical Review*.

It should have been noted in the above paper that neon, magnesium, and silicon, the even numbered light elements which contain isotopes, lie *adjacent* in the even numbered series, since their numbers are 10, 12, and 14. It is *possible* that a third isotope of chlorine exists.

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February 28, 1920

WILHELM PFEFFER

WILHELM PFEFFER, with Sachs the founder of plant-physiology as it has been studied for more than a generation, died in Leipzig on January 31, of this year. A long line of Americans, as well as many other foreigners, resorted to him, in addition to the Germans who studied with him. He probably shared with Strasburger the distinction of having a larger number of foreign students of botany than any other German university professor. By these men, and many others, he will be remembered as a striking personality as well as a great leader in the science to which he devoted his life.

The details of his life are probably known to few Americans, but the general outlines may well be set down. He was born March 9, 1845, in Grebenstein near Cassel, the son of an apothecary. The elements of science, and scientific curiosity, he probably acquired from his father; for the old-time German Apotheker was a very different sort of person from the American drug-store proprietor of to-day. He studied at the universities in Göttingen, Marburg, Berlin and Würzburg, taking his doctor's degree at Göttingen in 1865. He began his teaching career as Privatdocent in Marburg, going thence as Ausserordentlicher to Bonn and as Ordentlicher Professor to Basel, Switzerland. In 1878 he removed to Tübingen where, I believe, the first Americans worked with him, Goodale of Harvard, Wilson of Philadelphia, Campbell of Stanford, and perhaps others. In 1887 he went to Leipzig, where he stayed for the rest of his life, in spite of calls to what, to others, might have seemed more attractive posts. But in the Botanisches Institut in Leipzig he had a laboratory fitted to his ideas and desires, with a garden adjacent in which the material which he and his associates used could be readily grown, a garden of such size, position, and plan that it took the minimum of time for administration. The university and state administrations were able and willing to give him cordial support, and he made his laboratory the resort of all who were pursuing plant-physiological studies or were interested in them.

His long list of publications, beginning with one on mosses, plant-geographical in character, and one or two embryological papers, not only opened the way for plant-physiological work by many others, but directed and to a great extent molded their studies. He not only influenced botanical study, but his osmotical investigations were and are of fundamental importance in physical-chemistry. As friends and neighbors for years, Pfeffer and Ostwald conversed and thought together, to the corresponding advantage of the sciences to which they were devoted.

Two publications stand out from the many because of their general, rather than special, botanical interest, namely the Handbuch der Pflanzenphysiologie, which passed through two editions and in the second was translated by Ewart into English, and was the great reference book in plant-physiology for two generations; and the Jahrbücher für wissenschaftliche Botanik, founded by Pringsheim, and continued after Pringsheim's death and until Strasburger's, in collaboration with him. The Untersuchungen aus dem botanischen Institut zu Tübingen, which lasted only during Pfeffer's stay at the south German university, gave him experience in the mechanical detail as well as in the editorial work of serial publication.

Pfeffer is survived by his widow, his daughter-in-law, and a grandson. He had one child, a son who was of age to be one of the direct sacrifices of the war, and presumably was. But he himself, a man of deep feeling and clear vision, must also have been a sacrifice.

Just as the war began, a jubilee volume was being prepared to celebrate the fiftieth anniversary of his doctorate and his seventieth birthday. Contributions had been promised by his students all over the world. With the coming of war many found themselves prevented from sending their papers, and in consequence the Jubilee Volume which appeared in 1915, as part of the Pringsheim series of Jahrbücher, contained only a fraction of the contributions to science which his students had planned to make in his honor.

Belonging to an age in Germany in which ideas were more sought than discipline, when scholarship was more honored than military rank, when a professor was more likely than a tradesman to become a Geheimrath, his life lasted through the fall of German imperialism and came to an end before German reconstruction was more than begun. Honors, national and international, were conferred upon him; and we who had the privilege of studying under his direction will continue to honor him as an inspiring teacher and a great example of scholarly devotion and productiveness.

G. J. P.

SCIENTIFIC EVENTS

THE ORGANIZATION OF SCIENTIFIC WORK IN INDIA[1]

THE reorganization and development of scientific work in India are now under consideration, and important and far-reaching decisions on these questions will shortly be made by the Secretary of State. It has already been decided, both by the government of India and by the Secretary of State, that large sums of money must be found at the earliest possible moment for the purpose of fostering the development of the Indian empire by means of scientific research. The principle of state aid on a generous scale has been accepted, but the important question of the best method of utilizing this form of assistance in the future development of India remains to be settled. These matters were referred to by the Viceroy on January 30 last in his speech opening the present session of the Imperial Legislative Council at Delhi. It is evident from the report of Lord Chelmsford's remarks which appeared in the London *Times* of February 6 that the government of India is now considering large schemes of expansion in regard to the scientific activities of the state.

Two policies at present hold the field: (*a*) Centralization under a proposed Imperial De-

[1] From *Nature*, February 19, 1920.

partment of Industries of the government of India in which chemists, botanists, zoologists, and so on will be formed into distinct, water-tight, graded services, each under the control of a departmental head; and (*b*) decentralization under which the scientific workers at the various universities and research institutes will be given as free a hand as possible.

The policy of centralization and the creation of graded scientific services have been strongly advocated by the Indian Industrial Commission, which was presided over by Sir Thomas Holland, formerly director of the Geological Survey of India. It is favored by a number of administrators in India who consider that some measure of official control is necessary for all scientific investigators, and it has also received the support of several of the scientific witnesses examined by the commission. The arguments advanced by Sir Thomas Holland and his supporters in favor of centralized scientific services are set out in detail in Chapter IX. of the Report of the Indian Industrial Commission, published last year.

PORTLAND CEMENT IN 1919

Preliminary estimates compiled by the United States Geological Survey, Department of the Interior, indicate that the production and shipments of Portland cement in 1919 increased 13 and 21 per cent., respectively, over those in 1918 and that the stocks decreased 52 per cent., so that at the end of 1919 less than 5,000,000 barrels of Portland cement was in stock at the mills. The Portland cement industry was set back considerably in 1918, when war restrictions reduced the shipments from the 90,703,474 barrels shipped in 1917 to 70,915,508 barrels, but it is now regaining its lost ground. Early in 1919 the business was even poorer than in 1918, and practically all the increase reported was made during the latter part of 1919, so that 1920 started with favorable prospects for the cement industry. During 1919 the shipments from some mills were limited by the lack of freight cars. The increase in the value of the cement shipped in 1919 over that shipped in 1918 was about 28 per cent.

The shipments of Portland cement in 1919 amounted to 85,485,000 barrels, valued at $144,461,000; the production amounted to 80,287,000 barrels; and the stocks at the mills at the end of the year amounted to 4,976,000 barrels.

One new plant produced Portland cement in 1919—the Indiana Portland Cement Co., at Greencastle, Ind. The total number of plants that produced cement in 1919 was 110, and the total number of plants that shipped cement was 113. The average factory price per barrel for Portland cement in bulk in individual states in 1919 ranged from $1.57 in Kansas to $2.03 in Utah. The average factory price for the whole country in 1919 was $1.69, an increase of only 6 per cent. over 1918.

The exports of hydraulic cement from the United States in 1919 amounted to 2,463,689 barrels, valued at $7,516,019, or $3.05 per barrel, increases of about 9.27 and 16 per cent., respectively, over 1918.

THE INVESTIGATION OF FATIGUE PHENOMENA IN METALS

In 1915 Mr. Ambrose Swasey gave a fund of several hundred thousand dollars, the income of which was to be used "for the advancement of arts and sciences connected with engineering and for the benefit of mankind." The income of this fund has been given in small amounts to various engineering investigations by the Engineering Foundation, which is the body organized to administer the fund. Last spring the governing board of the foundation decided that it would be advisable to give the bulk of the income for the support of one major research, and they asked the National Research Council to recommend some piece of research to be supported.

During the war the National Research Council had organized a committee to study the failure of crank shafts of airplane engines, of welded ship plates, and of other metal parts of machines under the repeated loads applied to them in service. The committee on fatigue phenomena in metals was the title of the committee. Its chairman was Professor H. F. Moore, of the department of theoretical and applied mechanics, of the University of Illinois, and during the war and afterward some small pieces of research work were carried out under the auspices of the committee, mainly in the materials testing laboratory of the college of engineering of the University of Illinois by the chairman of the committee, and by W. J. Putnam, and A. G. Gehrig. The National Research Council recommended that the bulk of the income of the Engineering Foundation be given to the support of an extensive investigation of the resistance of metals to fatigue under repeated loading, and that Professor Moore be asked to take charge of the investigation.

Engineering Education, from which these facts are quoted, states that the formal arrangements have been completed for the active prosecution of this work, with headquarters and a laboratory at the University of Illinois. The financial support for the investigation will amount to $30,000, and it is expected to extend over a period of two years. Material for study and apparatus is already arriving, and a room is being fitted up for the installation of the score or more of special testing machines which will be required for the investigation.

The investigation is under the joint auspices of the Engineering Foundation, the University of Illinois Engineering Experiment Station, and the National Research Council, the last-named body being represented by an advisory committee of nine members, of which Professor Moore is chairman. In addition to the funds supplied by the Engineering Foundation, the university furnished Professor Moore's services, light, heat, power, a laboratory room, and the use of the standard testing equipment of the materials testing laboratory.

SCIENTIFIC NOTES AND NEWS

The degree of doctor of laws was conferred on Professor Theodore W. Richards, director of the Wolcott Gibbs Laboratory of Harvard University, at the University Day exercises of the University of Pennsylvania.

Professor Anton J. Carlson, chairman of the department of physiology at the University of Chicago, has been made an honorary M.D. by the University of Lund, Sweden. Professor Carlson has also been made a corresponding member of the French Biological Society.

Professor J. M. T. Finney, of the Johns Hopkins University, and Dr. Charles H. Mayo, of Rochester, Minn., have been elected honorary fellows of the Royal College of Surgeons of England.

Mr. Gifford Pinchot, of Milford, Pa., former chief forester of the United States, has been appointed commissioner of forestry of Pennsylvania by Governor Sproul to succeed Robert S. Conklin, of Columbia, who resigned to become a member of the State Water Supply Commission.

Dr. Henry Graves, chief of the U. S. Forest Service, and Albert F. Pottee, associate forester, have resigned.

Professor Robert B. Riggs, for thirty-three years professor of chemistry at Trinity College, will retire at the close of the present college year.

Mr. R. M. Brown, formerly librarian of the Coast and Geodetic Survey, has accepted an appointment with Rand, McNally and Company, to prepare and edit material for a new edition of their atlas of the world.

Mr. George A. Rankin, formerly with the Pittsburgh Plate Glass Company, and captain in the Chemical Warfare Service during the war, has joined the staff of the Geophysical Laboratory of the Carnegie Institution of Washington.

Julius Matz, formerly with the Florida Agricultural Experiment Station and for the past year assistant plant pathologist at the Insular Experiment Station of Porto Rico, has been appointed chief of the division of botany and plant pathology at the Insular Experiment Station, Rio Piedrus, P. R., beginning on January 1, 1920.

MR. PAUL A. MURPHY, field laboratory of plant pathology, Charlottetown, P. E. I., has resigned his position as officer in charge of potato disease investigation under the Dominion Department of Agriculture and will take up work on April 1, as assistant with Dr. Pethybridge in the division of seeds and plant diseases in charge of plant pathological work in Ireland. His new address will be Royal College of Science, Dublin.

ASSOCIATE CURATOR W. R. MAXON, of the U. S. National Museum, and his assistant, Mr. Killip, are making the Cinchona Tropical Botanical Station their base during March and April, while carrying on botanical exploration of the northern slopes of the Blue Mountains of Jamaica. Only small areas of this region have been actually explored by botanists, and it is to be expected that many interesting types of ferns and angiosperms are yet to be discovered in the primeval forest which covers this region.

WE learn from the *Journal* of the American Medical Association that Dr. Victor G. Heiser, of the Rockefeller Foundation, has returned to New York after a trip to Porto Rico with Dr. Grant to make a study of sanitary conditions of the island, especially as regards hookworm disease. Dr. Louis Shapiro, of the Rockefeller Institute, is now in Colombia at the request of the Colombian government, making a study of the prevalence of leprosy, malaria and hookworm disease.

THE Puget Sound Biological Station will hold its annual session, beginning June 21 and continuing for six weeks with the class work. The station, however, is open several weeks longer. The staff, exclusive of assistants, this year will consist of Dr. B. M. Allen, embryology, University of Kansas; Dr. Nathan Fasten, morphology, University of Washington; Dr. T. C. Frye, director, algæ, University of Washington; Professor F. W. Gail, algæ, University of Idaho; Dr. E. J. Lund, physiology, University of Minnesota; Dr. V. E. Shelford, ecology, University of Illinois, and Professor A. R. Sweetser, plant taxonomy, University of Oregon.

PROFESSOR ALBERT M. REESE, of West Virginia University, lectured upon "The Work of the Tropical Biological Station of British Guiana," with special reference to Crocodilia, on March 5, at Oberlin College.

PROFESSOR ARTHUR KEITH delivered the Galton lecture before the Engineers' Education Society on February 16, the anniversary of Sir Francis Galton's birth.

AT a public meeting held on March 7, at Oxford University, it was decided to form the "Osler Institute of General Pathology and Preventive Medicine" as a permanent memorial to the late Sir William Osler.

PROFESSOR OTTO BÜTSCHLI, of Heidelberg, distinguished for his contributions to cytology and other departments of experimental zoology, died early in February, aged seventy-two years.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board has appropriated $250,000 to an endowment fund of at least $500,000 to be used by Howard University for medical education, "the income from the appropriation to be made available pending the completion of the full amount."

PLANS have been completed for a new chemical laboratory at Cornell University, and work will start immediately upon the closing of the spring term. The increased facilities which the new laboratory will afford will enlarge the scope of the department and will make possible the opening of new branches, in particular a department of industrial research for chemists.

ACCORDING to plans now being considered by the authorities of the Johns Hopkins University, the libraries of the hospital, the school of hygiene, and the medical school ultimately will be collected under one roof in a new library building to be erected in the hospital group.

GIRTON COLLEGE, Cambridge, has received a gift of £10,000, the capital and interest of which are to be applied during the next twenty years for the encouragement of scientific research by women in mathematical, physical and natural sciences.

DR. G. CANBY ROBINSON, dean of Washington University Medical School, St. Louis, has resigned to accept a position as dean and professor of medicine in Vanderbilt University, Nashville, Tenn.

DR. ARTHUR M. PARDEE, professor of chemistry at Washington and Jefferson College, has been appointed professor of chemistry and head of the department at the University of South Dakota to take effect next September.

THE *British Medical Journal* states that in the appointment of professors to German universities precedence is at present being given to university teachers who have left towns which have passed out of Germany's possession. The anatomist, Professor Hugo Fuchs, who had recently been appointed to Königsberg, has thus been transferred to Göttingen as Merkel's successor.

DISCUSSION AND CORRESPONDENCE

IONIZATION AND RADIATION

RECENTLY I came across a communication by Professor R. A. Houstoun[1] in which it was proposed to explain ionization of gases by X-rays on the basis of the classical conception of electrodynamics, by considering the intereference of spherical wavelets in which the phases are distributed at random. Professor Houstoun stated:

> When X-rays pass through a gas, only a very small fraction of the molecules—in favorable circumstances, one in a billion—is ionized by them, and the extent of this ionization is unaffected by temperature. Writers on radiation seem to have difficulty in reconciling this with the wave theory of light. I venture to suggest that the difficulty arises from an imperfect comprehension of what the wave theory requires.

After applying Rayleigh's solution of the problem of the phases at random to ionization, he arrived at the conclusion:

> Thus it is not necessary to assume that X-rays consist of neutral atoms, or that the ether has a fibrous structure, or to take refuge in the nebulous phraseology of the quantum theory; the explanation follows naturally from the principle of interference as expounded by Fresnel.

This explanation of ionization occurred to me some ten years ago but I had soon to abandon it because it led to results which are at variance with facts.

Let I/r^2 denote the intensity in a wavelet at a distance r from the source, and n be the number of wavelets coincident at that distance. Then the probability of a resultant intensity greater than J is given by

$$e^{-(Jr^2/nI)}.$$

Therefore if J equals the minimum intensity necessary to ionize the molecules of a gas, the number of molecules ionized is proportional to this expression. Thus on this theory the intensity of ionization of a gas falls off exponentially as its distance from the source of X-rays is increased—a result which is contrary to the experimental fact that the intensity of ionization varies inversely as the square of the distance.

H. M. DADOURIAN

TRINITY COLLEGE

[1] *Nature*, April 24, 1919.

HOW DID DARWIN WORK?

LAST year Professor Francis B. Sumner published a very suggestive and interesting paper in *The Scientific Monthly* for March, dealing with "Some Perils which confront us as Scientists." In it he quoted with approval an indignant query: "Under what project did Darwin work?"—and again, "one wonders what institution or organization Newton or Darwin belong to." The solitary worker of Down seems the incarnation of scientific genius illuminating the world with the products of its own combustion. On closer inspection, however, this conception is seen to be illusory. In the whole history of science there has perhaps never been a man who worked more faithfully and persistently on a project. It was his own project to be sure; but none the less a definite project. So also, there has rarely been a man who so constantly sought the cooperation of all who could and would render him assistance. The "Origin of Species" is full of acknowledgements to his friends and correspondents, without whom he would have been comparatively helpless. From a close study of Darwin's life, we arise with the conviction that it is precisely the man of genius who should be the center of a cooperating group, and that it is through such cooperation that human knowledge, at least in the biological sciences, is chiefly advanced. To-day the adequate study of even a simple species of plant, as I have found in dealing with *Helianthus tuberosus,* requires not only a general botanist, but a plant physiologist, a taxonomist, a chemist, a soil physicist, an entomologist and others. Who is so versatile that he can perform all these functions? Yet our institutions are so constituted that each department stands by itself, and cooperation is no part of the regular program. We must not permit ourselves to be dictated to by persons who can not understand our aims or the conditions under which we must work, but the state has a right to demand efficiency. Are we sure ourselves, and can we convince others, that we are not overdoing our individualism? The world needs to be made wise and honest: can we afford to refuse to work together to this end?

T. D. A. Cockerell

University of Colorado

A CONVENIENT DEMONSTRATION MOUNTING FOR JELLYFISHES

The writer has found the following method of mounting jellyfishes (Scyphozoa), both convenient and satisfactory besides permitting the observation of many structures usually only clearly seen when specimens are removed from the preserving jar.

Choose from the material on hand a jellyfish whose diameter is approximately that of a Petri dish in which it then may be placed, enough 4 per cent. formalin being added to cover the specimen. After the dish has been covered, it may be forced down in a mold of fresh plaster of Paris until the space between the upper and lower halves of it is sealed, and the top of the upper half is flush with the surface of the mold. When the mold has firmly set, any obscuring plaster of Paris may be scraped from the glass, or the mold itself suitably shaped up with a scalpel. Formalin solution condensing at any time on the upper lid may be displaced by manipulation.

Perhaps the most convenient molding frame is a paper box of a size adaptable to that of the Petri dish, although it may be of any shape. It is best to vaseline the interior of the box, in order that the hardened material may come away freely. With some care, a clean-cut looking mount may be secured. If desired, the plaster of Paris part may be given a coat of shellac, making it more durable from the laboratory standpoint. Data concerning the specimen may then be placed upon it with India ink.

It is seen that the above procedure is a modification of an old laboratory trick whereby odd bits of natural history specimens such as corals, sponges, specimens in vials, etc., may be given a convenient and useful mounting.

N. M. Grier

Hollins, Va.

ORGANIZATION OF THE AMERICAN GEOPHYSICAL UNION

At its meeting on June 24, 1919, the "American Section of the proposed International Geophysical Union" passed the following motion:

Moved: That the members of the Section who go to the Brussels meeting be constituted a committee, with power to add to its membership, to consider permanent organization of the Section—the committee, after completing a plan for such organization, to report to a meeting of the Section, to be called at the discretion of the acting chairman of the Section, for the purpose of perfecting the permanent organization. *Adopted.*

The Brussels meeting referred to is that which was held from July 18 to July 28, 1919, to organize the International Research Council, and International Unions affiliated with it.

At this conference the International Geodetic and Geophysical Union was formed, with six sections, as follows: (*a*) Geodesy, (*b*) Seismology, (*c*) Meteorology, (*d*) Terrestrial Magnetism and Electricity, (*e*) Physical Oceanography, and (*f*) Volcanology. Officers elected were listed in Science[1] of October 31, 1919.

The delegates who went on behalf of the geophysical sciences from the United States to these meetings at Brussels, were Messrs. William Bowie, Chairman, L. A. Bauer, G. W. Littlehales, and Rear-Admiral Edward Simpson. At Brussels Messrs. C. E. Mendenhall and H. S. Washington who were already abroad were added to this delegation.

At the call of the chairman of the "American Section," on October 31,1919, an informal conference of these delegates, constituting the committee on organization authorized on June 24, with other members of the "American Section" who reside in and near Washington, was held at the offices of the National Research Council. At this meeting, after a general exchange of views, a subcommittee or organization to draft proposals for statutes, was designated by the committee of delegates —to consist of Messrs. L. A. Bauer, Chairman, William Bowie, W. J. Humphreys, G. W. Littlehales, and H. O. Wood. This subcommittee held several meetings early in November, at some of which it had the benefit of further extended conference with Messrs. Mendenhall and Washington, who were present at Brussels. As an outcome, a draft of "Proposals for the Permanent Organization and Statutes of the American Geophysical Union" was drawn up, approved by the committee of delegates charged with the duty of preparing for permanent organization, and since it was not considered expedient to call a meeting of the section in Washington this draft was submitted for a vote by mail ballot to all members of the "American Section." An affirmative vote was returned by a considerable majority of the members prior to the date set for the count of ballots and subsequent affirmative ballots delayed in transit were received from nearly all members. There were no dissenting votes.

These statutes of the American Geophysical Union, thus approved by the "American Section," were then submitted to the executive board of the National Research Council and were approved by that body on December 20, 1919, and on February 14, 1920, the American Geophysical Union was made a Committee of the Executive Board

This action established the American Geophysical Union as a permanent organization superseding the "American Section of the proposed International Geophysical Union." As thus constituted the American Geophysical Union serves as "the American 'National Committee' of the International Geodetic and Geophysical Union, and as the Committee on Geophysics of the National Research Council." Its initial membership is the membership of the "American Section" as this stood on July 1, 1919, together with the Chairman of the Division of Physical Sciences, the Chairman of the Division of Chemistry and Chemical Technology, and the Chairman of the division of Geology and Geography of the National Research Council, and the American officers of the International Geodetic and Geophysical Union and of its sections, as members ex-officio. Its general administration is delegated to an Executive Committee made up of the chairman and secretary of the union, and the chairman of each of its sections which, initially, are the same as those in the International Union, viz: (*a*) geodesy, (*b*) seismology, (*c*) meteorology, (*d*) terrestrial magnetism and electricity, (*e*) physical oceanography, and (*f*) volcanology.

At its first, regular, annual meeting officers will be elected in accordance with the terms of the statutes. Meanwhile, by action of the "American Section" taken on June 24, 1919, the chairman and secretary of that organization continue to serve.

By action of the provisional executive committee of the "American Section" an election of acting chairmen for each of the newly constituted sections was held in January, 1920,

[1] Bauer, L. A., "Geophysics at the Brussels Meeting," July 18–28, 1919, Science, October 31, 1919, 1296, pp. 399–403.

by mail ballot counted on February 2, in order to constitute an acting executive committee conforming in organization with the statutes, to prepare the way for the first annual meeting. As a result of that election the following acting chairmen were elected:

Section (*a*) William Bowie, Section (*b*) Harry Fielding Reid, Section (*c*) C. F. Marvin, Section (*d*) L. A. Bauer, Section (*e*) G. W. Littlehales, and Section (*f*) H. S. Washington.

Harry O. Wood,
Secretary, American Geophysical Union

SPECIAL ARTICLES

IS UNPALATABLE FOOD PROPERLY DIGESTED?[1]

It is well known that different psychic stimuli promote or retard the secretion of digestive juices. The following experiment was conducted to determine whether the ultimate return to the body from unpalatable food was different from that of the same food palatably served.

The experimental procedure was simple. A 7-day period during which the subjects were on a uniform diet, served palatably and amid pleasant surroundings, was followed by a 2-day period during which the same diet was fed in an unpalatable condition and in dirty and unpleasant surroundings. The food was rendered unpalatable and unappetizing by the following treatment. All the food ordinarily used for each meal (meat, biscuits, jelly, cornstarch, pudding, oleomargarine, etc.) was stirred together in a large, flat porcelain dish. The dish itself was smeared with animal charcoal, as was the beaker used as a drinking glass. The table was dirty and strewn with dirty dishes. A little indol was sprinkled about under the table. The subjects were kept in ignorance of the constituents of the unpalatable mixture. The food was so unpalatable that one subject vomited his first meal shortly after he had eaten it.

The table shows the finding, on the other subject.

Period	No. of Days	Nitrogen							
		Ingested		Excreted			Balance		Percentage Utilization
		Daily, Grams	Period, Grams	Urine, Grams	Feces, Grams	Total, Grams	Period, Grams	Daily, Grams	
Palatable	7	10.75	75.25	62.95	10.06	73.01	+2.24	+0.32	86.7
Unpalatable....	2	10.75	21.50	17.03	3.09	20.12	+1.38	+0.63	85.7

The differences in utilization of the palatable and unpalatable foods were quite small as were the variations in nitrogen retention. This short test indicates that flavor is not the outstanding dietetic asset that some people would have us believe. If the stomach and intestine can only be cajoled into making the proper effort, the unsavory concoction can be digested just about as satisfactorily as can the food mixture which makes a stronger appeal. If the things we eat have proper food value, we need not worry unduly as to their digestion, absorption, and utilization by the normal body. This ought to be good news to millions of people who eat unpalatable food in untidy surroundings, in spite of the fact that one of our leading physiologists says "What man likes best he digests best." This experiment simply shows how insulting we can be to the normal stomach and get away with it but does not necessarily prove this to be the wisest policy.

Ralph C. Holder,
Clarence A. Smith,
Philip B. Hawk
Jefferson Medical College,
Philadelphia

[1] From the Laboratory of Physiological Chemistry, Jefferson Medical College, Philadelphia, Pa.

THE WESTERN SOCIETY OF NATURALISTS

The Northwestern Division of the Western Society of Naturalists held its holiday meeting on January 2, in Portland, Oregon.

There were present delegates from the states of Oregon and Washington. The afternoon program was taken up with a discussion of "The Rôle of Research in the Development of Northwest Colleges" and also with a discussion of special papers. The evening program was given over to a symposium on premedical education. The following papers were read:

"The premedical education as a surgeon sees it," by Dr. Richard B. Dillehunt, of Portland.

"The premedical education as the medical school would like it," by Dr. H. B. Myers, University of Oregon Medical School.

"A premedical education and chemistry," by Dr. W. C. Morgan, of Reed College, Portland.

"A premedical education and biology," by Dr. H. B. Torrey, of Reed College, Portland.

"A premedical education as a university course," by Dr. J. F. Bovard, University of Oregon.

The papers were followed by a general discussion. At the business meeting Dr. G. B. Rigg, of the University of Washington, was elected Divisional Secretary for the ensuing year.

John F. Bovard,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

The two hundred and eighth regular meeting of the American Mathematical Society was held at Columbia University on Saturday, February 28, 1920, extending through the usual morning and afternoon sessions. The attendance included twenty-eight members. Vice-president R. G. D. Richardson occupied the chair. The following new members were elected: F. J. Burkett, Pennsylvania State College; A. D. Campbell, Cornell University; Y. R. Chao, Cornell University; R. E. Gilman, Brown University; D. C. Kazarinoff, University of Michigan; Norman Miller, Queen's University; G. M. Robison, Cornell University; Jung Sun, Pekin Academy; W. H. Wilson, State University of Iowa; S. D. Zeldin, Massachusetts Institute of Technology. Six applications for membership were received.

Professor Oswald Veblen, of Princeton University, was appointed to succeed Professor E. W. Brown, resigned, as representative of the society in the division of physics of the National Research Council.

Steps were taken to submit the question of the incorporation of the society to the vote of the members at the April meeting.

The following papers were read at this meeting:

Joseph Lipka: "On the general problem of dynamics."

A. R. Schweitzer: "On the iterative properties of the algebra of logic."

A. R. Schweitzer: "On improper pseudogroups, with application to the abstract field."

G. H. Hardy: "On the representation of numbers as sums of squares and in particular of five and seven."

J. W. Alexander: "On the representation of any n-dimensional two-sided manifold as a generalized Riemann surface."

J. W. Alexander: "On the equilibrium of a fluid mass at rest."

T. H. Gronwall: "Qualitative properties of the ballistic trajectory (second paper)."

T. H. Gronwall: "On the distortion in conformal mapping."

A. A. Bennett: "Fictitious matrix roots of the characteristic equation."

Pierre Boutroux: "On multiform functions defined by differential equations of the first order."

B. H. Camp: "The significance of a difference, and the value of a sample."

J. H. M. Wedderburn: "On division algebras."

Edward Kasner: "Geodesics of surfaces and higher manifolds."

The next meetings of the Society will be at Chicago, April 9–10; San Francisco, April 10, and New York, April 24. The summer meeting and colloquium of the society will be held at Chicago.

F. N. Cole,
Secretary

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RÉSUMÉ OF OBSERVATIONS CONCERNING THE SOLAR ECLIPSE OF MAY 29, 1919, AND THE EINSTEIN EFFECT[1]

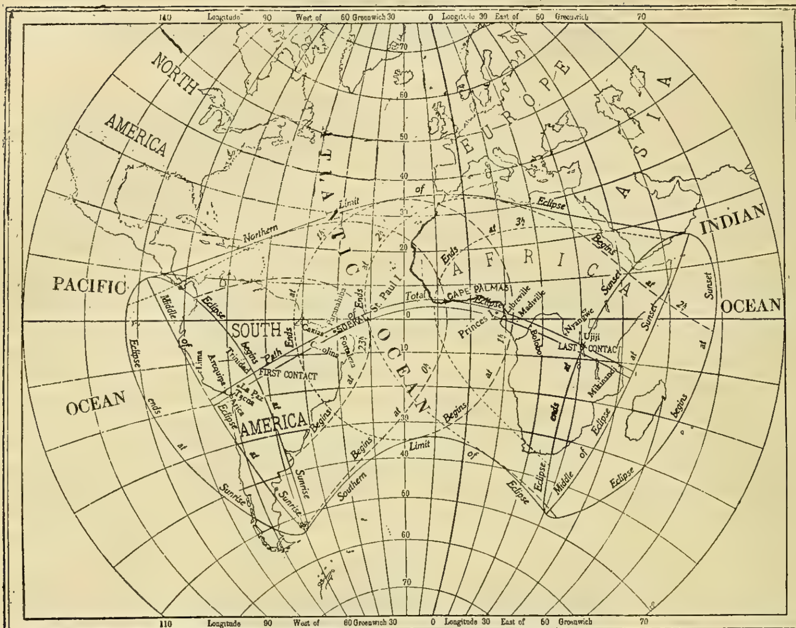
1. A TOTAL eclipse of the sun is of more than passing interest, not merely to the astronomer but also to the geophysicist. Indeed, by reason of the supposed verification of the so-called Einstein effect during the solar eclipse of May 29, 1919, which, in consequence, may make that eclipse the most famous of all eclipses observed thus far, an eclipse of the sun has become of profound interest also to the physicist, to the mathematician, and to the philosopher, in general.

In the following brief account of the chief phenomena observed during the solar eclipse of May 29, 1919, the path of totality for which is shown in Fig. 1, the attempt will be made to bring out succinctly the various points of interest to men of science.

2. To give a personal touch let me first briefly state the results of my own expedition to Cape Palmas, Liberia, where totality was longer (6 minutes and 33 seconds) than at any other accessible station, where the sky was comparatively clear, contrary to all good meteorological predictions, and where totality

[1] Abstract of papers presented before the Philosophical Society of Washington (October 11, 1919 and January 3, 1920), Royal Astronomical Society of Canada, Toronto (December 2, 1919), American Academy of Arts and Sciences, Boston (January 14, 1920), American Philosophical Society, Philadelphia (February 6, 1920) and American Physical Society (New York, February 28). Also basis of public lectures delivered at the following universities: Toronto (December 2, 1919), College of the City of New York (December 4, 1919), Johns Hopkins (January 12), Yale (January 13), Brown (January 15), Columbia (January 16), Swarthmore (February 7) and Middletown Scientific Association of Wesleyan University (March 9).

TOTAL ECLIPSE OF MAY 28-29, 1919.



Note:- The hours of beginning and ending are expressed in Greenwich Mean Time.

Fig. 1.

occurred at about one P.M. local mean time. The purpose of my expedition was not to make astronomical but *geophysical* observations, the chief of which were to be observations to detect, or verify, a possible effect on the earth's magnetic field such as has been shown by observations made under my direction, since the solar eclipse of May 28, 1900. Though it is not necessary for the detection of this magnetic effect to have a clear sky, as no layer of cloud could screen it, it has been my good fortune now three times[2] to have a clear sky when others whose work absolutely depended upon clear weather were not so fortunate.

3. When I left Washington early in March, 1919, it had been arranged that I should occupy conjointly with Dr. Abbot of the Smithsonian Institution, La Paz, Bolivia, in order that I might have there the conditions encountered during the eclipse of June 8, 1918, at my station, Corona, Colorado, the elevation of which is 12,000 feet. As Dr. Abbot intended to look after the photographic work, I did not provide myself with appliances for purely astronomical work. Upon arrival in England, it was found impracticable to reach a South American station in time for the eclipse; accordingly, it was

[2] Manua, Samoan Islands, April 28, 1911; Corona, Colorado, June 8, 1918; Cape Palmas, Liberia, May 29, 1919. In addition I made observations at Rocky Mount, North Carolina, of the total solar eclipse, May 28, 1900.

decided to proceed to Cape Palmas, Liberia, instead.

4. The station at Cape Palmas, Liberia, was one of five principal stations at which magnetic and allied observations were carried out by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in connection with the solar eclipse of May 29, 1919. Two of these stations were inside the belt of totality: Sobral, Brazil, in charge of Mr. D. M. Wise, assisted by Mr. A. Thomson; and Cape Palmas, in charge of the author, assisted by Mr. H. F. Johnson. A third station, at Huayao, Peru, north of the totality belt, was in charge of Dr. H. M. W. Edmonds; the fourth station, south of the belt of totality, at Puerto Deseado, Argentina, was assigned to Mr. A. Sterling; and the fifth, about 100 miles north of the belt of totality, at Campo Cameroun, was assigned to Mr. Frederick Brown. Observations were also made at a secondary station, Washington, outside the zone of visibility, by Mr. C. R. Duvall. In addition to these stations, special magnetic observations were made at the Department's magnetic observatory at Watheroo, Western Australia, and at observatories all over the globe, both inside and outside of the region of visibility of the eclipse, according to the department's program.[3] The reports already received from many of the foreign observatories indicate that the magnetic conditions were ideal for the detection of a possible magnetic effect. *There were clear indications at Cape Palmas of a magnetic effect in accordance with the results obtained during previous solar eclipses. Since Cape Palmas was nearly on the magnetic equator, the effect was especially noticeable in the vertical component of the earth's magnetic field intensity, or upon the magnetic dip.*

[3] The general scheme of work consisted in simultaneous magnetic observations of any or all of the elements every minute from May 29, 1919, 9^h58^m A.M. until 4^h32^m P.M., Greenwich civil mean time, thus for an interval of time from 35 minutes before the beginning until 48 minutes after the end of the eclipse on the earth. Similar observations for the same interval of time as on May 29 were to be made, if possible, on May 28 and 30 to afford the necessary means for determining the undisturbed course of the magnetic elements. Special continuous registrations were called for at magnetic observatories. Furthermore, special atmospheric-electric and meteorological observations were included in the program.

5. Our observation program at Cape Palmas (latitude, 4° 22′ N.; longitude, 7° 43′.7 or 30^m55^s West of Greenwich) included magnetic and electric observations, meteorological observations, shadow-band observations, times of contacts and photographs such as could be obtained with a small kodak camera. This comprehensive program was carried out successfully, excepting the atmospheric-electric work which, owing to the deterioration of the dry-cell batteries purchased in England, had to be abandoned. Sir Napier Shaw had kindly loaned us a Benndorf electrograph. Although I had stationed three observers, *no shadow-bands were observed this time, even greater precautions having been taken than at Corona during the eclipse of June 8, 1918, where they were observed.*

The full geophysical program, including complete atmospheric-electric observations, was carried out by our party in charge of Mr. Wise at *Sobral, where shadow-bands were clearly observed* by his assistant, Mr. Thomson.

6. *The eclipse of May 29 as observed at Palmas, was not nearly as dark, in spite of its long duration, as the much shorter one of June 8, 1918,* which I had observed at the mountain station, Corona, Colorado. There was a marked difference in light, both as seen visually and as shown by the photographs, between the inner corona and the outer extensions. The intense brightness of the inner corona may have been the cause of the fact that the eclipse of May 29, 1919, was not as dark as had been expected. Dr. A. C. D. Crommelin, the British astronomer at Sobral, Brazil says:[4] "The darkness during totality was not great; we estimated that the illumination was about the same as that 25 minutes before sunrise. The corona was very brilliant,

[4] *The Observatory*, London, October, 1919, pp. 370–371.

probably at least three times as bright as the full moon."

7. The *large crimson prominence*, appearing at Cape Palmas on the southeast limb of the sun, turned out to be the largest prominence thus far photographed; it was a most conspicuous and startling object, projecting about 100,000 miles out from the sun's disk and having a base of 300,000 miles. On the southwest limb was a striking V-shaped rift in the solar corona which showed marked equatorial extensions to the west and east. The corona was approximately of the intermediate type between that which is seen during years of minimum sun-spot activity, when there are great equatorial extensions of the corona, and that shown during years of maximum sun-spot activity, when streamers of about the same length extend from the sun in every direction.

8. I succeeded in obtaining with my small camera, which is provided with an excellent lens, two sharp photographs of 10 and 20 seconds exposure, which when enlarged show well the chief features of the corona and of the prominence.[5] In addition, as the result of the interest aroused by a lecture which I was requested to give in the Methodist Church at Cape Palmas the day before the eclipse, a number of free-hand sketches of the corona were made for me by white merchants and by Americo-Liberians; these sketches, while not one of them is complete, show a number of interesting details.

9. The results of the *meteorological observations* at Cape Palmas will be of interest in connection with one of the theories suggested for the explanation of the bending of light rays, to which reference will be made later. Through the courtesy of Sir Napier Shaw and Colonel H. G. Lyons the British Meteorological Office loaned us a complete outfit of self-recording meteorological instruments, which were kept in operation by my assistant, Mr. Johnston, as long as the conditions permitted during our month's stay at Cape Palmas.[6] On the day of the eclipse there was a steady decrease in temperature from 12^h G.M.T., 0.7 minute after the first contact, to 12.7^h G.M.T., and then a more rapid decrease until the minimum temperature of 79°.4 F. was reached at 14^h G.M.T., which was approximately 0.4^h later than the middle time of totality. *The temperature drop during the time of the eclipse was, accordingly, about 2°.5 to 3°.0 F.* The increase in temperature after 14^h was rapid, the maximum 82°.7 F. being reached at 14.9^h G.M.T. The hygrogram for May 29 showed the following effect: the humidity, which was 71 per cent. at 12^h G.M.T. steadily increased to 78 per cent. at 14^h G.M.T. There was a more rapid decrease from 14^h G.M.T. to 15^h G.M.T., when the humidity was 66 per cent. *The maximum humidity, therefore, occurred at 14^h, or approximately 0.4 hour later than the middle time of totality. The barogram showed nothing marked during the time of the eclipse.*

At Sobral, Dr. Crommelin states:[7]

> The eclipse day opened very unpromisingly, the proportion of cloud at first contact being about 0.9. . . . The cloudiness during the early stages was doubtless the cause of the fall of temperature during totality being unexpectedly small; perhaps this latter fact was connected with the dead calm that prevailed during totality.

COMPLETE SERIES OF PHOTOGRAPHS

10. There was next shown in my lectures a complete series of photographs taken by the various observing parties, namely: C. G.

5 During the duration of totality it was necessary for the author, (*a*) to take and record the readings of the magnetic-intensity variometer and attached thermometer at one- or two-minute intervals, and to check every fifth minute the Liberian assistant, Professor G. W. Hutchins, who had volunteered to take the declinometer-readings every minute; (*b*) to observe the times of contacts, obtain photographs, and give any required additional directions to the shadow-band observers. Thus though totality lasted at Cape Palmas 6½ minutes, it was none too long for a strenuous program in a tropic region.

6 Mr. Johnston was also entrusted with the earth-inductor work.

7 *The Observatory*, London, October, 1919, pp. 370–371.

Abbot, of The Smithsonian Institution, at La Paz, Bolivia; H. Morize, in charge of the Rio de Janeiro Observatory party at Sobral, Brazil; the British Astronomical Party (C. Davidson and A. C. D. Crommelin) at Sobral; L. A. Bauer at Cape Palmas, Liberia; and the British Astronomical Party (A. S. Eddington and Mr. Cottingham) at the Île of Principe in the Bight of Africa. Also slides of the great solar prominence of May 29, 1919, as photographed at the Yerkes Observatory, were exhibited. Grateful acknowledgement is here made to the Astronomer Royal of England, Sir Frank W. Dyson, and to those just mentioned, for copies of the photographs taken by their expeditions, as also to Dr. W. W. Campbell, who supplied slides showing how the corona changes its shape during the sun-spot cycle.

11. The chief features of the solar corona and prominence, as shown by the series of slides exhibited, have already been stated in paragraphs six and seven, where the observations at Cape Palmas were described. Careful measurements have been made between the various prominent features, as shown on the photographs taken along the belt of totality from Bolivia to the French Congo. From all the data supplied it is found that the mean heliographic latitude of the prominence during the time of the eclipse was about 18° south, and on the east limb, whereas the pronounced V-rift was about 45° south, and on the west limb. Practically diametrically opposite the V-rift was a less-pronounced rift, which I have called the U-rift. The solar prominence during the average time (11^h48^m G.M.T., civil) of totality at the two South American stations and the average time (13^h 55^m G.M.T., civil) of the two African stations changed comparatively little, though later in the day, according to the Yerkes Observatory photographs, kindly supplied by Professor Frost and Mr. E. Pettit, very great changes took place; thus, for example, at 20^h23^m G.MT., civil, the prominence had shot up to the height of 472,000 miles from the sun's limb.[8]

[8] See Mr. Edison Pettit's account in the *Astrophysical Journal*, for October, 1919, pp. 206–219.

12. A distinct purpose was had in mind in exhibiting first the various features of the solar corona and prominence, which persisted for four rotations of the sun and filled portions of the solar atmosphere with the products of eruptions, in order that one might be the better prepared to pass judgment upon the results concerning the deflection of light rays. For the same reason was given an account, though incomplete, of the results of our geophysical observations. We shall find that all the various phenomena though apparently unrelated have, indeed, an important bearing upon our next topic.

13. Altogether the solar eclipse of May 29, 1919, as observed at Cape Palmas, Liberia, was the most magnificent one of the four[9] it has been my good fortune to observe. Similarly Dr. Abbot with reference to what he saw at La Paz, Bolivia, says:[10]

> Taking into account the great length and beauty of the coronal streamers, the splendid crimson prominence throwing its glory over all, and the fact that the eclipse was observed so near sunrise from so great an elevation as 14,000 feet, with a snow-covered range of mountains upwards of 20,000 feet high as a background for the phenomenon, it seemed to the observers to be the grandest eclipse phenomenon which they had ever seen.

RESULTS OF OBSERVATIONS FOR DEFLECTION OF LIGHT

14. The most important result, undoubtedly, of the observations made by the astronomical parties during the solar eclipse of May 29, 1919, is the disclosing of the fact that the rays of light coming from stars, which appeared on photographs taken of the eclipsed sun and surrounding region, were bent by a measurable amount. No matter what the cause of the bending actually was, the fact is of profound interest and is bound to advance our knowledge. The chief possible causes which have been advanced thus far are:

(*a*) *Newton-Maxwell Effect.—Deflection of the rays of light by the sun's gravitational*

[9] See footnote 2.

[10] Abbot, C. G., and A. F. Moore: "Observations of the Total Solar Eclipse for May 29, 1919," Smithsonian Collections, Vol. 71, No. 5, p. 3, Washington, January 31, 1920.

action, just as the path of a projectile fired into the air is bent by the earth's gravitation pull upon the projectile, the amount of deflection being in accordance with Newtonian mechanics and Maxwell's electromagnetic theory of light. [If we assume, as did Newton, that light consists of corpuscles of matter traveling at great velocity, then it is easy to see why light should be bent under the action of gravity, for a cubic foot of light would in this case differ from a cubic foot of other ponderable material only in matter of *weight.* Newton in fact, had predicted such bending. But as our knowledge of light advanced we were forced to abandon Newton's theory for the undulatory or wave theory of light—a wave motion in the ether supposed to fill all space, the vibrations being electromagnetic ones according to our latest theory (Maxwell's). Light then consisting of some sort of wave motion possesses energy, or the power to do work, and it was furthermore shown about 20 years ago, by a Russian physicist, Lebedew, and by two American physicists, Nichols and Hull, that light exerts a measurable *pressure* when it falls upon a surface just as would material particles when fired at that surface. That light exerts pressure was in fact predicted by Maxwell a half century ago, but it was an open question whether light also had *weight.* The pressure of light resulted from the electromagnetic energy inherent in light, by which it is endowed with inertia just as is a body of material mass. Would gravity act upon something having electromagnetic inertia in the same way as upon a body of material mass? If so, the precise gravitational effect upon light could be predicted.] If a ray of light from a distant star just grazed the sun's edge (limb), it would be bent inwards (towards the sun) by 0″.44, as viewed by a solar observer. As the ray of light passed out of the sun's gravitational field on its journey to the earth it would suffer another deflection of about 0″.44, and in such a way that the final and total bending as perceived by an observer on the earth, would be away from the sun 0″.87—the angle which an object one inch high would subtend at a distance of three and three fourth miles.

(*b*) *Einstein Effect.—Twice the deflection of the rays of light predicted in* (*a*), this time *again by the sun's gravitational action, but according to the principles of Einstein's generalized relativity theory.* (These principles are tersely stated by Professor A. G. Webster):[11]

> First, that of the constancy of the velocity of light with respect to all directions and to any system moving with any velocity whatever with respect to any other system; second, a relation between time and distance such that either of two bodies seem shortened in the direction of their relative motion by an observer attached to the other; third, that it is impossible to distinguish a gravitational field from the acceleration of the frame of reference; and fourth, that everything that has mass, as determined by inertia, has mass of the sort determined by weight or attractability.

According to the Einstein law of gravitation, the deflection of a ray of light which grazed the sun's limb would be away from the sun by 1″.74[12], as we, or anyone outside the sun's gravitational field, might perceive it.

(*c*) *Refraction in the Solar Atmosphere.*—Bending of rays of light by refraction in passing through the sun's atmosphere, which, in more or less attenuated form, is known to extend out so far that the rays from all the stars concerned in the measurements would have to pass through it on their way to the earth.[13] [Such bending of light actually takes place all the time as the rays from the sun and other celestial bodies pass through our own atmosphere; the amount of atmospheric

11 *The Review*, January 31, 1920, p. 116.

12 See A. S. Eddington's "Report on the Relativity Theory of Gravitation," London, 1920, p. 55.

13 See Dr. H. F. Newall's suggestive note in *Monthly Notices of the Royal Astronomical Society*, Vol. LXXX., No. 1, November, 1919. Mr. Jonck-heere (*The Observatory* for August, 1919, Vol. XLI., p. 216) suggested that refractions may be caused by "a hypothetical condensation of ether near the sun." This hypothesis is treated by L. Silberstein in connection with the theory of Stokes-Planck's ether in the *Phil. Mag.*, Vol. 39, pp. 161–170, February, 1920.

refraction of light depends upon the atmospheric conditions (temperature, pressure, humidity) and decreases with altitude of the celestial body above the horizon. Adequate correction of the observed deflections because of this known source of bending in the earth's atmosphere had to be made.]

(*d*) *Terrestrial Refraction Effects.*—Disturbance refraction effects as rays of light from the distant stars passed through the region of the earth's atmosphere affected by the solar eclipse, especially during totality. This cause would give a deflection in the right direction but apparently not of sufficient magnitude to account for the observed effects.[14]

15. The law of decrease in the amount of deflection of light for causes (*a*) and (*b*) is a very simple one, namely, inversely as the distance of the ray from the sun's center when it passes through the solar gravitational field. For cause (*c*) the law may or may not be as simple as that just stated, depending among other things on the variation of the density and distribution of the solar atmosphere with distance from the sun.[15] For our own atmosphere the law of atmospheric refraction is a somewhat complicated one. Sufficient has been said to show how intensely interesting a full discussion of the observed deflections of light will prove to be. Even had no deflections been observed a valuable contribution to science would have resulted.

16. Table I. contains the deflections of light rays observed by the British Astronomical Expedition, equipped and sent to Sobral, Brazil, under the direction of the Astronomer Royal of England, Sir Frank W. Dyson. Let α be the total deflection of a light ray coming from a star, S, and passing through the sun's gravitational field and finally reaching the observer on the earth. Suppose α_0 be the value of α if the ray grazed the sun's limb, and ρ, the radius vector or distance from the sun's center to the ray of light passing the sun. (The values of ρ for the various stars are given in units of the sun's radius in the third column of the table.) Then

$$\alpha = \alpha_0/\rho. \tag{1}$$

As already stated, according to the Newton-Maxwell law, $\alpha_0 = 0''.87$, and according to the Einstein law, $\alpha_0 = 1''.74$. As the observed effects appear to agree better with the Einstein law, the comparison is made in the table with those computed from that law. The main tabular quantities have already been given in various publications. Detailed data were also courteously furnished by the Astronomer Royal for my lectures; these data gave the results separately for each of the seven stars and for each of the seven plates obtained by the observer, Dr. A. C. D. Crommelin, using a 4-inch lens of 19-foot focus and an 8-inch cœlostat. From the detailed data members of my staff computed the probable errors found in the last three columns of the table. From the coordinates furnished we also were able to compute the angle A, which the radius vector, ρ, to any star made with the declination axis, counting it from the north end in the direction east or west; these values are contained in the fifth column. The computed effects in right ascension and declination were obtained by multiplying the value of α from (1) by $\sin A$ and $\cos A$, respectively. From the fourth column it will be seen that the photographic magnitudes of the stars ranged from 4.5 to 6.0. The British astronomers were thus exceedingly fortunate in being able to make their observations during a solar eclipse when there was an exceptionally rich field of bright stars, the Hyades, close to the sun.

17. It will be observed that from the figures

[14] This hypothesis was suggested by Dr. J. Satterly at the close of the author's lecture at the University of Toronto, December 2, 1919. It had also occurred to Dr. Alexander Anderson, of the University College, Galway, and has been discussed by him and others (Eddington, Cromelin, Cave, Dines and Schuster) in various issues of *Nature*, December 4, 1919–January 29, 1920.

[15] In the discussion of the author's paper before the American Academy of Arts and Sciences, January 14, 1920, Dr. E. B. Wilson, of the Massachusetts Institute of Technology, suggested that if the density of the solar atmosphere varied inversely as the square of the distance from the sun's center, a refraction law would result similar to the one for causes (*a*) and (*b*).

in the three columns headed O–E (Observed-Einstein value that), relatively, the observed right-ascension deflections depart more markedly from the computed ones than do the observed declinations-deflections. The observed total deflections in every case, except for star 11, exceed the Einstein values.

nomical Expedition, at the Ile of Principe, west coast of Africa, where the weather conditions were unfortunately not as favorable as at Sobral, showed only a few stars and the scale could not be directly determined as it was not possible to remain at Principe the required time. Instead, plates of another region

TABLE I

Comparison of Deflections of Light Rays Observed by the British Astronomical Expedition at Sobral, Brazil, May 29, 1919, with Values Computed according to the Einstein Theory

(*Instruments:* 4-inch lens of 19-foot focus and 8-inch coelost at. *Observer:* A. C. D. Crommelin)

No.	Star	Dist. in Sun's Radii	Phot. Mag.	Angle A	Right Ascension			Declination			Total			Probable Error		
					Obs'd	Einstein	$O-E$	Obs'd	Einstein	$O-E$	Obs'd	Einstein	$O-E$	R. A.	Dec.	Tot.
				°	″	″	″	″	″	″	″	″	″	″	″	″
3	κ_2 Tauri	1.99	5.5	8.2W	−0.20	−0.12	−0.08	+1.00	+0.87	+0.13	1.02	0.88	+0.14	.02	.02	.02
2	Pi. IV. 82	2.04	5.8	96.2E	+0.95	+0.85	+0.10	−0.27	−0.09	−0.18	0.99	0.86	+0.13	.04	.05	.04
4	κ_1 Tauri	2.35	4.5	8.6W	−0.11	−0.10	−0.01	+0.83	+0.74	+0.09	0.84	0.75	+0.09	.03	.03	.03
5	Pi. IV. 61	3.27	6.0	144.8W	−0.29	−0.31	+0.02	−0.46	−0.43	−0.03	0.54	0.53	+0.01	.04	.05	.05
6	υ Tauri	4.34	4.5	6.3E	−0.10	+0.04	−0.14	+0.57	+0.40	+0.17	0.58	0.40	+0.18	.04	.04	.04
10	72 Tauri	5.19	5.5	14.9E	−0.08	+0.09	−0.17	+0.35	+0.32	+0.03	0.35	0.34	+0.01	.04	.05	.05
11	56 Tauri	5.38	5.5	86.6W	−0.19	−0.32	+0.13	+0.17	+0.02	+0.15	0.25	0.32	−0.07	.06	.02	.05

18. From the observational results in Table I., the resulting value of the deflection, α_0, at the sun's limb, as published by Dr. Crommelin, is 1″.98,[16] thus agreeing with the Einstein predicted value, 1″.74, within 14 per cent. The result from the astrographic plates taken by the other British observer at Sobral, Mr. C. Davidson, using the astrographic object glass of the Greenwich Observatory in conjunction with a 16-inch cœlostat, was not so satisfactory, the star-images being diffuse on account of a probable change in figure of the cœlostat mirror; the discordance between the mean results from the individual plates was said to be rather large, but from the whole series an outward deflection reduced to the limb, of 0″.93, or 0″.99, according to the method of treatment, was found, with a probable error of about 0″.3.[16]

19. The plates taken by Dr. A. S. Eddington and Mr. Cottingham, the second British Astronomical Expedition, at the Ile of Principe, west coast of Africa, where the weather conditions were unfortunately not as favorable as at Sobral, showed only a few stars and the scale could not be directly determined as it was not possible to remain at Principe the required time. Instead, plates of another region of the sky taken at the same altitude were used and compared with plates of the same region and of the eclipse-field obtained previously at Oxford. The determination of scale was therefore somewhat weak, though the uniformity of temperature at Principe was in its favor. The final result of the discussion of the plates gave an outward deflection of 1″.61 with a probable error of 0″.3.[17]

20. *Except then for the unsatisfactory Sobral astrographic plates, the general conclusion to be drawn is that deflections of light were observed by the British astronomers that agree better with the Einstein law of gravitation* (*Cause b*) *than with the Newton-Maxwell law* (*Cause a*). This is well shown by Fig. 2, constructed by the Department of Terrestrial Magnetism, giving a graphical representation of the law of variation with distance followed by the observed deflections for each star, as well as by the computed ones on the basis of causes a and b. It is seen at once that, excepting the most distant star (56 Tauri), each star shows a deflection agreeing better with the Einstein value than with the Newton-Maxwell

[16] See *Nature*, November 13, 1919, p. 281. The probable error as given by Dr. Crommelin is 0″.12, whereas Dr. H. Spencer Jones, of the Greenwich Observatory, in his summary (*Science Progress*, January, 1920, p. 372) gives 0″.06.

[17] See reference to Dr. Jones's article in previous footnote.

one. Though the result from 56 Tauri is discordant, it still is about midway between the two computed curves (Causes *a* and *b*). It should be noted also that the probable error of observation, as shown by the size of the circle around each star, is largest for 56 Tauri, so

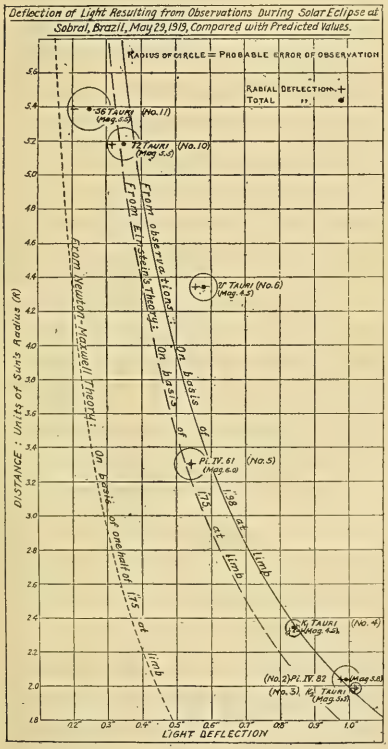


FIG. 2.

that no wholly safe inference as to cause of its departure from the Einstein value may be made.

In view of the recognized difficulties of the observations and the conditions under which they had to be made, and recalling, furthermore, that the preparations and securing of the requisite instrumental equipments were undertaken during the stress of the great war, every one will surely agree that the Astronomer Royal of England and the British observers are heartily to be congratulated upon the splendid results of their labors.

ANALYSIS OF OBSERVED LIGHT DEFLECTIONS

21. In conclusion an analysis was sketched of the observed light deflections and some evidences were pointed out showing that while the simple law (1) was followed to the greater extent, the effects in addition to varying inversely as the distance from the sun's center also apparently depended in some measure upon the heliographic latitude, ϕ, of the star. As a consequence the observed effects are not strictly radial, the departures from radiality occurring in a strikingly systematic manner, and not in the accidental manner that would be the case if the non-radial effects were attributable wholly to errors of observations. When such trigonometric functions are added to law (1) as would arise from forces similar in effect to centrifugal ones, the additional effects are largely accounted for. This possible additional cause, whatever it turns out to be, is designated as *e*. In complete allowance for differential atmospheric refraction effects in the earth's atmosphere may also be the cause of non-radial effects. Resolving the observed actual deflections into two components, radial (along radius vector) and the other non-radial (perpendicular to radius vector), preliminary computations were made with the aid of the expanded law.

$$\alpha = \frac{\alpha_0}{\rho} + f(\rho, \phi). \qquad (2)$$

A value resulted for α_0 agreeing better with the Einstein value of 1″.74, than the value 1″.98 stated in paragraph 18. A future paper will give further account of this interesting matter.[18] I must not fail to record here

[18] The possibility of non-radial effects arising from cause *e* was announced at the meeting of the American Philosophical Society, Philadelphia, Feb-

the assistance received in the construction of diagrams and in the computational work from members of my staff, viz., W. J. Peters, H. B. Hedrick, C. R. Duwall and C. C. Ennis.

22. It is, of course, impossible without further analysis to state at present just what portion of the observed effects may be accounted for by the various causes described in paragraphs 14 and 21. Dr. Newall, for example, see reference in footnote 13, is ready to accept an effect from cause *a* (the Newton-Maxwell effect), but prefers considering the possibility of accounting for the greater portion of the remaining effect by cause *c* (Refraction in the Solar Atmosphere).

23. If it should prove to be the case that the observed light deflections are the result of a combination of the causes mentioned, the way may be open to explain the *results obtained by Dr. W. W. Campbell's eclipse expedition of June 8, 1918, at Goldendale, Washington.* Using two 4-inch photographic objectives photographs were taken of the sun and its surroundings, the exposures being 110 seconds, 50 stars to the ninth magnitude being recorded. He states his results as follows:[19]

The measurement of photographs, 14 inch × 17 inch in size, is a difficult problem even with suitable apparatus: we found it necessary to construct a special measuring machine, and this was made in our own shops. Duplicate photographs of the eclipse field were secured at Mount Hamilton seven months after the eclipse. As the difference of latitude between Mount Hamilton and the eclipse station is only a few degrees, no errors were introduced by not obtaining the comparison field at the eclipse station. These were taken at the proper altitude to avoid the chief refraction troubles in the comparison with the eclipse plates, so that second differences of differential refraction alone entered into the comparison. The plates were measured right and left. The same scale-divisions were used for corresponding pairs of stars. As far as possible the measures were freed from any known source of error. The corrected differences of position were measured along radii from the sun to each star and were arranged in order of distance from sun to star. Dr. Curtis was not able to say that there was anything systematic about these differences, which showed no change of the order required by Einstein's second hypothesis. The probable error of one star position was the order of 0″.5, regrettably large when we are dealing with the differences of small quantities—the difference between the expected displacements of the nearest and furthest stars only being 0″.26. A telescope of great focal length would have been of great help in this work. For the one we used the stars were too faint and in the long exposure required we suffered from the increased extent of coronal structure. Curtis divided his stars into inner and outer groups. The differential displacement between the two groups should have been 0″.08 or 0″.15, according to which of Einstein's hypotheses was adopted. The mean of the results came out at 0″.05 and of the right sign. After getting this result Curtis looked over the collection of 40-foot coronal plates. In the 1900 eclipse there were six stars fairly bright, but not well distributed. It is useless to take a duplicate photograph now owing to uncertainty in the values of the proper motions. Reference has been made to the Paris plate in the Carte du Ciel, but Curtis was unable to say from the comparison that the innermost star showed a displacement due to the Einstein effect.

"It is my own opinion," concludes Dr. Campbell, *"that Dr. Curtis's results preclude the larger Einstein effect, but not the smaller amount expected according to the original Einstein hypothesis."*

24. It will be observed that although Dr. Campbell was not so fortunate as the British astronomers in the matter of bright stars close to the sun, he obtained an effect at more than twice the distance from the sun of the farthest star (56 Tauri), shown in Fig. 2, in the right direction and of about the same amount as that given by cause *a* (Newton-Maxwell Effect). It is of interest to note here that the farthest star, 56 Tauri, in Fig. 2, also gave a deflection approaching that given by cause *a*, though since that star gave the largest probable error, not much weight is to be attached

ruary 6, 1920, and slides were shown exhibiting the systematic character of these effects. The matter was gone into more fully at the New York meeting of the American Physical Society, February 28, 1920.

[19] *The Observatory*, London, Vol. XLII., No. 542, August, 1919 (298–300).

to the fact. It would be of great importance to know, of course, whether as the distance of a star from the sun greatly increases, the deflections of light will correspond more and more closely with that given by cause *a*. There is no possibility that the Einstein effect with increased distance will merge into the Newton-Maxwell effect, since theoretically the former should always be twice the latter. However, if the main cause of light deflections should prove to be *a*, *c* and *e*, or *a* and *e*, or similar ones in effect, it may be possible, as already stated, to harmonize Dr. Campbell's results with those of the British observers. As a caution it may be well to bear in mind that Dr. Campbell unfortunately was obliged to get his results from very distant stars and hence had to look for quantities very much smaller than those concerned in the British observations of the solar eclipse of May 29, 1919.

OUTSTANDING MOTION OF MERCURY'S

25. As a further proof of the Einstein theory of gravitation has been cited the very satisfactory way[20] in which the theory accounts for the outstanding motion of the perihelion of mercury, characterized by the late Professor Simon Newcomb as one of the greatest of astronomical puzzles. Dr. Charles L. Poor, of Columbia University, at the close of my lecture there on January 16 suggested that the outstanding motion of Mercury's perihelion could also be fully accounted for if the equatorial radius of the sun were found to exceed the polar radius by 0″.5, so that the sun would not be truly spherical. Seeliger advanced the hypothesis[21] "that the scattered zodiacal-light materials, if condensed into one body might have a mass fairly comparable to that of the little planet Mercury, " and he has concluded that the attractions of the zodiacal light materials upon the planet Mercury could explain the deviation of that planet from its computed orbit. This problem can not yet be regarded as definitely settled."

EINSTEIN DISPLACEMENT OF LINES OF SPECTRUM

26. Dr. Einstein appears to regard as essential to this theory the verification of the shifting towards the red of the lines of the spectrum of light from the sun and stars. However, Sir Joseph Larmor, according to a paper presented before the Royal Society on November 20, 1919, does not apparently agree with him. The predicted effect has not yet been successfully observed, or, as Professor Joseph S. Ames in his concluding remarks at the end of my lecture at the Johns Hopkins University put it, "has not yet been disentangled from the various possible other causes for shifts of the spectrum lines."

CONCLUDING REMARKS

27. The endeavor has been to set forth impartially all the facts pro and con with reference to the question of the verification of the Einstein theory of gravitation by the recent astronomical observations, so as to enable the reader to form an independent judgment and reach his own decision. Though we may differ as to whether the Einstein theory has been definitely verified, or not, one result of fundamental importance appears to have been established with fair certainty, upon which perhaps chief emphasis should be laid, viz.: that *light has weight*—just how much depends upon whether the Newtonian or the Einstein principles will ultimately be found correct. Possibly the best attitude to take is that of open-mindedness and to let no opportunity pass by for further experimental tests. The British astronomers are already zealously preparing to make observations during the solar eclipse of September, 1922, which will occur in Australia. Perhaps one of the most satisfactory results of the discussion aroused by the subject has been the stimulus imparted to further research in many fields, which is bound to bear fruit.

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20 See A. S. Eddington's *Report on The Relativity Theory of Gravitation*, London, 1920, p. 52.

21 W. W. Campbell, "The Solar System," published in *The Adolfo Stahl Lectures*, p. 10, San Francisco, 1919.

UNITY AND BALANCE IN THE ZOOLOGY COURSE

In an earlier number of this journal,[1] apropos of an article by Professor Bradley M. Davis upon the botany course of the future, I briefly described the introductory course in zoology in operation for several years at the University of Michigan, and pointed out some of the advantages which a course centered around biological principles possessed over the usual course based on the dissection of types. Many inquiries concerning this course were received from all over this country, and several from the other side of the world, indicating a feeling of unrest and dissatisfaction with the present prevailing type course. Some of the writers of these letters clearly recognized the defects of the present method of teaching, and had striven to remedy them without completely reorganizing their courses. Others, while perceiving that something was wrong, had failed, it seems to me, to discern wherein lay the difficulties. In the hope that a clear understanding of the fundamental mistakes of the type course will assist in removing these difficulties, I have undertaken to present herewith what appear to me to be the requisites of the beginning course.

The nature of the first course in science should not be a matter of untrammeled opinion, it should be determined by certain principles. If those principles can be agreed upon, the details may perhaps be varied without harm. I submit two propositions which I regard as almost axiomatic, namely, that the course should be representative, and that it should possess unity. If these propositions are valid, the remainder of this article may have some value.

To apply the first of these rules, it is necessary to have in mind the content of the subject. On this question there may be differences of opinion, but most of these opinions can probably be arranged into two fairly well-defined groups. Zoology consists either (1) of a knowledge of Protozoa, Porifera, Coelenterata, Platyhelminthes, etc., or (2) of a body of principles that may be brought under such rubrics as morphology, physiology, ecology, taxonomy, geographical distribution, paleontology, and evolution. Between these views the teacher must make a choice, if he is to make his course representative, and the nature of the course will depend upon his decision. If the first of these views of the content of zoology should prevail, he who studies cell permeability in *Paramecium* is to be regarded as a protozoologist, not as a physiologist, or else he is not a zoologist at all; the student of heredity in *Drosophila* is a dipterist, not a geneticist; and one who traces the origin of the horse is a mammalogist, not a paleontologist or evolutionist. Very few of the scholars mentioned would be content with the proposed appellation.

If the second conception of the content of zoology be entertained, as has been done in the preparation of our first course, the incongruities just referred to disappear. Other difficulties are also removed, for the seven divisions of zoology named above are not mutually exclusive, but overlap, a circumstance which, far from being a misfortune, is of much value in connection with the second proposition to be developed later. Genetics might fairly be added as an eight division, but its main features are either morphological, or physiological, or evolutionary.

The beginning course must contain the elements of each of these branches of the subject, if it is to be a *general* course. Whether the course should be general or not may be debated, but if it is to be general it must include something from each field.

The classical course in zoology is morphological, a dissection of types of the chief animal groups. Very little even of physiology has been included in it, until in recent years in a very few institutions. Such a course was the proper course once upon a time, when zoology was an almost purely morphological subject. But as the subject grew, the type course became a misfit. It has been a misfit for a long time.

Good teachers have attempted to ameliorate this growing inaptness of their courses by

[1] Science, December 27, 1918.

putting the non-morphological phases of zoology into their lectures and recitations. But the laboratory work has inevitably put an over-emphasis on the morphological side, and may even have over-emphasized the physiological. The seven branches of the science need not, of course, be treated equally. Morphology deserves a greater share than any of the others, for each of the divisions is partly morphological. But a course on morphology alone (or nearly alone) can scarcely be representative. Unprotesting use of the type course means either that the teacher regards the content of zoology as Protozoa, Porifera, Cœlenterata, etc., or that he is satisfied to administer an unbalanced ration to his students.

Quite independent of the foregoing consideration of the content of zoology is the question of unity of the first course. Whether the type course or the topic course be employed, that course should be unified. It should proceed step by step, one thing leading up to and necessarily following others. Unity has not been ignored by those who employ the type method, but they have justified their course by the evolutionary series which the animal scale is supposed to present. When the animal series was thought to be single and continuous, that was a fair assumption. But this notion of the phylogenetic tree has been largely abandoned, it is recognized that the animal series is a disjointed one. At least if there are connections everywhere, they are so attenuated in places that even a superior student is unable to detect them. The step from an echinoderm to an annelid is not an easy one, nor the step from a mollusk to an arthropod.

The lack of unity consequent upon the employment of type dissections has long been recognized, and has led to the widespread notion, referred to above, that something is wrong with the beginning courses in biology. One can not converse long with teachers of biology who are interested in the pedagogy of their work, without encountering the question, what is to be done about the beginning course? Sometimes the unrest is vague, sometimes it is not recognized that lack of unity is the fundamental defect, but in few quarters is the present course regarded as satisfactory.

Various proposals have been made for remedying the defect. One plan offered by a botanist for the beginning course in botany is frankly to make the course practical, utilitarian. Since there may readily be a counterpart of this plan on the zoological side, it is worth considering. The author of this proposal does not recognize lack of unity as the thing to be overcome. He would, for example, study wheat: where it is grown, the proper kinds of soil, its uses, its markets, etc.; then potatoes, their soils, geography, industrial uses, diseases and so on. However desirable a course in agriculture may be, little can be said for the above plan with regard to its unity. One plant may, it is true, unify soils and markets after a fashion, but the gap between wheat and potatoes can hardly be bridged in the same arbitrary manner. The proposed course is simply a type course of another kind, the types being no more closely connected than are the taxonomic groups of organisms to which they belong.

One experienced teacher of zoology proposes that the history of the development of the biological sciences be employed. This teacher has detected the fundamental defect of the present course, and his plan is avowedly an attempt to secure unity. His plan could be successful if the historical development of the science were steadily from the simple to the related complex. If one could learn the history of the rise of a subject by the same steps as he learned the content of the subject, then history would be a unifying study. But were that done in zoology, one would study the development of the chick before he learned of the existence of cells: and he would know of the parthenogenesis of the honey bee before he knew the existence of germ cells. Whereas theoretically simple things should be discovered before complex ones, many circumstances, such as the lack of microscopes, has prevented that order from being followed.

Are we to forget that we now have microscopes, in order to let history unify our subject for us? History may explain a good many discrepancies, especially in earlier biology, but it does not unify anything. History unifies only subjects that are essentially historical in their nature, like political development, or philology. I do not mean that history is uninteresting or unimportant, for it is neither; but it unifies only the history, not the *content*, of biology. Only the facts of a science can unify the science itself.

Unity can be acquired only by arranging subjects, placing the simple first, and laying thereby a foundation for related subjects that are more complex. Each subject should lead to another, and rest upon those that precede. Such unity a course based on the dissection of types can have only in small degree. Otherwise one teacher could not begin with Protozoa, another with vertebrates, or another with Arthropoda which are followed by Protozoa, leaving the vertebrates to the last. Did types insure unity, we would not have that interesting chapter on "animals of uncertain affinities" squarely in the middle of the course. Nematodes do not lead naturally to the Bryozoa, nor do the annelids obviously follow the echinoderms. There is no manifest necessity for having the mollusks precede the arthropods. The teacher of the type course may claim unity for his course, on the ground that he goes from the simple to the complex. A grindstone, a bicycle, a typewriter and a calculating-machine may be arranged in order of complexity, but the unity permeating the series still not be very obvious.

Homology, on the contrary, does lead to taxonomy, taxonomy and ecology to distribution, distribution in space to distribution in time. Cell division leads to cell aggregation, and reproduction to embryology. The connections stated are not merely obvious, they are necessary.

The study of topics entails certain difficulties, one of them being the larger amount of diverse material required in the laboratory. Some may think that this use of many different animals is confusing, rather than unifying. Our experience indicates that such is not the case. Using many animals to demonstrate the truth of the cell doctrine is not more confusing than the study of profit and loss in arithmetic by problems involving vinegar, woolen goods, automobiles, and ostrich feathers. What would be thought of an arithmetic that employed problems relating to vinegar for addition, division, profit and loss, compound interest and cube root, before woolen goods were used to illustrate the same operations? Or what of a school system in which vinegar was studied chemically, biologically, and industrially before woolen goods were studied from the same points of view? Those would be type studies, type arithmetics, type school systems.

In only one other science, so far as I am aware, do teachers as consistently use the type method as we have done. Whether another method would do as well in that subject I am not qualified to say. Biology is, then, one of the few sciences which have allowed their wealth of material to obscure their subject matter.

How do the students react to the treatment I have described? Perhaps, although the course has been given seven times, we have not been using the new method long enough to speak authoritatively; but some things seem to be observable. I have seldom heard students ask that question formerly not infrequently heard, not only in our own laboratories but in those of other institutions, "How much of all this are we expected to remember?" Students now recognize for themselves that the things which they study are important, for they draw conclusions from them. They have perhaps been quicker than teachers to see the advantages of the new method. Verily, these things were hid from the wise and prudent, and were revealed unto babes.

If culture be measured by the number of ways one has of entertaining himself, certainly the knowledge of biological principles far outweighs from the cultural standpoint an acquaintance with the details of structure of selected forms. For a knowledge of animals, as members of taxonomic groups, is not lacking in those who pursue zoology in the way I have outlined; and about these animals there is always something besides structure that is worth knowing. In order that these worth-while things may be known adequately, they must be the subject matter of the laboratory exercises as well as the recitations.

Nothing in this article is intended to imply that advanced courses should be of the kind described for beginning students. It is recognized that to become a zoologist, or to prepare for certain professions, it is necessary to have a systematic knowledge, not only of taxonomic groups, but of several other fields of zoology as well. In the acquisition of such knowledge there must be courses in which facts seem to outweigh principles. But to attempt to gain such knowledge in the elementary courses, even for those who must later acquire it, is neither necessary nor desirable.

A. Franklin Shull

University of Michigan

A FORERUNNER OF EVOLUTION

BICENTENARY OF CHARLES DE BONNET, NATURALIST AND PHILOSOPHER

March 13, 1920 marks the two hundredth anniversary of the birth of one of the most interesting of eighteenth century scientists, whose researches in entomology and botany were of solid and permanent importance in the history of these branches of learning, and whose philosophy, if superseded, was at least interesting and to some extent prophetic; yet who is comparatively seldom spoken of to-day.

Charles de Bonnet on that date was born in Geneva, the sometime home of one against whom he wielded most fiercely his philosophic pen—Jean Jacques Rousseau. Rather curiously, de Bonnet's birth and death dates anticipate by an exact century those of a pioneer of evolutionary science, John Tyndall. The earlier master died on May 20, 1793, after a life almost uneventful except for its mental activities.

One of the most striking facts about de Bonnet's career is the extreme precocity of his talent. His entire work in natural history is crowded into the first twenty-five years of his life; after which failing eyesight, induced by close work with the imperfect microscopes of the day, turned him perforce from laboratory research to theoretical speculation.

At sixteen he read Réamur's work on "Insectology." It proved the turning-point of his life. Born of a Huguenot exile family, all of whom were accustomed to hold high offices in the Swiss government, de Bonnet was studying law with the expectation of following in the footsteps of his kinfolk. His introduction to entomology ended his interest in law; although he persevered in his studies until he attained the degree of Doctor of Laws, he never practised, but devoted the rest of his life to the science which had become his passion.

Two years after he first read Réaumer and Pluche, he sent to the former a long list of "additions" to his works, based on further investigations. What was Réaumur's astonishment to discover that his valuable collaborator was a boy of eighteen! By the time he was twenty, de Bonnet had established the fact of at least usual, and probably invariable, parthenogenesis in aphides. Before he was of age, he had been appointed a corresponding member of the Academy of Sciences. Two years later he successfully demonstrated the reproduction of some forms of worms by simple fission; and in the same year he discovered the pores, or "stigmata," by which caterpillars and butterflies breathe, and made important studies in the structure of the tapeworm.

Turning to botany, and newly appointed a fellow of the Royal Society, the youthful scientist next experimented in plant physiology with special reference to the functions of leaves, and attempted to prove that all chlorophyllic plants are endowed with sensation and what he termed "discoverment." It was at this stage of his career that threatened blindness diverted his studies into an entirely different field.

De Bonnet's philosophical theories were largely influenced by the time in which he lived; he wrote a work on the "Proofs of Christianity" to defend Revelation, and valiantly opposed the teachings of Voltaire and Rousseau, and the epigenesis theory of Buffon. On the other hand, he advanced the purely materialistic idea that all thought is due to vibrations of the nerves. Bodily activity, he said, is a necessary condition of thought.

Following Cuvier and Leibnitz in the doctrine of original creation by a Deity, de Bonnet then premised a "germ" of perfecting evolution in every living thing. In his "Contemplation of Nature," he taught that all beings in nature form a graduated and unbroken scale from lowest to highest, with no gaps from the lowest atom of matter to "Archangels"; though the flaw in his perfectability theory appears when he denies that the highest of his heirarchy can ever exactly equal Deity itself. In "Philosophic Palingenesis," he elaborated this doctrine to show the survival not merely of man, but of all animals, and the perfecting of their faculties in the future state. Man, he said, is composed of a material body and an immaterial mind, resident in his brain; but he carries within himself the germ of a more attenuated body which will clothe his mind in the next stage after life on earth—a curious approximation to some of the teachings of modern Spiritualism. What he does not make clear is whether he expects each individual to carry within himself the germ of his own perfectability, or whether it is only races of men and kinds of animals that are perfected *en masse*.

De Bonnet's philosophy is chiefly interesting as a commentary on his scientific attainments. If he had died at twenty-five, he would have left his most valuable achievements already accomplished; but if, two hundred years ago, he had never been born, the world of science even to-day would have been a great deal the loser.

Maynard Shipley

SCIENTIFIC EVENTS

THE PRESERVATION OF NATURAL CONDITIONS

For three years the Ecological Society of America has had a committee composed of about twenty-five interested persons, investigating the question of preserving natural conditions for scientific study. The work to date has been concerned with (*a*) listing and describing preserved areas and areas desirable for reservation, (*b*) determining the policies governing existing reservations and the desirability of reserving natural areas within them, (*c*) collecting arguments in favor of preserves, (*d*) determining lines of research and education, scientific, artistic and historical which require or can make use of reservations, and (*e*) methods which have been successfully employed in securing reservations. The matter in hand includes a list of more than six hundred areas in United States and Canada which are preserved or are desirable for preservation. It is evident that some types of natural conditions are not represented and for some localities no areas have been brought to our attention. Persons having information regarding areas desirable for preservation or already preserved or knowledge concerning any of the subjects noted above, especially methods employed in securing reservations, are requested to send information, which will be fully credited, to the chairman or any member of the committee. The present committee is composed of C. W. Alvord (history), Univ. of Ill.; H. C. Cowles (plant communities), Univ. of Chicago; R. T. Fisher (forest practice), Harvard Univ.; S. A. Forbes (entomology), Univ. of Ill., A. S. Pearse (aquatic preserves), Univ. Wis., C. F. Korstian (grazing), Ogden, Utah; R. B. Miller (forest laws), Univ. of Ill.; T. C. Stephens (bird preserves), Sioux City, Ia.; R. H. Wolcott (fires), Univ. of Nebr.; F. B. Sumner, La Jolla, California; M. J. Elrod, Univ. of Mont.; F. J. Lewis, Univ. of Alberta; John Davidson, Univ. of Br. Columbia; G. B. Rigg, Univ. of Washington; F. Ramaley, Univ. of Colo.; G. A. Pearson, Flagstaff, Ariz.; G. W. Goldsmith, Univ. of Nebr.; J. R. Watson, Univ. of Fla.; J. W. Harshberger, Univ. of Pa.; W. L. Bray, Syracuse Univ.; C. D. Howe, Univ. of Toronto; F. E. Lloyd, McGill Univ.; C. O. Rosendahl, Univ. of Minn.

V. E. SHELFORD, *Chairman*

UNIVERSITY OF ILLINOIS

THE NATIONAL COMMITTEE ON MATHEMATICAL REQIREMENTS

AT the last meeting of the General Education Board in New York on February 28, the sum of $25,000 was appropriated for the use of the National Committee on Mathematical Requirements to continue its work for the year beginning July 1, 1920.

A preliminary report on "The Reorganization of the First Courses in Secondary School Mathematics" was published for the Committee by the U. S. Bureau of Education about the middle of February. It has been distributed widely. Copies of the report have gone to all the state departments of education, to all county and district superintendents in the United States and to all city superintendents in cities and towns of over 2,500 population. It has been sent to all the normal schools in the country, to some 1,500 libraries and to almost 300 periodicals and newspapers. In addition it has been sent to about 4,500 individuals, the names and addresses of which were furnished the Bureau of Education by the National Committee. This list of individuals consists chiefly of teachers of mathematics and principals of schools throughout the country. Additions to this mailing list to secure future copies of the reports of the committee can still be made. Individuals interested in securing these reports should send their names and addresses to the chairman of the committee (J. W. Young, Hanover, N. H.).

A subcommittee consisting of Professor C. N. Moore, of the University of Cincinnati, Mr. W. F. Downey, of Boston, and Miss Eula Weeks, of St. Louis, has been appointed to prepare a report for the Committee on Elective Courses in Mathematics for Secondary Schools. Any material or suggestions for this report may be sent directly to the chairman of the subcommittee.

The recent work of the national committee had a place on the program of the organization meeting of the National Council of Teachers of Mathematics held in Cleveland on February 24 in connection with the meeting of the Department of Superintendence of the National Education Association. The meeting for the organization of the National Council was enthusiastically attended. A constitution was adopted and officers and an executive committee elected. Mr. J. A. Foberg, of the National Committee on Mathematical Requirements, was elected secretary-treasurer of the National Council.

Recent meetings of teachers at which the reports of the national committee have been discussed have taken place in New York City, Cincinnati, San Francisco, Cleveland, Oklahoma, Philadelphia, Springfield (Mass.), Providence (R. I.). Meetings in April will take place in Alabama, Illinois, Iowa, Michigan and Kentucky.

THE NEW YORK STATE COLLEGE OF AGRICULTURE AND THE NEW YORK STATE EXPERIMENT STATION

THE State College of Agriculture at Ithaca and the State Agricultural Experiment Station at Geneva have now become formally affiliated. Each will retain its separate organization and carry on its own appropriate work; in addition provision is made for somewhat closer correlation, for ready exchange of all facilities of research and experimentation, and for more frequent conferences. To these ends the trustees of Cornell University have appointed to the staff of the college eight persons on the staff of the station at Geneva: Whitman H. Jordan, director; R. J. Anderson, chemist; Robert S. Breed, bacteriologist; R. C. Collinson, chemist; U. P. Hendrick, horticulturist; Percival J. Parrott, '06, entomologist; Fred C. Stewart, '98, botanist; and L. L. Van Slyke, specialist in fertilizers. And reciprocally the board of control has appointed to the Geneva staff six members of the agricultural faculty: Professors Chandler, Emerson, Herrick, Lyon, Reddick, and Stocking.

The *Cornell Alumni Weekly* says: "This closer relationship promises benefits not only to the college, particularly in enlarging the regular opportunities of graduate students and investigators, but also to the farming interests of the state, to whom the combined efforts and results are valuable. The affiliation, thus bringing a mutual extension of privileges, is characterized by the authorities as a gain to both institutions without cost or loss to either."

SCIENTIFIC NOTES AND NEWS

The next meeting of the American Astronomical Society will be held at Smith College Observatory, Northampton, Massachusetts, beginning on September 1. The society will also visit the observatory at Mt. Holyoke College.

The American Association of Anatomists will hold their annual meeting at the National Museum, Washington, D. C., from April 1 to 3. The program contains about sixty titles for papers and fifty demonstrations.

The second annual meeting of the American Society of Mammalogists will be held in the American Museum of Natural History, New York City, May 3–5, 1920. There will be opportunities to visit the New York Zoological Park, the Brooklyn Museum, the New York Aquarium, and other institutions of interest to members. Headquarters will be at the Hotel York, 7th Avenue and 36th Street, three blocks north of the Pennsylvania Station.

Dr. John Charles Hessler has been appointed assistant director of the Mellon Institute of Industrial Research of the University of Pittsburgh. Dr. Hessler, who is now serving as president of James Milliken University, Decatur, Ill., will enter upon his new work at the close of the present academic year. As a member of the administrative staff of the Mellon Institute, he will be in supervisory charge of certain of the researches in organic chemistry, a field in which he has specialized during the past twenty years.

Dr. John W. Macfarlane, professor of botany and director of the Botanical Laboratory and of the Botanic Gardens of the University of Pennsylvania, has tendered his resignation after twenty-eight years of service, to take effect on June 30.

Dr. Waldemar T. Schaller has resigned as chemist in the division of physical and chemical research, United States Geological Survey, and has accepted a position with the Great Southern Sulphur Co., Inc., of New Orleans, La., operating at Orla, Texas.

The French government has conferred the decoration, "Officier de l'Instruction Publique," upon Professor E. B. Van Vleck, of the department of mathematics of the University of Wisconsin, in recognition of his services as teacher and investigator and for his work during the war.

Professor Warren H. Lewis, of the Johns Hopkins Medical School, has been elected an honorary member of the Society of Medicine of Gand.

At its meeting held on March 10, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of $250 to Professor Julius Stieglitz in aid of the publication of Marie's "Tables of Constants."

At a meeting of the Royal Society of the Medical and Natural Sciences of Brussels held on December 1, Dr. John J. Abel, professor of pharmacology at the Johns Hopkins University, was elected an associate member of the society.

The Committee on Scientific Research of the American Medical Association has made these grants for scientific work: Professor G. Carl Huber, University of Michigan, for study of nerve repair, $400. Professor H. M. Evans, University of California, for study of the influence of endocrine glands on ovulation, $400. Professor E. R. LeCount, Rush Medical College, for study of extradural hemorrhage and of the hydrogen-ion content of the blood in experimental streptococcus infections, $200. Dr. E. E. Ecker, Western Reserve University, for a study of the specificness of antianaphylaxis, $200. Dr. Henrietta Calhoun, Iowa, State University, for a study of the effect of protein shock on diphtheria intoxication, $400.

The council of the Royal Society has recommended the following: Dr. Edward Frankland Armstrong, Sir Jagadis Chunder Bose, Dr. Robert Broom, Professor Edward Provan Cathcart, Mr. Alfred Chaston Chapman, Dr. Arthur Price Chattock, Mr. Arthur William Hill, Dr. Cargill Gilston Knott, Professor Frederick Alexander Lindemann, Dr. Francis Hugh Adam Marshall, Dr. Thomas Ralph Merton, Dr. Robert Cyril Layton Perkins, Professor Henry Crozier Plummer, Professor Robert Robinson, and Professor John William Watson Stephens.

At the annual meeting of the Optical Society, London, Mr. R. S. Whipple was elected to the presidency; the vice-presidents are: Professor F. J. Cheshire, Sir Herbert Jackson, and Mr. H. F. Purser.

Professor B. A. Houssay, of the University of Buenos Aires, has been elected corresponding member of the Société de Pathologie exotique at Paris in token of appreciation for his extensive research on snake venom and on scorpion and spider poisons.

Dr. Chalmers Mitchell, the English zoologist, under the auspices of the London *Times*, undertook to make a flight from Cairo to the Cape with special reference to scientific observations, leaving Cairo in a Vickers-Vimy machine with a crew of four pilots and mechanics on February 6. A forced descent after delays by engine troubles at Tabora, in the Tanganyika territory damaged the machine so that the flight could not be continued.

Mr. Carl L. Hubbs, assistant curator of ichthyology and herpetology in the Field Museum of Natural History, has resigned to accept the position of curator of fishes in the Museum of Zoology, University of Michigan.

Assistant Professor Gerald L. Wendt, of the department of chemistry at the University of Chicago, has been appointed associate editor of the *Journal of the Radiological Society of North America.*

Frank H. Reed, Ph.D. (Chicago, '17), has been made supervisor of Industrial Research for the Butterworth-Judson Corporation of Newark, New Jersey.

Dr. E. P. Wightman, recently of Parke Davis and Co., of Detroit, has accepted a position as research chemist with the Eastman Kodak Co., Rochester, N. Y.

Lieutenant Schachne Isaacs, formerly instructor in psychology at the University of Cincinnati, and at present psychologist in the Air Service, Medical Research Laboratory, Mitchell Field, Long Island, has been awarded the fellowship in psychology offered by the Society for American Fellowships in French universities. This enables the holder to do graduate work in the French universities for two years. The purpose of the society is to develop an appreciation among American scholars of French achievements in science and learning.

Dr. Charles R. Stockard, professor of anatomy at Cornell University Medical School, New York City, read a paper on "Growth Rate and its Influence on Structural Perfection and Mental Reactions" before the Philadelphia Psychiatric Society, on March 12.

A special meeting of the College of Physisians of Philadelphia was held March 19, as a memorial to Dr. Horatio C. Wood. Dr. George E. de Schweinitz read a memoir to Dr. Wood. "Recollections of a Pioneer in Pharmacology in the United States," was read by Dr. Hobart A. Hare; "An Appreciation," by Dr. Francis X. Dercum, and "Reminiscences, Chiefly Neurological and Medico-Legal," by Dr. Charles K. Mills.

Dr. George D. Allen, instructor in zoology in the University of Minnesota, died from pneumonia on March 11.

Dr. K. A. J. Mackenzie, dean of the medical department of the University of Oregon, a surgeon of national reputation, is dead at Portland, Ore., from heart disease superinduced by influenza.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Michigan has received an anonymous gift of one million dollars.

Rentals amounting to \$2,367,000 will go to the university under the terms of a lease arranged by Levi L. Barbour, the Detroit manufacturer, with the stipulation that the money shall be used for educating women of the Far East.

Cornell University has received a gift of \$100,000 for a new dormitory, to be named for the donors' parents, from W. G. Mennen and his sister, Mrs. Emma Mennon Williams, of Detroit.

Bates College is to receive \$500,000 from the fund to be raised by the Northern Baptist Convention.

On recommendation of the medical faculty of Cornell University, women who are students in medicine may hereafter take the first year's work at the Medical College in New York City.

Professor Walter Edward McCourt, head of the department of geology of Washington University, has been appointed dean of the schools of engineering and architecture of Cornell University. He will assume the duties of his new position at once. The appointment was made to fill the vacancy caused by the resignation of Professor A. S. Langsdorf.

Professor E. T. Bartholomew, of the department of botany of the University of Wisconsin has accepted a research professorship in the Graduate School of Tropical Agriculture at Riverside, Cal., in connection with the University of California. His special work will be the investigation of the diseases of lemons and other citrus fruits.

Sir Archibald E. Garrod has been appointed to be regius professor of medicine in the University of Oxford in succession to the late Sir William Osler.

DISCUSSION AND CORRESPONDENCE

MODERN INTERPRETATION OF DIFFERENTIALS

To the Editor of Science: Without attempting to discuss the historical questions involved, I wish to point out that the theory of "differentials" given by Professor A. S. Hathaway in Science for February 13, 1920, would prove highly misleading to the modern student.

Professor Hathaway defines $\Delta' y$ as $N\Delta y$, where N is some multiplier and Δy a simple increment, and then defines dy as the limit of $\Delta' y$ as Δy approaches zero. The inevitable consequence of such a definition is that $dy = 0$, which is obviously futile.

In view of the continual recrudescence of such fallacies (with or without a historical background), it may be worth while to repeat here the modern interpretation of the differential, though this may be found correctly stated in any good text-book of calculus.

Consider the graph of a function $y = f(x)$, with the tangent line drawn at the point $x = x_1$, $y = y_1$. Give x an arbitrary increment

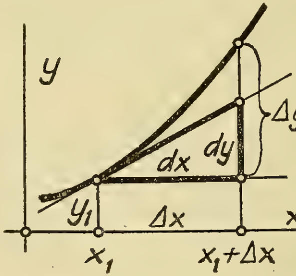

Fig. 1.

which, since x is the independent variable, may be denoted indifferently by Δx or dx. Corresponding to any such increment in x we have the *increment* of y, called Δy, extending up to the curve, and the *differential* of y, called dy, extending up to the tangent. Now when Δx (or dx) is made to approach zero, the ratio dy/dx remains constant, being the slope of the tangent line, while the ratio $\Delta y/\Delta x$ is a variable, approaching the slope of the tangent as a limit. *But the limit of Δy taken by itself is zero, and the limit of dy taken by itself is also zero.*

There are thus two very good reasons why we can not say that "dy is the limit of Δy." First, dy is a variable and therefore can not be the limit of anything; secondly, zero is the limit of Δy, and therefore nothing else can be.

A list of similar fallacies, which still persist in some books (and, apparently, in some classrooms also), may be found in a paper by the present writer on "The proper use of the differential in calculus."[1]

The word *derivative* means, of course, the ratio dy/dx.

EDWARD V. HUNTINGTON
HARVARD UNIVERSITY

WEIGHT AND CENTRIPETAL ACCELERATION

TO THE EDITOR OF SCIENCE: Mr. Carl Hering's suggestion for a new form of dynamic compass[1] ought to be challenged before some one organizes a company to work the idea out on a commercial basis. The fact is, of course, that the change in weight which Mr. Hering refers to occurs only when the motion is *in a circle having its center in the earth's axis.* Mr. Hering's disk is a plane tangent to the earth's surface and motion in this plane does not, on the basis of Newtonian mechanics, affect the weight of a body. It is understood of course, that the disk is not forced to remain tangent to the earth as the earth rotates. This would complicate the situation by introducing the gyroscopic effect. If the disk is mounted in gimbals so that the earth in turning does not force a change in direction of the shaft there would, as stated above, be no tendency of the shaft to set itself parallel with the earth's axis.

The suggestion that the light disk with equal weights at extremities of a diameter would rotate in balance when in a north and south plane, but out of balance in an east and west plane is equally mistaken. Any change in the weight of a body on the basis of Newtonian mechanics must be due to an acceleration of the body, part of the gravitational force being used to produce the acceleration. We may, therefore, examine the accelerations of these bodies to see whether they could produce the effect described. Each of the weights on the light disk has an acceleration composed of two components.[2] One of these components is directed toward the center of the disk. This component is due to the rotation of the disk, and may be called the *disk component.* Since the two weights are at opposite extremities of a diameter the disk components of their acceleration are equal in magnitude and opposite in direction, and their only effect is to produce the well-known centrifugal stress in the disk. The other component of acceleration is common to the two weights. It is the acceleration of the center of the disk due to the earth's motion. It is altogether independent of the rotation of the disk. This acceleration will affect the weights of the two bodies, but the effect will be the same for both bodies in all positions of the disk, and cannot therefore, produce unbalanced rotation.

Curiously enough there is another cause that would produce a minute unbalance in a disk of the sort just considered when rotating in any vertical plane at any point on the earth's surface. When the line of the weights is in a horizontal position let the weight of each be represented by w. Then neglecting the weight of the disk and shaft the downward pressure on the bearings is $2w$. When the line of the weights has turned through 90° to a vertical position one of the bodies has approached the earth and consequently its weight is increased. The other has receded from the earth but its weight has decreased less than the other increased since the attraction varies as the inverse *square* of the distance. Consequently the pressure on the bearings is greater when it is horizontal. This would produce a minute effect of unbalance which, however, would be just as great when the disk rotates slowly as when it rotates at high speed.

BURT L. NEWKIRK
UNIVERSITY OF MINNESOTA

[1] Society for the Promotion of Engineering Education: *Bulletin,* Vol. 4, pp. 19–28, 1914, or *Proceedings,* Vol. 22, pp. 115–124, 1915.

[1] SCIENCE, Vol. LI., p. 46.

[2] Gimbal mounting is assumed again to eliminate gyroscopic effect.

THE SITUATION OF SCIENTIFIC MEN IN RUSSIA

To the Editor of Science: The information about Professor Pavlov conveyed in a letter to Science (March 12) is somewhat puzzling in its purport. It is customary to make announcement of events which actually occurred; as for instance birth, deaths, marriages, etc. It would be a most unique procedure to treat the public to news items like these: so-and-so has not yet been born, has not yet died, married, got an increase in salary. Why then this item that on a certain date A.D. Professor Pavlov *was not yet dead?*

It seems likely, therefore, that the only object of the note was to give publicity to a quotation from a letter of Pavlov to some other party to the effect that he was starving and instead of engaging in scientific pursuits was occupied in peeling potatoes. Now, this alleged quotation bears earmarks of a spurious nature. It undoubtedly belongs to that class of hoaxes which the daily press has been imposing upon its innocent readers with an invidious design. It is impossible to reconcile the two statements in the quotation, that Professor Pavlov is starving, and that he has so many potatoes to peel as to be obliged on that account to forsake his science. Even one not versed in the theory of nutrition would be skeptical about the probability of starvation in the midst of plenty of potatoes. (Consult Hinhede on the nutritional value of the potato.)

Like all statements intended primarily to force public opinion into a preformed mould, it is not what is actually said but what is indirectly implied that really matters. The quotation from Pavlov's letter is obviously calculated to rouse in us indignation over the sufferings of the distinguished physiologist. But does it not also insinuate a suggestion that the genius which was the man's great asset under the benign and enlightened government of the Czar of all the Russians has under the new régime become a crushing liability on him? So, ere we are moved to deep pity over Pavlov's unfortunate lot, let us reflect if with our well-meant sympathy we may not cause him more distress than comfort.

It so happens that I have some news of another venerable savant, Professor Timiriazev, distinguished botanist of the University of Moskow, an Sc.D. of Cambridge, a fellow of the Royal Society. As I have no "obvious" reason for hiding my informant, I may say that he is Arthur Ransome, whom I herewith quote:

> He [Timiriazev] is about eighty years old. His left arm is paralyzed, and, as he said, he can only work at his desk and not be out and about and help as he would wish. A venerable old savant, he was siting with a green dressing gown about him, for his little flat was very cold. He spoke of his old love for England and for the English people. Then speaking of the veil of lies drawn between Soviet Russia and the rest of the world, he broke down altogether and bent his head to hide his tears. I suffer doubly—he said—I suffer as a Russian, and, if I may say so, I suffer as an Englishman. My grandmother was actually English. I suffer as an Englishman when I see the country I love misled by lies, and I suffer as a Russian because those lies concern the country to which I belong, and the ideas which I am proud to hold.
>
> The old man rose with difficulty, for he, like every one else in Moskow, is half starved. "If I could let them know the truth—he said—those friends of mine in England, they would protest against actions which are unworthy of the England we have loved together."

S. Morgulis

The Creighton University

RUSSIAN AND AMERICAN SCIENTIFIC MEN

To the Editor of Science: In Science of March 5, I have noticed the report that Professor Pavlov, still alive in Petrograd last summer, was peeling potatoes when last heard from. Without wishing to jest on this truly pitiable situation, it may not be amiss to submit also the report that no small portion of the professors of this country are now likewise engaged in peeling potatoes or similar menial work, at any rate for a large part of their time. Under present conditions they can not get others to do such work for them.

The cause, here as in Russia, is the glorification of "labor"—apparently synonymous with cessation of labor, at any rate for a price proportioned to its value.

When a professor does not actually "quit his job," the public supposes he is giving the same service as formerly. In fact he may be simply meeting his classes as before, some ten or twenty hours in the week; the rest of his active time, which should be spent in preparation, study and research, is under present conditions too often dissipated in chores of house and garden, for which "help" is no more to be had. In effect the professor has "quit his job," for half time and in that half is situated somewhat like Professor Pavlov.

The irony of it is that the professor is the last man in the world to shirk his professional work, which is also his pleasure; but the topsy-turvy economics of the day are forcing many to do so.

A MEMBER OF THE EXPLOITED CLASSES

QUOTATIONS

NITROGEN FROM THE AIR AND THE BRITISH GOVERNMENT

THE report of the Nitrogen Products Committee has at last been allowed to emerge from the seclusion of the government pigeon-hole, in which it has reposed, in type, for at least seven months. It is a voluminous document of over 350 pages, containing the results of nearly three years' work, largely voluntary, on the part of a number of scientific men, who in that period explored in great detail the statistical and economic aspects of the nitrogen problems and also supervised much experimental research. The latter was devoted especially to the Haber process for the synthetic manufacture of ammonia by the direct union of its elements, nitrogen and hydrogen—a process which, coupled with the oxidation of the ammonia to nitric acid, undoubtedly enabled Germany, cut off from supplies of nitrate from Chile, to continue the war longer than would otherwise have been possible. The general principles of that process were familiar enough in this country, but acquaintance with the technique of its operation was confined to Germany. However, the committee made such progress towards remedying this deficiency that in their report they feel justified in recommending the immediate establishment of the process on a "commercial unit" scale in this country and its extension up to a minimum of 10,000 tons of ammonia annually.

For this purpose they suggest the utilization of a factory at Billingham-on-Tees. The Explosives Department of the Ministry of Munitions decided to start this factory in a hurry, and perhaps in advance of the technical knowledge available at the time, towards the end of 1917; but their attitude towards it was somewhat Laodicean, and it has not been finished. Its completion would cost a considerable sum, but the committee's view is that, as a matter of national insurance, we ought to be in a position to manufacture nitrates artificially in this country, since, from the military aspect, we cannot afford the risk of being dependent on saltpeter imported from Chile for the nitrogen compounds which are indispensable for modern high explosives. Perhaps the best solution would be for private enterprise to take over and equip the factory, with some measure of government control and interest; and the appearance a few weeks ago of an advertisement inviting offers for it suggests that this is the direction in which events are moving. It is believed, indeed, that an important group of firms is in negotiation for the place. In this connection it must be remembered that nitrates are as essential in peace, for fertilizing purposes and the manufacture of mining explosives, as they are in war.

A cheap and abundant supply of electric power being essential for the commercial success of some of the processes of fixing atmospheric nitrogen, the committee considered very fully the question whether this condition can be met in the United Kingdom. In particular, they investigated the possible advantages of employing preliminary processes of carbonization and gasification in connection with large electric power stations, instead of firing the coal direct into the furnaces of steam boilers. Such methods offer the attraction that they permit the recovery of by-products that are lost with direct firing, and it is, therefore, disappointing to find that the committee's conclusions are adverse. They conclude that, in the present state of knowledge, the direct burning of coal under steam boilers forms the cheapest method of generating electricity on a large scale from coal, even when the indirect processes are credited with the revenue obtainable from the sale of the recovered by-products. What is still more unfortunate—from the point of view of those who hope for an increased supply of home-produced liquid fuel, as well as cheaper electricity from capital power stations with gas-fired boilers—they make out that the advantage of direct firing increases with rising costs of coal and labor.—The London *Times*.

NOTES ON METEOROLOGY AND CLIMATOLOGY

RAINFALL (AND SNOWFALL) OF THE UNITED STATES[1]

THE Weather Bureau has just issued a reprint from the *Monthly Weather Review* entitled "Seasonal distribution of precipitation and its frequency and intensity in the United States,"[2] by Joseph B. Kincer. Three reviews and abstracts are included in the reprint: "Some characteristics of the rainfall of the United States,"[3] by R. DeC. Ward; "New seasonal precipitation factor of interest to geographers and agriculturalists,"[4] by R. M. Harper; and "The snowfall of the United States,"[5] by R. DeC. Ward. Since these three papers are easily available, this note will cover only Mr. Kincer's article and the graphs added to the reviews of Professor Ward's two papers.

Here are published, for the first time, reliable and detailed maps of the average rainfall of the whole United States for each month. The topographic (hachured) base-map used shows at once the close dependence of rainfall on topography as it affects precipitation of moisture from the prevailing westerly winds. We have long known of the marked spring and early summer rainfall maximum in the prairies and Great Plains; but these monthly maps give us almost a moving picture of the wave of rainfall which spreads northward and westward as the warm southerly winds blow in day after day from the Gulf of Mexico. From its February position across east Texas, northwest Arkansas and southern Illinois, the 3-inch monthly rainfall line in March has moved westward into Oklahoma, central Missouri and northern Illinois; in April, to central Texas, central Oklahoma, eastern Kansas and central Iowa; in May, to the 101st meridian in south Texas, across the Panhandle into northeastern New Mexico, through western Kansas, west central Nebraska, the Dakotas and northern Minnesota, and in June still farther westward in the central and northern Great Plains—in Montana even to the Rockies. By June in the southern Plains and by July in the northren Plains the spring-time flood of moist air has spent itself, and the rainfall lines are beginning to retreat—eastward as the summer passes, and southward as the coldness of the oncoming winter renders much precipitation impossible. The four maps of precipitation by seasons summarize this same movement of the isohyets. With such a series of maps before one it is obvious that the Gulf of Mexico and the open country to the north and northwest allow our prairies and plains to be so productive.

If the conditions year after year were like those shown on these maps of average rainfall, we should not have been experiencing or

[1] *Cf.* notes on this subject in SCIENCE, July 19, 1918, N. S., Vol. XLVIII., pp. 69–72 (snow, SCIENCE, February 11, 1916, N. S., Vol. XLIII., pp. 212–214).

[2] September and October, 1919, Vol. 47, pp. 624–633, 695–696, 7 graphs, 30 maps—13 in text and 17 full-page lithographs. (For copies, apply to "Chief, U. S. Weather Bureau, Washington, D. C.")

[3] *Scientific Monthly*, September, 1919, Vol. 9, pp. 210–223.

[4] SCIENCE, August 30, 1918, N. S., Vol. XLVIII., pp. 208–211.

[5] *Scientific Monthly*, November, 1919, Vol. 9, pp. 397–415, map.

reading of the great droughts, recently ended, which were at their worst in west Texas and the northern Great Plains. The flood of warm, moist air from the Gulf is variable in size and duration. These variations are felt most near its western and northwestern limits, where farmers have learned to look on partial crop failures as normal. This variability, which is the most important aspect of rainfall, aside from the average amount, is clearly brought out by Mr. Kincer in a number of graphs and maps. In drought years as well as in years of plenty, farmers are inclined to believe in stories of progressively decreasing or increasing rainfall: comparisons of rainfall averages by successive 20-year periods show, however, that in this region there is no perceptible progressive change in rainfall.

In years of decreasing rainfall, real-estate agents for the semi-arid lands of western Kansas explain to prospective buyers that although the total rainfall is decreasing, the decrease is mostly confined to the washing and flooding downpours, and that the proportion of rains of beneficial amount is increasing. They are discussing another essential element which must be considered in comprehensive rainfall discussions. Mr. Kincer presents maps showing the average annual number of days with precipitation 0.01 to 0.25 inch, 0.26 to 1.00 inch, and 2.00 inches or more. Further details of rainfall intensity are given on maps showing the average annual number of days with precipitation more than 1.00 inch in an hour, and the maximum precipitation in 24 hours. Two more maps which might be called "drouth maps" show the percentage of years with 30 consecutive days or more without 0.25 inch of rainfall in twenty-four hours from March 1 to September 30, and the greatest number of consecutive days without 0.25 inch of rainfall from March 1 to September 30. These are all based on the rainfall data for the 20-year period, 1895–1914.

There are three snow maps presented. A large one shows the average annual snowfall of the United States, 1895–1914, drawn on a topographic base-map with close attention to the effects of altitude and exposure. The other two maps show the average annual number of days (1) with measurable snowfall, and (2) with snow cover. In the eastern United States (except near the Atlantic) the line of one day with snow cover (the average of several days in one winter, with no days in several years) is near the 33d parallel of latitude; that of 30 days with snow cover lies close to the 39th parallel; that of 60 days near the 42d; that of 90 days near the 43d, and that of 120 from near the 44th in the East to the 47th in Minnesota. As a broad generalization, the number of days with snowfall is about half the number of days with snow cover.

The publication of these interesting precipitation maps with the discussion makes us hope that still another year will not pass before the issue of the long-expected precipitation section of the Atlas of American Agriculture, with its colored maps, carefully made graphs and detailed discussion. Still later, the folio on temperature and the other climatic elements are to come.

CHARLES F. BROOKS
WASHINGTON, D. C.

SPECIAL ARTICLES

INTERSEXES IN DROSOPHILA SIMULANS

ON the first day of January, 1920, a stock of *Drosophila simulans* Sturtevant[1] from Rochester, Minn., was found to contain intersexual individuals. Over 200 such intersexual specimens from this stock and derivatives of it have now been examined. About a dozen of them have been dissected and about the same number have been cleared in KOH and examined in balsam. All these specimens apparently belong to a single type. Male and female parts are both present, as will appear from the following table.

The intersexes are sterile, inasmuch as their gonads are almost, if not quite, absent. Their sexual behavior seems to agree best with that of the normal females. They are courted by males, but mating has not been seen.

[1] For a description of this species see *Psyche* (1919), 26, p. 153.

	Males	Females	Intersexes
Sex combs on fore tarsi	Present	Absent	Absent
Number of dorsal abdominal tergites	5	7	7
Ovipositor	Absent	Present	Present
Spermathecæ	None	2	2
Penis	Present	Absent	Absent
First genital tergite	Present	Absent	Present
Anal plates	Lateral	Dorsal and ventral	Lateral
Claspers	Present	Absent	Present
Tip of abdomen	Black	Banded	Black
Gonads	Testes	Ovaries	Very minute if present

Crosses of normals from the intersex stock have made it possible to study the character. The intersexes are modified females—*i. e.*, they have two X-chromosomes. This is shown by the fact that in cultures in which half of the males show sex-linked recessive characters but all the females are wild-type, the intersexes never show these sex-linked characters. This relation has been found to hold true for three sex-linked characters that are not closely linked to each other; and the intersex gene itself has been found not to be sex-linked (see below). Therefore the relation just noted can not be due to linkage between the intersex gene and the sex-linked genes in question.

Numerous crosses of the intersex stock to unrelated stocks have never given intersexes in F_1, but have frequently produced them in F_2. The intersex character is therefore recessive.

Pair matings that have produced intersexes have given a total of 510♀: 165 intersex: 754♂. There is an excess of males, but this is evidently a 3:1 ratio of females to intersexes, indicating not only that the gene is recessive but also that it is not sex-linked. The final proof of the latter point has been obtained through the discovery that the intersex gene is linked to the autosomal recessive gene for "plum" eye-color. Three F_1 pairs from a mating between the intersex stock and the plum stock have given in F_2:

Females		Intersexes		Males	
Wild-type	Plum	Wild-type	Plum	Wild type	Plum
198	91	87	0	293	65

The absence of the intersex plum class shows that the two genes are linked; and plum is known to be an autosomal recessive.

It has been shown by Morgan and Bridges[2] that individuals of *D. melanogaster*[3] that are partly male and partly female are produced, though only rarely, by most stocks. These "gynandromorphs" have been shown, by genetic evidence, to have two X-chromosomes in their female parts and only one X in their male parts. They are sex mosaics, and each part develops as it would in a whole animal of the same genetic constitution. There is strong evidence that the intersexes described here are not of this nature. The male and female parts in them probably both possess two X-chromosomes. This has been shown as follows. A total of 104 intersexes have been produced by females heterozygous for the sex-linked gene for "yellow" hairs and bristles. Half of these intersexes—about 50—must then themselves have been heterozygous for yellow. If the intersexes are really gynandromorphs, the male parts at the posterior end of the abdomen should have contained a single X-chromosome, and in about half of the specimens that were heterozygous for yellow (*i. e.*, in about 25 individuals) this should have been the yellow-bearing X. As Morgan and Bridges have shown, these parts should then have borne yellow hairs and bristles. The 104 intersexes were all carefully examined for this point, and *none of them had yellow male parts.*

We may conclude that the intersexes are females, modified by a recessive autosomal mutant gene that causes them to show male parts, though these parts themselves still have two X-chromosomes. The normal sex-determining mechanism is not affected at all, but the end result is modified by a gene that is not even in the sex chromosomes. It has

[2] Carnegie Inst. Washington (1919), publ. 278, pp. 3–122.

[3] I have unpublished data on exactly similar cases in *D. simulans* itself.

been assumed by Goldschmidt,[4] Hertwig,[5] Banta,[6] and others working with intersexes that in their animals the normal sex-determining mechanism itself was failing to function as usual. The present example shows that such an assumption can not be accepted without proof.

A. H. Sturtevant
Columbia University and
Carnegie Institution

THE ILLINOIS STATE ACADEMY OF SCIENCE

The thirteenth annual meeting of the Illinois State Academy of Science was held at Danville, Illinois, February 20 and 21, 1920, under the presidency of Dr. Henry B. Ward, of the University of Illinois.

The principal items of business transacted were the following: The academy voted unanimously to become affiliated with the American Association for the Advancement of Science under the terms adopted by the council of the association at the St. Louis meeting. It was voted that one half-day session of the next annual meeting be devoted to section meetings and the following sections were provided for: medicine and public health; biology and agriculture; geology and geography; chemistry and physics; mathematics and allied sciences; the science of education and education in science. It was voted that the council of the academy be empowered to select chairmen for these sections. The committee appointed last year to secure affiliation of science clubs in high schools with the academy reported five such clubs which had accepted the terms of affiliation, two of these taking national membership under the plan of affiliation with the American Association for the Advancement of Science.

In addition to the regular program of scientific papers, Dr. Henry B. Ward, president of the academy delivered an illustrated lecture on Alaska.

The following officers were elected for the ensuing year: Dr. Henry C. Cowles, University of Chicago, president; Dr. Chas T. Knipp, University of Illinois, vice-president; J. L. Pricer, State Normal University, Normal, secretary; Dr. W. G. Waterman, Northwestern University, treasurer. Dr. A. R. Crook, State Museum, Springfield, is ex-officio librarian of the academy, in charge of the sale of back numbers of the transactions and of the exchange of current issues.

One hundred and five new members were elected to the academy.

The following are the titles of the papers presented at the different sessions:

Development of smokeless fuel from Illinois coal: Professor S. W. Parr, University of Illinois, Urbana.

Tastes and odors in the Danville water supply in the summer of 1919: Dr. Edward Bartow and R. E. Greenfield, Illinois State Water Survey, Urbana, and H. N. Ely, Superintendent, Interstate Water Co., Danville.

A new test indicator for water analysis: R. E. Greenfield, Illinois State Water Survey, Urbana.

The founding of sanitary districts: Dr. Edward Bartow, Illinois State Water Survey, Urbana.

Some comments on the present status of tuberculosis: Dr. Walter G. Bain, St. John's Hospital, Springfield. During the war, chief of the laboratory service of the U. S. Army General Hospital No. 8.

Statistical study of the incidence and mortality of influenza in Illinois: Dr. Henry B. Hemenway, Division of Vital Statistics, State Department of Public Health, Springfield.

Report of progress at Illinois State Museum: Dr. A. R. Crook, chief of Division of State Museum, Springfield.

Gaining and losing power: C. L. Redfield, Chicago.

The progress of barberry eradication in Illinois: L. R. Tehon, assistant pathologist, U. S. Department of Agriculture.

Road oil and its uses: Dr. A. F. Gilman, Illinois Wesleyan University, Bloomington.

The absorbtion of oxides of nitrogen formed in silent discharge: Dr. F. O. Anderegg, Purdue University, Lafayette, Ind.

A possible standard of sound; a further study of wave form and operating conditions: Dr. Chas. T. Knipp and C. J. Lapp, University of Illinois.

Evidence that catalase is the enzyme in animals and plants, principally responsible for oxidation: Dr. W. E. Burge, University of Illinois, Urbana.

New species of fossils from the Devonian limestone in Rock Island County, Illinois: Dr. T. E. Savage, University of Illinois, Urbana.

[4] *Proc. Nat. Acad. Sci.* (1916), 2, pp. 53–58; *Jour. Exper. Zool.* (1917), 22, pp. 593–611, and elsewhere.

[5] *Biol. Zentralbl.* (1912), 32, pp. 65–111, and elsewhere.

[6] *Proc. Nat. Acad. Sci.* (1916), 2, pp. 578–583, and (1918) 4, pp. 373–379.

The formation of clay balds in arid lands: Dr. W. H. Haas, Northwestern University, Evanston.

The intercision of Pike River near Kenosha, Wis.: John R. Ball, Northwestern University, Evanston.

The effect of sewage and other pollution on animal life of rivers and streams: Dr. Frank Collins Baker, curator of Natural History Museum, University of Illinois, Urbana.

A possible interpretation of the synchronous flashing of fireflies: Dr. Christian A. Ruckmick, University of Illinois, Urbana.

Animal physiological life histories and modern methods of representing climate: Dr. V. E. Shelford, Natural History Survey, University of Illinois, Urbana.

Sexual dimorphism in the Acanthocephala: Dr. H. J. Van Cleave, University of Illinois, Urbana.

Notes on the life history of the Crane-fly of the genus Geranomyia Haliday: C. P. Alexander, University of Illinois, Urbana.

A review of the species of water mites: Dr. Ruth Marshall, Lane Technical High School, Chicago.

The morphology of the antorbital process in the Urodeles: Geo. W. Higgins, University of Illinois, Urbana.

Some controlling factors in the use of fungous diseases in combatting insect pests: Dr. R. D. Glasgow and C. S. Spooner, University of Illinois, Urbana.

A comparison of soil temperature in up-land and bottom-land forests: Dr. W. B. McDougall, University of Illinois, Urbana.

An effect of topography and exposure on plant distribution: Dr. H. S. Pepoon, Lake View High School, Chicago.

Topographic relief as a factor in plant succession: Dr. Geo. D. Fuller, University of Chicago, Chicago.

On the plant ecology of Ogle County, Illinois: H. de Forest, introduced by Dr. Geo. D. Fuller, University of Chicago, Chicago.

A note on the distribution of oaks in LaSalle County: Dr. Geo. D. Fuller, University of Chicago.

Preserves for ecological study. (The work of the Ecological Society of America's committee): Dr. V. E. Shelford, University of Illinois, Urbana.

Distribution of oaks on Lake Chicago beaches in Evanston and New Trier Townships: Dr. W. G. Waterman, Northwestern University, Evanston.

Forest distribution in northern Evanston and southeastern New Trier Townships: Lillian Margarite Simmons, Northwestern University, Evanston. (Introduced by Dr. W. G. Waterman.)

A probable cause of foot rot of wheat: Dr. F. L. Stevens and E. Dungan, University of Illinois, Urbana.

The sooty blotch of pome fruits: A. C. Colby, University of Illinois, Urbana.

The genus Septoria, presented in tabulation, with discussion: Philip Garman and Dr. F. L. Stevens, University of Illinois, Urbana.

Forest types and forest associations: (a) From the ecologist's point of view: Dr. Henry C. Cowles, University of Chicago, Chicago. *(b) From the forester's point of view:* R. B. Miller, state forester of Illinois, Urbana. General discussion, by Dr. Geo. D. Fuller and Dr. A. G. Vestal.

The cause of increased oxidation in the fertilized egg: Dr. W. E. Burge, University of Illinois, Urbana.

Notes on the life history of Psithyrus, an inquiline in the nests of Bumblebees: Theodore H. Frison, University of Illinois, Urbana.

Cnidosporidia in the vicinity of Urbana: Dr. R. Kudo, University of Illinois, Urbana.

The cultivation of Spirochæta Novyi without the use of tissues from animal organs: C. H. Behrens, Purdue University, Lafayette, Ind.

The relation of legibility of the printed page to reading: Madison Bentley, University of Illinois, Urbana.

The cumulative effects of rational increments: Coleman R. Griffith, University of Illinois, Urbana.

J. L. Pricer,
Secretary

Normal, Ill.

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THE UNIVERSITY DEPARTMENT OF MEDICINE

That all is not well with medical education is obvious from the number of investigations, addresses, polemics, plans and schemes which at present center about this subject. In the writer's opinion the root of the difficulty lies in the extremely close association which has always existed and exists to-day between medical education and practise, and in the idea which generally prevails that the problems relating to medical education and those having to do with the practise of medicine are inseparable. While many persons admit for purposes of discussion that a line of separation exists between the science of medicine and the art of the practise of medicine, yet when these individuals begin to think in practical terms, they fail to take this fact into consideration. Indeed, in their inmost souls, most medical men refuse to admit that medicine is a science, or they think of the scientific side of the subject as something apart from medicine itself, as though scientific medicine were simply the group of underlying sciences upon which medicine depends for sustenance. Even Sir Clifford Allbutt, in his remarkable essay on the "New Birth of Medicine," speaks of the new birth as an "enlargement from an art of observation and empiricism to an *applied* science . . ., from a craft of tradition and sagacity to an *applied* science." Why is it that we can conceive of medicine only as an application of science to an "art" or "craft," and not as a new, real and independent science replacing an obsolete mass of tradition and empiricism?

It is true that the science of medicine is in the process of making—but so is every other science. There is no such thing as a rounded, completed or finished science. At any given time any science is but the result of all previous attempts to arrange in order and to explain the facts and phenomena relating to some field of knowledge which is more or less definitely outlined, and which is large enough and important enough to deserve such treatment. As new facts are constantly being discovered in all realms of knowledge, all sciences are in a constant state of development.

The abnormalities and functional disturbances of man surely constitute a large and important field of human interest. Marked advances in knowledge concerning the phenomena and nature of disease have already been made, especially in recent years, and this knowledge is constantly being arranged, and the phenomena are being studied in their relation to each other and to other phenomena. Medicine, then, is developing just as other sciences have done and are doing; its subject-matter is receiving the same kind of treatment that is succeeding in other domains of human knowledge. Therefore, on account of the importance of the subject, and because of the advances which have already occurred in our knowledge concerning disease and the progress which has been made in the scientific treatment of this knowledge, medicine deserves to rank as an independent science.

If physiology may be an independent science, if anatomy may be an independent science, why not medicine? Why should medicine be only an *applied* science, any more than anatomy or physiology? Anatomical and physiological knowledge may be applied to practical affairs as well as medical knowledge. Why should medicine be inseparably associated with the doctor's consulting room any more than anatomy with the surgeon's operating room or the artist's studio?

Since definition is more important than argument, let us consider what we mean by medicine, or better, the science of medicine. First, let us consider what it is not. It is not anatomy, it is not physiology, for these sciences deal with the normal or healthy; it is not pharmacology, strictly speaking, for as this science has so far developed, it has dealt with the nature of drugs and their action on normal animals. These sciences, however, together with such fundamental sciences as chemistry and physics, are frequently spoken of as the medical sciences, the institutes of medicine, or indeed collectively as the science of medicine.

To define exactly what medicine is is not easy. Medicine deals with disease, the antithesis of health; it deals with the abnormal, the departure from the average. When we come to consider whether medicine includes all aspects of disease, or only certain ones, we meet with difficulties. The accepted use of the term does not aid us, for there is no universally accepted use, even among the most strict and thoughtful men. The dictionaries define medicine as the science and art dealing with the *prevention, cure* or *alleviation* of disease. Pathology, on the other hand, is defined as the science treating of the *nature, causes, progress, manifestations* and *results* of disease. According to the definitions, therefore, pathology has to do with the nature of disease, medicine with the application of that knowledge. That these definitions are purely academic, however, and not real, is made evident by referring to the textbooks dealing with these subjects, for we must consider that the text-books of the day present not only the accumulated knowledge concerning the subjects treated, but also the contemporary conception of the boundaries of these subjects.

If we refer to any text-book on medicine, whether it be labelled practical medicine, the practise of medicine, or merely medicine, and look up any disease, it will be found that nine tenths of the subject-matter deals with the "nature, causes, progress, manifestations and results" of the disease, under the headings etiology, symptomatology, complications, prognosis and so forth, and only one tenth deals with prevention and cure. On the other hand, most text-books of pathology do not treat of the "nature, causes, progress and manifestations" of disease at all; they consider only the morphologic changes resulting from disease. It is evident, therefore, that the definitions of pathology and medicine quoted above are obsolete, even though practitioners of medicine may not take cognizance of the fact. In my opinion, the old implied distinction between pathology and medicine has had a blighting effect upon the development of medicine as a science. Twenty-five years ago, however, it became dimly recognized that this distinction between medicine and pathology is not a real one, at least that pathological anatomy is an essential part of the science of medicine. The improvement in the teaching of medicine which occurred at that time and the resulting increase in medical knowledge may be directly traced to this new conception.

It is of importance that medicine should now be generally recognized as an independent science, just as physiology and anatomy are independent sciences. *Medicine may then be defined as the science dealing with the phenomena of disease.*

Let us grant now that there is or may be a science dealing with disease. How can this science best be fostered and how can this new science be most effectively utilized? As our medical schools are now organized, they are composed, on the one hand, of a group of departments devoted to the teaching and development of the so-called contributing sciences, anatomy, physiology and pharmacology; and on the other hand, of a large group of distinct departments, the chief function of which is to train men for the practise of medicine. As I have previously stated, however, anatomy, physiology and pharmacology have only the same relation to medicine that chemistry and physics have to anatomy and physiology. That the departments of anatomy, physiology and pharmacology are not independent university departments, but are included in the medical school, is in my opinion only accidental and is not an essential condition for the development either of these sciences or of medicine. The inclusion of these departments in the medical school has occurred chiefly because almost all the students working in them expect later to study medicine. Not so many years ago, however, practically all students of chemistry likewise expected to study medicine, and in many colleges the department of chemistry was also included in the medical school. To-day only a relatively small number of the students of chemistry look forward to the study of medicine, and in consequence, the department of chemistry constitutes a part of the medical school in only a very few universities.

The present organization of the medical school, therefore, has been largely influenced by expediency and by the effort to obtain economy in administration. With a satisfactory university administration, the department of medicine (and under this term I include all the departments of the medical school that are engaged in the study of disease) might perfectly well constitute the whole medical school, probably with considerable advantage to the departments of anatomy and physiology. With the present laws governing medical practise, however, it is necessary that the grouping of various departments into medical schools be continued. There is no serious disadvantage in this so long as there is a full realization of the reasons for this grouping, and so long as the relation of the various departments to each other and to the university, and especially the relation of the department of medicine to the university, is kept clearly in mind.

During the past fifty years a marked improvement has taken place in the departments which are concerned with the so-called contributing sciences. In many schools these departments now rank among the strongest university departments, both in the quality of the instruction and in the contributions which they make to the advancement of knowledge. One of the most important of the factors which have contributed to this improvement has been the release of these departments from the restrictions imposed upon them by those engaged in the practise of medicine. No longer are the teachers themselves practitioners of medicine, no longer is the efficiency of the department judged entirely by the contributions made to the immediate demands of practise. That is, they have become true university departments.

The department concerned with medicine, however, has not developed in the same way. There the demands of practise and the needs of practitioners are still the controlling factors in organization and development. As one result of this there has been developed within the department of medicine numerous branches having little coherence and no general guiding principle of organization or function. In many schools some of these branches have become much more important than the parent stem, both as regards resources and as regards the character of the work which is undertaken. There are departments of surgery, of orthopedics, of psychiatry, of genito-urinary diseases, of gastro-intestinal diseases, of pediatrics, of ophthalmology, of dermatology, of laryngology, of endocrinology, of elecerotherapeutics, and so forth, and so on. Some of these departments, owing to the skill and prominence of the professors in practise, have acquired buildings and equipment of greater extent than the educational importance of the subjects warrants, and of far greater extent than the scientific development of these subjects justifies.

It is true that one additional circumstance has contributed to this extensive partitioning of the department of medicine. Most universities and medical schools have been compelled to employ general hospitals for teaching purposes, hospitals which were primarily planned and organized to care for the sick poor. Now, within limits, the larger the general hospital, the more efficiently and economically it can be conducted, and in the medical and surgical treatment of large numbers of persons, a high degree of specialization has been found to be most effective. It does not follow, however, that the same principles which should apply to the organization of a general hospital should also apply to the organization of a clinic designed primarily for investigation and teaching, merely because both have one function in common, namely, the care and treatment of the sick. The university department of medicine has an added function, the investigation of disease and the teaching of students, and if a general hospital is to serve this added function, its organization must be modified accordingly.

In the efforts which have been made to improve the teaching of medicine, not infrequently that division of medicine having to do with the study of so-called internal diseases has received the least and last consideration. These diseases, however, because of the suffering and loss of life which result from them. are of far more practical importance than any other group of diseases. Of much more significance than this, at least from the educational standpoint, is the fact that the diseases of internal medicine are the ones which are most susceptible to scientific study, and thus far they are the principal diseases to which modern scientific methods of investigation have been applied. They are therefore the diseases with which the student of medicine should be chiefly concerned during his earlier years. It is in the study of these diseases that the student should develop his perspective and should obtain a knowledge of the methods which should be employed in the study of all other diseases. For this reason, in writing the following discussion of the department of medicine as a whole, I have had the division of internal medicine chiefly in mind, for this division should be a pattern for all the others.

Bearing in mind our definition of medicine and the conception of the boundaries of the department of medicine which we have adopted, let us consider what we mean by a university department of medicine. It is a department designed for the purpose of studying and investigating diseases, of accumulating and distributing the existing knowledge concerning disease and of contributing to the extension of this knowledge.

What is needed to create a university department? Exactly the same materials that are required in every other scientific department of the university—men, laboratories and books; and the most important of these is men. By men I mean students, of various grades. Some, the more advanced, we call teachers; the others, less developed, we call students; but they must *all* be constantly acquiring knowledge or the department is a failure. Moreover, the essential requirements for admission must be the same for teachers and students, though differing in degree. They must all have the desire for acquiring knowledge, they must have the desire to add to knowledge, and they must have the training and ability to enable them to carry out their desires. While all science is complex and all sciences are mutually dependent, medicine seems the most complex of all. To know the abnormal we must have knowledge of the normal. That is, whatever is known of structure of the human body and the little that is known of function must be available. In other words, knowledge concerning anatomy and physiology must be in the possession of every student, and knowledge of these sciences requires knowledge of chemistry and physics. These are well-recognized facts that need not be dwelled upon further.

Are men available for such a department, as teachers and students, men who are interested in the study of disease and who desire to increase the knowledge concerning disease without any other material reward than the rewards of the student and scholar? Or has scholarship gone out of fashion? Or is this such an uninteresting subject that no men can be found to undertake its study? As long as men will study the stars with scientific methods, as long as men will study the stones with scientific methods, men will be found to study disease. The men are ready and waiting, the opportunity only is needed.

The second essential is laboratories. The astronomer must have his telescope through which to observe the stars; he must also have his chemical and his physical laboratories. The student of medicine must also have *his* observatory, the hospital, and in this he should also have laboratories—*his* laboratories—and not be a guest or intruder in laboratories belonging to other scientific workers—chemists, physiologists or others. It is just as impossible that the science of medicine can be studied at the bedside alone, where only superficial observation is possible, or that it can be studied only in the laboratory, where disease as it occurs in man is never present, as that astronomy can reach its highest development by observation through the telescope alone, or by spectroscopic and chemical studies alone. It is not uncommon that the contributing sciences in the medical school are spoken of as the *laboratory* branches and the medical divisions are spoken of as the *clinical* branches. This in my opinion reflects the mistaken opinion which prevails concerning the nature and proper methods of the study of medicine. For the development and teaching of medicine, laboratories are as essential as they are for the study of physiology. But if they are to be used, they must be in close proximity to the wards, and they must be so arranged and organized that the work in the laboratories and in the wards can go on simultaneously and harmoniously in both. This conception of the hospital, however, is rare even among those who take the most advanced views concerning medical education. I know of one university hospital which is being planned before the professors or staff that are to work in it have been appointed. No architect or hospital superintendent can possibly accomplish this task. For instance, the superintendent of a general hospital must, of necessity, take an entirely different view of a hospital from the one which has been sketched. It would be just as sensible to have a foreman of a machine shop design a laboratory for the department of physics as to have a hospital superintendent design a university hospital. In each case the superintendent or foreman might be of great assistance and give useful suggestions, but he would be as incapable of conceiving the purpose, and therefore of working out the idea, in the one case as in the other.

It can not be denied that it will be expensive to install in each clinic of the hospital well-equipped laboratories in which the varieties of technique already developed in bacteriology, physiology and chemistry, can be used, and in which entirely new methods may be devised. This is essential, however, if the science of medicine is to develop. In a given clinic probably all the laboratories would not at any one time be of equal importance. In each clinic the development would probably be mainly along special lines. If the division of internal medicine, for instance, was a large one, there might be several clinics or units, in one of which the chief attention would be given to one variety of disease, in another, to another variety. In the study of human disease, however, much is gained in economy and effectiveness if studies take not only one, but several directions at the same time. The subjects studied are so complex that it is wasteful to confine an investigation to a single narrow path. Thus in studying a group of patients suffering from an infectious disease, it is frequently important that they be studied not only from the standpoint of etiology, in which the chief work will be done in the bacteriological laboratory of the clinic, but it may be of great importance that, at the same time, alterations in metabolism and disturbances in function of the circulatory and respiratory systems be investigated, in which case the laboratory and technique of physiology or possibly of physics will be required, and on the same patients chemical studies of the blood or excretions may be valuable, all of which must be carried out in the special laboratories of the clinic. By carrying out all these procedures on the same patients, not only is expense saved, but each observation gains much in importance by being supplemented by the others.

In the university department of medicine there should not only be facilities for studying disease as it occurs in man, but there should also be facilities for carrying out experimental studies on animals. In many cases only by animal experimentation can the suggestions obtained from detailed observations on patients be confirmed or disproved.

With regard to the library, little need be said here except that it must be alive, not dead.

The above is my conception in brief of the essentials of a department of medicine in a university. Grant a central concept such as this on which to build, and it will not be difficult to elaborate the details, at least it will not be impossible. For instance, let us consider the number and kinds of the divisions into which any given department of medicine shall be divided, or in other words, the kinds of diseases for the study of which special clinics shall be provided. There can be little question that the diseases spoken of as surgical (because operative technique is employed in treating them) are of such great importance and the technique of their therapy has become so specialized, that one or more clinics of the department should be devoted to the study of these diseases. This does not mean, however, that the methods employed in studying these diseases differ from those used in studying any other group of diseases. Exophthalmic goiter is the same disease whether we treat it by removal of the thyroid or by rest and drugs. Whether we call the professor who studies especially those diseases in which the chief therapeutic procedures are operative, a professor of surgery or a professor of medicine, is unimportant so far as the principle is concerned. His methods should be those of the professor of medicine as I have sketched him, and the surgical clinic should be exactly like the medical clinic with the addition of facilities for employing complicated operative procedures. The same principle should also govern the organization of the division of pediatrics or any other one of the divisions into which it is decided to separate the department of medicine.

The exact number of divisions in any department of medicine will have to depend upon the men and resources available and upon the contemporary state of knowledge concerning the various groups of diseases, and upon the immediate importance of increasing this knowledge. There seems to be no good reason, however, for dividing the department of medicine into a great number of divisions and subdivisions. Indeed, from the educational standpoint very great disadvantages are inherent in this method, owing to the scattering of interest which results. The efficiency of a department of medicine does not depend upon the number of its clinics or instructors, or upon the variety of subjects treated. The attempt to present to the student every known fact and theory concerning disease and to exhibit to him examples of every known form of disease only causes him to become confused and bewildered. What is much needed at present in medical education is the elimination of the unessential and the untrue. No student can be expected to learn all that has been thought about disease and all the theories that have been proposed. He should have, however, opportunities to learn what is actually known about important diseases and to receive the kind of training that will enable him to discriminate between the true and the false.

A further detail of the organization of the department of medicine concerns its relation to the department of pathological anatomy. From what has been previously stated, it is obvious that the department of pathological anatomy should constitute an integral part of the department of medicine. The laboratory of pathological anatomy should be closely connected geographically, as well as in organization, with each one of the clinics. It should not be a block or a mile away from the clinics, or even in an isolated building on the hospital grounds. *It should be physically a part of the department of medicine.* There would be a great advantage in having at all times at least one assistant from each clinic acting as a member of the pathological staff. Each of these assistants should be engaged, under the direction of the professor of pathological anatomy, in studying and teaching the anatomical changes resulting from the special group of diseases which is being studied in the clinic which he represents. On the other hand, the professor of pathological anatomy should be a member of the administrative staff of the department of medicine. The effect of such an association as I have described would not only be of great educational value, but I believe that it would bring about a "new birth" of pathological anatomy.

The objection will probably be raised by some that, although the introduction of the proposed principles and plans into the department of medicine might result in a greater and more rapid accumulation of knowledge concerning disease, it would have no immediate effect upon society at large or upon the practise of medicine. If this were so, the value of the plan might be questioned, though I would not go so far as to deny its value even under these circumstances. I assume, however, that one of the most important functions of the department of medicine must be to train men in order that they may become capable practitioners of medicine. Now the practise of medicine, or the practical application of the science of medicine, may be considered to be directed in several lines:

1. Prevention of disease or decay.
2. Diagnosis, care of the sick and alleviation of pain.
3. Cure of disease.

At the present time the first function of the practising physician is exercised in a very minor degree. The medical schools take little cognizance of it. Therefore we may omit discussion of it here, though in my opinion it is the most important of the three, and the department I have in mind would exert great effort upon the development and extension of this function.

The second important function of the practising physician is to make diagnoses, that is, to bring the particular symptoms from which a patient suffers and the most striking features of his malady into relation with a group of symptoms and signs which have already been described and given the name of a disease. This is of great importance from the standpoint both of prognosis and treatment. Originally the classification of disease was empirical; later it was founded, in part on an anatomical, in part on an etiological basis, and in part merely on the presence of some striking feature. There is much that is empirical, superficial and traditional in this subject; nevertheless, in the present state of the science, it is important. The physician, therefore, must be trained in the methods of diagnosis. He must be trained in the method of Zadig. There are many tricks, short cuts and simplified methods in diagnosis with which the practising physician should be familiar, though they have not an essential place in the fundamental science of medicine.

At present, however, the chief efforts of the department of internal medicine in our medical schools are directed towards the cultivation of diagnostic skill in the student. Much time is frequently devoted to the recognition of some rare disease, even though only a half dozen cases have ever been recognized and although nothing essential about the disease itself is known. Indeed the more unusual the special group of signs and symptoms, the more important does it seem to become. An analogy may be drawn to the state of affairs lately existing in botany when the chief attention was given to the classification and naming of plants. We now know that this is only a part, and a relatively unimportant part, of the science of botany. A man may still be a great botanist even though on walking through a field he may not be able to name correctly every plant or tree which he meets. While diagnosis in medicine is important, its position in the educational scheme is misplaced. Instead of placing it at the beginning of the study of medicine, it should come later, after a knowledge of the more fundamental principles of medical science has been acquired. If a student knows much about a few of the common, more important forms of disease, the recognition of the rare forms will be relatively easy.

Another function of the practising physician is the care of the sick and the relief of pain, mental and physical. Part of this labor is borne by the nurse, but the physician must bear the larger share, and if he is able to analyze disturbances in function, he is oftentimes able to bring relief even though he can not cure.

One of the chief efforts of the physician is to establish a feeling of confidence in the patient and in the family, and to relieve anxiety. The success of this effort depends largely on personality, but consciousness of real knowledge is a most important factor contributing to such an inspiring personal relationship.

In our present system the student learns less about therapeutics than about any other feature of disease. For a system of education that claims to be essentially practical, it obtains most impractical results. However much we may rail at the ineffectiveness of treatment —and the best practitioners are accustomed to do this—there are at least a few therapeutic measures that are of great effectiveness and a few diseases over which the physician has absolute control. Yet how little does the student actually learn during his student days of the really practical methods of employing these measures! How ill prepared he is to meet actual conditions, unless the procedures to be employed are of the greatest simplicity!

By present methods, therefore, students are not well trained, even in the elements of practise, except as concerns diagnosis. They should be better trained for practise.

In order to judge of the probable effect of the proposed plan, not only on the development of the science of medicine, but on the practise of medicine as well, let us sketch briefly the proposed organization of the division of internal medicine and the nature of the work which it is intended should be carried on.

The number of clinics which compose the division of internal medicine will depend upon the funds and men available and upon the size of the university or school. Each clinic, however, should have, let us say, a hundred or a hundred and fifty beds, its own independent laboratories equipped for the prosecution of chemical, physical, physiological and bacteriological studies, as well as laboratories for pathological anatomy and facilities for animal experimentation. The number of students admitted should be limited; these students should have had a general college, scientific training, preferably with specialization in chemistry, physics or biology. Before admission to the department of medicine, they should have studied anatomy, physiology and bacteriology. This work may have been done in any university. The custom of studying one subject in one university, and another subject in another university, should be encouraged. This would result in bringing into the department methods and points of view derived from many sources.

The teachers should be carefully chosen young men who have had a good training in clinical methods and who are also well grounded in at least one of the contributing sciences, some in chemistry, some in physiology and so forth. Before appointment, they should have given evidence of ability not only to teach but also to aid in extending the boundaries of medical knowledge. In this department brief courses should be given in the methods for observing and recording the more superficial features of disease, history-taking, physical diagnosis, X-ray examination, etc. There should also be courses in pathological anatomy, including study of the blood and other tissues that can be obtained during life, courses dealing with the application of physiological and chemical methods to the study of disease, and courses devoted to the study of the pathogenic bacteria and other parasites. As soon as possible, the students should begin the actual study of disease as it occurs in the patient, and the results as seen at autopsy. The students should spend a large part of their time in the wards and laboratories, making their study at first hand and relating all that they do to actual cases of disease. Reading must be encouraged and the student should be urged to consult original sources. It might be advisable to have the student devote a given period of his course to the study of infectious diseases, during which period much of his time would be spent in the bacteriological and pathological laboratories of the clinic. In another period the time would be spent mainly in the study of so-called diseases of metabolism, during which period he would have his working place and spend much time in the chemical laboratory of the clinic.

During his course the student should make an intensive study of at least one disease, making an attempt to learn all that is known about that disease, repeating with his own hands the important steps which have led to present knowledge, and if possible, he should add something, however slight, to existing knowledge concerning this disease. By means of seminars and conferences, both at the bedside and in the laboratory, each student would at all times be kept in touch with the work of all the other men in the clinic—students and teachers. The student would himself become an instructor of his fellow workers. The teachers would be engaged in directing and assisting the students in this work and in carrying out their own investigations.

At the end of two years the student would have acquired a great deal of knowledge about a considerable number of diseases, their prevention, nature, causes and treatment, and would be well trained in the methods of studying disease. He would also be familiar with the methods and principles of diagnosis.

It may be true that the department of medicine I have sketched will not provide the student with the wide experience with disease in its various manifestations which would make him an able practitioner. But even with present educational methods, no one assumes that immediately after a student obtains his degree he is a capable, or even a satisfactory practitioner of medicine. It will be asked, where, under the system proposed, will the student get this wider experience and practise in technique. He will get it exactly where he gets it now, in the hospital year or years, or where he used to get it, in actual practise. No better system for producing good workmen, be they physicians or bricklayers, has been devised than the apprentice system. It is of great importance, therefore, that a good example be set in the hospitals in which students obtain experience and skill in the practical application of medical principles; this is almost as important as it is that the work in the university should be of the right kind. While the hospital can only occasionally and with difficulty make good practitioners of men who have had little or poor training in the science of medicine, it can very easily ruin men, however well they may have been fundamentally trained. There will always be the opportunity and need for good practitioners who teach by example. The preceptor system is of great value in its proper place. The trouble with the present system of medical education is that it consists almost exclusively of the old preceptor system employed in a wholesale and frequently inefficient manner. Modern developments require for medical education a scientific basis, with a final polish added by a preceptor system correctly applied.

The question will now be asked: Should the professors of medicine in the university department of medicine be trained in clinical medicine, or may they be men who have been trained only in physiological methods or chemical methods, or who have had experience with disease only as it occurs in experimental animals? In my opinion, the professor of medicine must be prepared to study the symptoms and the more superficial manifestations of disease as seen in patients, as well as to carry on complicated laboratory investigations. It is chiefly through the observations of patients that clues are obtained as to the proper direction the more complicated studies should take. It is true that much knowledge concerning disease has been obtained by bedside study alone. In the present state of the science of medicine, however, this method of study is now relatively unproductive, and unless combined with more elaborate and complicated methods is likely to result chiefly in the elaboration of theories. While theories are of importance in the study of disease, just as they are in all scientific inquiry, they are of little value, until tested by experiment.

An additional reason why professors of medicine should have a wide knowledge of disease as it occurs in man is that they will themselves have to be responsible for the care and treatment of human beings sick of disease. It is essential not only that no harm come to the patients who are the objects of study but that everything possible be done to bring every one to a state of health, or as near that as possible.

To avoid the necessity of having as teachers of the science of medicine only such men as have enjoyed a wide experience with disease in all its forms and who possess a knowledge of the craft or art of practise, two makeshifts have already been attempted. One expedient has been to have men skilled in practical medicine take over the actual care of the patients, while the real studies are made by those who have special knowledge of one of the sciences, but who have no knowledge of practise, possibly no knowledge of disease. For instance, the physiologist is invited into the clinic to make observations or studies on certain cases. In some instances this method has no doubt led to advances in knowledge. It has distinct limitations, however. Oftentimes the facts accumulated in this way have very little immediate practical significance, whereas if the observations had been made by persons properly trained in medicine, possibly only a slight modification in the methods employed would have made the data obtained of great practical value. Combined investigation such as this has made little impression on the method of study of disease or on the men who are constantly engaged in the study or practise of medicine. Indeed it has a blighting effect on the scientific aspirations or scholarly ambitions of the men in the department of medicine. Specialists in the various branches of science can always be employed in the university department of medicine to give advice, to assist, and even to share in investigations, but the department will reach its greatest effectiveness only when the men engaged in teaching medicine and in investigating disease have not only a wide knowledge of disease as it occurs in man, but special training in one or more of the so-called contributing sciences as well.

The second expedient is to establish in connection with the medical school a department of experimental medicine, or research medicine. This is neither sound in theory nor effective in practise. It is better than nothing, but its establishment in a medical school means that the teaching of medicine will go on in the same old way, although a certain amount of reputation may accrue to the school from the fact that investigations are carried on within its walls. The employment of this makeshift has arisen from a disinclination to make any fundamental change in the old order, while recognizing that change is necessary. It arises from the recognition by those already engaged in teaching that they are not prepared to adopt new methods. These teachers do not object, however, to grafting a new department on the old one, so long as they personally retain their old prestige and perquisites. In certain schools, both in this country and in Europe, it has been proposed to divide the medical school clinics into several units, one or more of these units to retain their old character, more or less obviously, one or more to be organized into so-called full-time or university clinics, the latter term being the one which I prefer because it puts the emphasis upon the character of the work. If certain schools want to try out this method, one can not object. It is very doubtful, however, whether the need for reform can be met in this manner and it seems that the reorganization of the medical teaching in such a half-hearted way is almost bound to result in failure.

It will be noted that up to the present I have not mentioned full-time or part-time employment as applied to teachers. With the conception of a department such as I have tried to present, this question settles itself. To make scientific progress requires all of the time of the most able-bodied and able-minded men that we now possess. We are not discussing a practical trade school, but a scientific university department dealing with one of the most interesting, the most important and the most complex branches of human knowledge. Could any teacher engaged in this great work want to neglect it to engage in a practical pursuit for money? If so, he has no place in this institution. If public humanitarian appeals should sometimes call him away from his hospital and laboratory, probably that would be good for him. In any case, it does not seem that we need to worry that this will interfere too much with his work, unless human nature changes.

The very important question may now be raised whether the proposed plan would not have exactly the opposite effect on the development of the science of medicine from that intended. If men in the departments of physiology and anatomy and the other contributing sciences should no longer engage in the solution of medical problems, would not the result be disastrous? It is not intended, however, that the organization of the department of medicine in the manner described would prevent men in any other department of the university from undertaking the solution of medical problems. Men in the department of physiology have been known to contribute to anatomical knowledge and the investigations in the department of anatomy are not infrequently directed toward the solution of physiological questions. It is to be hoped and expected that in the future as in the past all the departments of biological and physical and chemical science will bring contributions to medicine. The fact that the department of medicine is itself investigating the problems of disease need have no deterring influence on these other departments; indeed this fact would undoubtedly increase the interest of the other departments in medical science. On the other hand, the university medical clinic might itself become a contributor to these other sciences. For instance, it will not infrequently happen that in order to approach its own problems, the medical clinic may first have to undertake the solution of problems which are commonly studied in the chemical laboratory or the physiological laboratory, and so on. Indeed, under certain circumstances it may be necessary to devise new bacteriological or chemical methods or new physical apparatus. Neither the student of medicine nor the student of any other branch of science should be restricted in his methods; though the student of medicine may not lose sight of the fact, that however far off his goal, his ultimate concern is with the problems of disease.

I firmly believe that if a department of medicine such as has been described were established in a first-class university, a greater advance would be made in medical teaching and in medical science and practise than was made in this country twenty-five years ago.

The one essential premise is that there exists or can be created such a thing as a science of medicine. If this is true, this science can best be fostered by giving it a place in which it can grow unhampered by the restrictions of practise. Medicine must be regarded as a real science, not an "*applied science*." The proper applications are important but in this place they should not dominate.

Let us labor to place the teaching of medicine in its true position. Let us emancipate the student, and give him time and opportunity for the cultivation of his mind, so that in his pupilage he shall not be a puppet in the hands of others, but rather a self-relying and reflecting being. Let us ever foster the general education in preference to the special training, not ignoring the latter, but seeing that it be not thrust upon a mind uncultivated or degraded. Let us strive to encourage every means of large and liberal education in the true sense of the term, and so help to place and sustain our noble profession in the position which it ought to occupy. (William Stokes, 1861.)

Rufus Cole
Hospital of the Rockefeller Institute,
New York City

RAYMOND B. EARLE[1]

We unveil this portrait of Professor Earle, the gift of his wife to Hunter College, not because those of us who were so fortunate as to know him, ever need any portrait to keep his memory living in our hearts. That beloved memory is too securely enshrined. We have no need for ourselves, to recount his successes or his charm. But for the sake of those who did not know him, memory lingers now a moment to view some of the sources and manifestations of his power.

Born in Massachusetts of an old and honorable line, his first ancestor here, Ralph Earle, came from England in that stirring seventeenth century which planted this new-world republic, and that name is still borne in the family by his brother Ralph Earle, now almost 300 years later.

In his youth our Professor Raymond Earle felt the charm of nature; began to make collections of specimens; and pressing on to College, studied geology at Harvard under the inspiration of Professor Shaler, an influence which never left him, and was always an ideal. Taking his A.B. degree at Harvard in 1900, his Sc.B., 1901 he followed with his Sc.M., 1912 and Sc.D., 1913, at New York University, after a period spent as a lawyer and economist geologist.

At New York University he taught, 1911–1913, in the department of geology under Professor J. E. Woodman. To Hunter College he came in 1913, becoming associate professor of geology, and building up what became by 1917 one of the largest of geology departments among colleges for women. He had just begun his sixth year here, in the prime of vigor and only the forty-first year of his age, at the time of his sudden death of pneumonia, November 10, 1918.

He was equally at home in geology or in physical or economic geography. His research specialty had been in iron ores, with other investigations local to the Hudson. He was especially successful as a teacher in arousing and sustaining the enthusiasm of his students in his subject. He also carried over the benefits of his legal training and practise into the applications of his science. He was an extensive traveller, alone, or later with parties, conducting the latter with the purpose of giving scientific and educational views of our country, particularly in California and Alaska. He kept up his interest in a wide field of nature; his collections of birds' eggs is now at Hunter College, and many anthropological collections of Indian stone tools and weapons, pigmy bird-points of exquisite work, etc.

He was an organizer and the first director of the summer session of Hunter College, and a founder of the Physiographer's Club of New York City. He also gave public lectures here and elsewhere through the State.

A reader and forceful speaker, a skilled organizer, an intuitive discerner of human nature, Professor Earle was an unusually happy combination of the qualities which insure success. To them he added the attraction of his frank, genial, sociable, daily life at college; and at home there followed the fitting seal to his day, when in true fulfilment of his quiet but deep religious nature he gathered his little family around the evening table, and gave thanks to the Divine Giver for the blessings of the day.

[1] Memorial address at Hunter College, New York City, by Edward S. Burgess, on the unveiling of a portrait of his associate, Professor Earle, March 1, 1920.

RESOLUTIONS ON THE DEATH OF MEMBERS OF THE MELLON INSTITUTE

The following resolutions have been adopted by the Robert Kennedy Duncan Club, the organization of the Industrial Fellows of the Mellon Institute of Industrial Research of the University of Pittsburgh, on the death of three members of the Institute, viz.: Dr. David Shepard Pratt (d. Jan. 28), for three years, until January 1, 1920, an assistant director; Dr. Francis Clifford Phillips (d. Feb. 16), emeritus professor of chemistry at the University of Pittsburgh; and Dr. Leonard Merritt Liddle (d. Feb. 21), since 1913 an industrial fellow.

Whereas, Dr. David Shepard Pratt, recently an assistant director of the Mellon Institute, was intimately associated with the work of many of us and was our true friend and adviser, and

Whereas, Dr. Pratt has faithfully employed his talents in our behalf and has made his breadth of knowledge, his fertile imagination and his keenness of perception of great practical assistance to us both by active cooperation in the laboratory and by helpful suggestion; therefore be it

Resolved, That we, the members of the Robert Kennedy Duncan Club, take this opportunity of expressing our sense of sorrow at his untimely death.

Be it further resolved, That we deplore the loss of one who was utilizing his many talents for the good of American industry.

Whereas, Dr. Francis Clifford Phillips, our distinguished colleague, was loved by us because of his kindly and genial ways, his unselfish consideration of others and his humor, and

Whereas, Dr. Phillips has brought fame both to himself and to the University of Pittsburgh, by his scholarship, his ability as a teacher and his remarkable contributions to the advancement of science, and

Whereas, Dr. Phillips has been an inspiration to all who knew him by reason of his personal qualities and his devotion to science. Therefore be it

Resolved, That we, the members of the R. K. D. Club, express our sadness at the close of his beautiful life of service.

Be it further resolved, That we believe that American science has lost a most sincere student and investigator.

Whereas, Dr. Leonard Merritt Liddle has been a friend and associate among us for the past eight years and has endeared himself to each of us by his spirit of helpfulness, his kindliness and his good fellowship, and

Whereas, Dr. Liddle has stood out as leader in the Institute in scientific ability, in untiring energy, in devotion to his chosen profession and in loyalty to the best ideals of the Mellon Institute. Therefore, be it

Resolved, That, we, the members of the R. K. D. Club, wish to express our profound sorrow at the loss of our comrade and sincere friend, who has been cut down thus early in his useful career. We also deeply regret the removal of one who was devoting his life to the betterment of American industry by the application of science to the solution of its problems.

SCIENTIFIC EVENTS

MEMORIAL TO SIR WILLIAM OSLER[1]

A public meeting was held in the University Museum, Oxford, on March 6, to initiate a memorial to the late Sir William Osler, Bart., Regius professor of medicine in the university for the past fifteen years. The vice-chancellor presided. Sir Clifford Allbutt, who introduced the proposal, paid a feeling and eloquent tribute to the memory of Sir William Osler, to the wide range of his intellect, and to the singular charm of his character. He referred to his international reputation and to the binding influence he had on the medical profession in many lands, to his love of peace and goodwill, and to the extraordinary power he exerted in diffusing without diluting friendship. The president of Magdalen, Sir Herbert Warren, mentioned the many-sidedness of Osler's interests and activities, the breadth and accuracy of his scholarship, and the clear and steady optimism with which he regarded life and its progress in all ages. Sir William Church, who introduced the specific proposal that the memorial should take the form of an Osler Institute of General Pathology and Preventive Medicine, stated that such a memorial as that suggested would be a singularly appropriate tribute to the outlook and ideals that Osler had kept before him in his life-work Professor Thomson emphasized the need of new laboratory accommodation in Oxford for teaching and research. The dean of Christ Church and Sir Archibald Garrod also spoke. It was announced that the honorable secretary, Professor Gunn, had received expressions of sympathy with the proposed memorial from a large number of people representing many interests, and that a collateral committee had been formed in America to aid in raising the memorial.

[1] From *Nature.*

THE CORNELL UNIVERSITY ENTOMOLOGICAL EXPEDITION TO SOUTH AMERICA OF 1919–20

Under the leadership of Professor J. Chester Bradley the Cornell University Entomological Expedition to South America of 1919–20 is carrying on entomological investigation and making collections in various South American countries.

Dr. Bradley sailed for Brazil early in September last on the steamship *Vestris;* owing to a fire developing in one of the holds of the steamer, a delay of thirteen days occurred at the Island of Santa Lucia, where interesting and unexpected collecting was done. At Rio de Janeiro he was joined by a volunteer assistant, Mr. R. Gordon Harris.

After spending some time in Rio de Janeiro, a trip was made in company with Brazil's foremost entomologist, Dr. Adolph Lutz, to the State of Minas Geraes in the north, as far as to Pirapora, the head of navigation on the Sao Francisco River; some days were spent at Lassance on the Rio das Velhas as guests of the Institute Oswaldo Cruz. It was at this place that Dr. Chagas first worked out the details of the transmission by a Redwing bug (*Conorhinus*) of a trypanosome causing a very serious endemic disease of the region. Some days were also spent on the alpine meadows at Diamantina, Brazil's highest city, and also as guests of the State of Minas Geraes at the Capital, Beldo Horizonte.

Returning to Rio de Janeiro, the party proceeded to cross the States of São Paulo and Matto Grossa by sail to Corumba on the Paraguay River, and thence to Urucum. Interesting collecting was encountered at various points along this trip, but especially at Urucum, 20 kilometers from Corumba, on an isolated mountain range at an elevation of 2,200 feet, at the upper limit of a tropical forest. Here, despite continuous rainy weather, a very interesting and abundant fauna was encountered.

From Corumba they proceeded by rail via São Paulo to Uruguayana on the Uruguay River, at the Argentinean frontier, a distance of 2,500 miles; from there they were about to proceed, when last heard from, to the Falls of the Iguazu on the Alta Parana River.

The plans of the party contemplate spending a brief while in Argentina, at Buenos Aires, La Plata, Cordoba, Mendoza and possibly Tucuman, a visit to Montevideo, and then to spend from six weeks to two months in Chile, visiting several places, to as far south as Chiloe Island; thence to Oruro, Cochabamba and La Paz in Bolivia, and to Lima in Peru.

At Lima Dr. W. T. M. Forbes and Jesse Williamson will join the expedition, which will, if conditions prove favorable, cross the Andes via the central route and down the Pichis, Pachitea, Ucayalli and Maranon Rivers to Iquitos; stopping at favorable points on the eastern side of the Andes. The party will return to New York in September next.

The expedition is entrusted with the delivery of extensive collections of North American insects and of vertebrates to four scientific institutions in South America. While not neglecting general collecting, Dr. Bradley is devoting especial attention to the collection of Hymenoptera, especially of the aculeates, and is endeavoring to obtain series of nests of Vespidæ with their inhabitants. Mr. Harris is doing general collecting of insects. Dr. Forbes will devote his attention primarily to Lepidoptera, and relieve the other members of the necessity of devoting attention to this time-exacting group after he joins the expedition. Mr. Williamson will collect Odonata.

ST. LOUIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

The spring meeting of the American Chemical Society will be held with the St. Louis and University of Missouri Sections in St. Louis, April 13 to 16, inclusive. Every indication points to the fact that the meeting will be one of the largest and most interesting ever held in the West by the American Chemical Society. St. Louis is the center of the rapidly growing Middle West and contains large and varied chemical interests. It has always been the leading drug center of the West, and leads the country in the production of synthetic pharmaceuticals, alkaloids, and anaesthetics. St. Louis possesses all the units of a balanced, self-sufficient chemical industry. It is a center for ceramics, glass, paint, lead and zinc manufacture. The following excursions are planned: Laclede By-Products Coke Plant; Monsanto Chemical Works, East St. Louis plant; Laclede-Christy Clay Products plant; Standard Oil Refinery, Wood River, Ill.; and Illinois Glass Company, Alton, Ill.

The general program is as follows:

Tuesday, April 13

10 A.M.—General meeting, Hotel Statler.
Address of welcome, Honorable Henry W. Kiel, mayor of St. Louis.
Response, Dr. W. A. Noyes, president, American Chemical Society.
Address, Honorable E. P. Costigan, tariff commissioner, "Chemical industry and legislation."
Address, Dr. Chas. H. Herty, editor, "Victory and its responsibilities."

2 P.M.—Hotel Statler, general meeting.
J. H. Hildebrand, "The prediction of solubility."
Victor Lenher, "Selenium oxychloride a neglected inorganic solvent."
E. T. Wherry, "Studying plant distribution with hydrogen ion indicators."
Three additional general papers to be announced.

8 P.M.—Missouri Athletic Association. Smoker for men.

8 P.M.—Theater party for ladies.

Wednesday, April 14

9 A.M.—Hotel Statler, divisional meetings.

2 P.M.—Excursions to Laclede Gas Works, Monsanto Chemical Works, East St. Louis plant, and Laclede-Christy Clay Products plant. Automobile tour for ladies to parks, Art Museum, Washington University, Missouri Botanical Garden and tea at Bevo Mill.

8 P.M.—Central High School. Public address. Speaker and subject will appear in final program.

Thursday, April 15

9 A.M.—Hotel Statler, divisional meetings.

2 P.M.—Hotel Statler, divisional meetings.

8 P.M.—Hotel Statler, subscription banquet.

Friday, April 16

9 A.M.—Excursion to Standard Oil Refinery, Wood River, Ill., and Illinois Glass Company, Alton, Ill.

The Division of Industrial and Engineering Chemistry will hold a symposium on Cellulose Chemistry, this symposium having been organized by Mr. Jasper E. Crane, and will devote the remainder of its program to general papers.

A Section of Leather Chemistry has been authorized to establish a forum for the discussion of the chemistry of leather manufacture and other closely allied industries.

A Section of Sugar Chemistry will also meet for the first time in St. Louis, under the chairmanship of C. A. Browne, with Frederick J. Bates, of the Bureau of Standards, as secretary.

The Division of Physical and Inorganic Chemistry will give a half day to a "Colloid Symposium."

Papers are promised by Col. W. D. Bancroft, Albert V. Bleininger, Martin H. Fischer, and John Arthur Wilson.

Members who are to read papers having a popular appeal are requested to send synopses of them for the use of the A. C. S. News Service, care of American Chemical Society, 35 E. Forty-first St., New York City. A short abstract (about 100 words) should be sent with the title of papers or handed to the secretary of the division at the time of presentation, so that it may appear in SCIENCE.

The final program will be sent about April 5 to all members signifying their intention of attending the meeting, to the secretaries of sections, to the council, to members of the St. Louis and University of Missouri Sections.

CHARLES L. PARSONS,
Secretary

THE UNITED STATES FOREST SERVICE

SECRETARY MEREDITH has selected Colonel W. B. Greeley, assistant forester in the Forest Service, for chief forester to succeed Colonel Henry S. Graves, on the latter's retirement on May 1. Colonel Greeley is a graduate of the University of California and the Yale Forest

School, and has been in the Forest Service continuously since 1904, except for two years of military service with the American Expeditionary Forces.

From 1906 to 1908 he was supervisor of the Sequoia National Forest in California. After a short period of service in the Washington office he was appointed district forester in charge of the National Forests of Montana and northern Idaho, with headquarters at Missoula, Mont. In this position it fell to him to protect these forests, having a total area of over 29,000,000 acres, at the time of the great fires in 1910. The following year he was appointed assistant forester and placed in charge of the branch of silviculture, now the branch of forest management, in the Washington office. This branch has supervision of all national forest timber sales and timber cutting, together with other important lines of work.

With the opening of the war it was decided to raise and send to France forestry troops, and their recruiting was assigned to Colonel Greeley. To prepare the way for their operations in the French forests, the chief forester, Colonel Graves, was sent to France and attached to the General Staff. After Colonel Graves returned to the United States, Colonel Greeley took his place and finally became chief of the forestry section in the American Expeditionary Forces, in charge of 21,000 forestry troops and 95 sawmills, with lumbering operations scattered from the zone of military operations to the Pyrenees and from the Swiss border to the Atlantic.

Colonel Graves, in presenting his resignation after ten years of service as chief forester, wrote:

> Since the pecuniary returns afforded professional and scientific men in the government service inadequately provide against the exhaustion of the working powers which must inevitably take place in time, and entail sacrifices from which employment elsewhere is free, the only course consistent alike with self-respect and a regard for the public interests seems to me to be retirement from office before efficiency has been impaired. Present conditions, which amount to a heavy reduction in the rate of compensation in practically every branch of the government service, emphasize this point of view.

SCIENTIFIC NOTES AND NEWS

At the mid-year commencement exercises of the University of Pittsburgh honorary degrees were conferred upon Dr. William H. Nichols, retiring president of the American Chemical Society, and Dr. William A. Noyes, present president.

Dr. W. W. Campbell, director of the Lick Observatory, has been appointed "Commander of the Order of Leopold II." by King Albert, of Belgium. Dr. Campbell has also been elected to honorary membership in the Royal Institution of Great Britain.

Professor Wilder D. Bancroft, of Cornell University, at present chairman of the division of chemistry of the National Research Council, has been elected a foreign member of the Chemical Society, London.

Dr. F. G. Novy, of the University of Michigan, has been elected a corresponding member of the Society of Biology, of Paris, and associate member of the Royal Society of Medical and Natural Sciences of Brussels.

Dr. Frederick P. Gay, of the University of California, has been elected an honorary member of the Philadelphia Pathological Society.

Professor A. Fowler, professor of astrophysics, Imperial College of Science and Technology, London, has been elected a corresponding member of the Paris Academy of Sciences, in succession to the late Professor E. Weiss, of Vienna.

Professor R. A. Sampson, astronomer royal for Scotland, has been appointed Halley lecturer at the University of Oxford for 1920.

Dr. Arthur L. Day, who has been engaged in research work at the Corning Glass Works, Corning, N. Y., is resuming the directorship at the Geophysical Laboratory of the Carnegie Institution, Washington, D. C.

Karl Sax has been appointed biologist at the Maine Agricultural Experiment Station to take charge of the plant-breeding work.

Dr. Chester Snow has resigned as professor of mathematics at the University of Idaho, to accept a position as physicist in the Bureau of Standards, Washington.

Professor Arthur D. Butterfield, of the department of mathematics at the Worcester Polytechnic Institute, has resigned to become educational director for the Norton Company.

Seth S. Walker has resigned as soil chemist to the Agricultural Experiment Station, Baton Rouge, La., to become chemist to the Florida Citrus Exchange and Exchange Supply Co., with laboratory and headquarters at Tampa, Florida.

Mr. J. Howard Roop, former chief chemist of feedingstuffs in the state chemists' department of Purdue University, has accepted a place as chief chemist of the Nobelsville Milling Co., Nobelsville, Indiana.

Mr. Hoyt S. Gale, geologist in charge of the section of non-metalliferous deposits of the U. S. Geological Survey, who recently returned from Europe where he examined and reported on the potash deposits for the Geological Survey and Bureau of Mines, is on furlough for five months to make an examination of the oil fields of eastern Bolivia. Mr. K. C. Heald, geologist of the survey, is returning from Bolivia by way of the Amazon to the east coast of Brazil.

Professor E. H. Starling, F.R.S., has sailed for India to advise as to the locality and equipment of an All India Research Institute. Delhi, the new capital of India, has been suggested as a site for a new institute to serve as the headquarters of the research organization, but other places have been mentioned.

Professor G. N. Lewis delivered the faculty research lecture on "Color and molecular structure" during the charter week ceremonies of the University of California.

Dr. J. Walter Fewkes, chief of the Bureau of American Ethnology, Smithsonian Institution, delivered an address on "American Archeology: Its History and Technique" before the Washington Academy of Science on March 8.

Dr. Colin G. Fink, head of the laboratories of the Chile Exploration Company, recently lectured to the graduate students, school of chemistry, Yale University, on "Industrial research" and on "The value of physical chemistry to the organic chemist."

Captain Carl W. Lewis, head of the chemistry department of Northwestern University lectured on March 12 at Oberlin College on "Problems of Gas Warfare."

Professor Pierre Boutroux, of Princeton University, lectured on "French Science" on March 18 at Columbia University.

At a joint meeting of the Washington Academy of Sciences and the Medical and Anthropological Societies on March 31, Sir Arthur Newsholme, K.C.B., former chief medical officer of health of the Local Government Force, England, delivered an address on "The National Importance of Child Welfare Work."

The third annual Silvanus Thompson memorial lecture of the Röntgen Society was delivered by Professor W. H. Bragg on March 2, the subject being "Analysis by X-rays."

Dr. Harvey Cushing, Peter Bent Brigham Hospital, Boston, has been requested by Lady Osler to prepare a biography of Sir William Osler. He will be grateful to any one who will send him either letters or copies of letters, or personal reminiscences, or information concerning others who might supply such information.

We learn from *Nature* that a meeting convened by the chancellor of the University of Cambridge and the president of the Royal Society was held on March 4, at the rooms of the Royal Society, to consider the question of a memorial to the memory of Lord Rayleigh. After a preliminary statement by the president of the Royal Society announcing the purpose of the meeting, speeches in favor of the proposal to erect a memorial were made by Mr. A. J. Balfour, Sir Charles Parsons, Dr. P. Giles (vice-chancellor of the University of Cambridge), Sir Arthur Schuster, Sir Richard Glazebrook, and Sir Joseph Larmor. It was agreed that a fund should be raised for the purpose of placing a memorial, preferably a window, in Westminster Abbey. A general committee was appointed, as well as an executive committee, to consider details, and also the further question of raising a fund in memory of Lord Rayleigh, to be used for the promotion of research in some branch of science in which he was specially interested.

Dr. James Emerson Reynolds, professor of chemistry at the University of Dublin from 1875 to 1903, since engaged in research work in the Davy-Faraday laboratory of the Royal institution, died on February 26 at the age of seventy-six years.

Lucien Poincaré, author of works on physics and vice-rector of the University of Paris, died on March 9, at the age of fifty-eight years. M. Poincaré was a brother of President Poincaré, and a cousin of the great mathematical physicist, Henri Poincaré.

Dr. Hugo Eisig, who cooperated with Anton Dohrn in the foundation and conduct of the Naples Zoological Station, died in Switzerland on February 10, aged seventy-three years.

The American Pharmaceutical Association has available a sum amounting to about $450 which will be expended after October 1, for the encouragement of research. This amount either in full or fractions will be awarded in such manner as will in the judgment of the research committee produce the greatest good to American pharmaceutical research. Investigators desiring financial aid in their work will communicate before May first with H. V. Arny, chairman, 115 West 68th St., New York, giving their past record and outlining the particular line of work for which the grant is desired. The committee will give each application its careful attention and will make recommendations to the American Pharmaceutical Association at its meeting in Washington, May 3–8, when the award or awards will be made.

UNIVERSITY AND EDUCATIONAL NEWS

The fund for the University of Montreal (Laval), recently destroyed by fire, has attained to more than $3,500,000.

The *Journal* of the American Medical Association states that Toronto University needs $4,000,000 for its reorganized medical department. Dr. George E. Vincent, of the Rockefeller Foundation, has been in Toronto and has been conferring with the special committee of the medical department, presided over by Dr. Alexander Primrose, C.B. It is planned to pay whole-time professors in medicine, surgery, obstetrics, pathology, and perhaps one or two others, $10,000 a year. Representatives from Queens, Western at London, and from Winnipeg interviewed Dr. Vincent as to their likelihood of participating in the $5,000,000 to be allotted to Canada for medical education from the foundation.

A bequest of £4,000 has been left to the University of Manchester by the late Mr. William Kirtley, a nephew of Stephenson, who constructed the Manchester and Liverpool Railway. The fund will be used to establish a William Kirtley scholarship for the promotion of the study of mechanical engineering.

According to the forthcoming annual report of President Harry Pratt Judson, a building which the University of Chicago stands especially in need of is a research laboratory for the department of chemistry. The present Kent Chemical Laboratory is overcrowded with students. Such a building is estimated to cost about $350,000 and would be erected directly west of Kent Chemical Laboratory.

Dr. W. C. Allee, of Lake Forest College, will next year be head of the department of biology at Knox College.

DISCUSSION AND CORRESPONDENCE

THE U. S. GEOLOGICAL SURVEY

In a recent number of Science, the director of the United States Geological Survey calls public attention to the deplorable fact that the Survey is rapidly losing many of its capable geologists. He seems to ascribe this rapid depletion of the scientific staff entirely to the low salaries offered by the government as compared with the high salaries, often with privileges of investment, offered by corporations—particularly oil companies. Geologists who are familiar with the conditions in the Geological Survey during the past twenty years or more are aware, however, that the director has mentioned only one of the reasons why geologists are rapidly leaving the survey to accept more attractive positions elsewhere. It seems important that all the other factors should be brought to public attention so that there may be a general understanding of the situation, resulting in pressure upon Congress and the officials of the administration to preserve what remains of the survey's usefulness.

The low salaries paid by the government and the needlessly strict prohibition against investments in any kind of industrial projects even remotely connected with survey work are not the only financial handicaps that beset the employees of the Federal Survey. Geologists engaged in field work often incur more or less danger—in some cases a great deal; yet a serious injury will bring no compensation from the government, but will on the contrary generally cost the injured man his position, if his usefulness has been permanently impaired. Cases of severe illness cost the unfortunate geologist full pay during the time lost, so far as it exceeds the arbitrary "sick-leave" allowance. Again, the Survey has no provision for pensioning those who have grown old and superannuated in its service.

A more important factor, as it seems to many of us, is the less interesting work now-a-days assigned to various members of the Survey. Little by little the amount of scientific research carried on by the survey has been curtailed in favor of routine statistical and classificatory activities. In large measure survey geologists have been gradually reduced from scientific investigators to technical or scientific clerks who have but little to say about the planning and initiation of their work, and who publicly get but little individual credit for the result. There are many men of zeal and high purpose who are willing to work for a relatively small salary provided they have adequate opportunities for and encouragement in the pursuit of their chosen researches; but of late the survey has not been attractive to men of this type.

Scientific research without appropriate and opportune publication soon becomes a mockery. Long delays in the appearance of survey reports have for years been the rule rather than the exception, until the situation has become a standing joke both inside and outside the bureau. Many a report of field and laboratory investigations has been held in "cold storage" year after year until it has been duplicated and superseded by the work of others. While the war greatly aggravated this condition it was an obvious tendency even before 1914.

The most serious blow which has been struck at the survey in its entire history has come within the last few months in the guise of an administrative order greatly curtailing the space and facilities available for the work of the Geological Survey. For years members of the survey endured the conditions of the old survey office building—in which the overcrowding was a national disgrace—on the assurance that a new building would soon be constructed wherein there would at last be room enough. No sooner had the survey moved into the new building, however, than the exigencies of the war prevented them from obtaining all the space to which they were apparently entitled. Now comes the order, from a source evidently lacking an understanding of how scientific work is done, greatly reducing the already limited quarters and depriving even the more important and distinguished members of the survey of their laboratories and private offices. Men of national reputation in their science are crowded together three or four in an office suitable for one. Some of the geologists are attempting to do their more important work at their homes, to which they have removed their libraries and working materials normally kept at their survey offices. Others with more fortunate connections manage to continue work in laboratories of the National Museum. Many, however, have cut the Gordian knot by resigning, and still other resignations are following from month to month.

It should be distinctly understood by every one that although the geologists of the survey need and are entitled to salaries appropriate to their positions and in keeping with the increased cost of living, the most serious defect of the survey to-day is the paucity of actual scientific opportunities either for geologists already on the staff or to offer promising young men of the stamp formerly attracted to survey work. No reversal of the survey's present decline curve need be expected until adequate provision is made for such opportunities.

Eliot Blackwelder

Denver, Colorado,
January 22, 1920

THE AWARD OF THE NOBEL PRIZE TO PROFESSOR HABER

To the Editor of Science: The statement of the First Secretary of the Swedish legation (published in the February 27 number of Science, p. 207), relative to the award of the Nobel Prize to Professor Haber, contains some erroneous conclusions and some half-truths which should not be allowed to pass unchallenged. While Professor Haber's perfection of the commercial synthesis of ammonia amply warrants the award of the prize to him, I would comment upon the other numbered statements as follows:

2. The production of ammonia is only a step, this product being oxidized to nitric acid and nitrates by the Oswald process. While the Haber process will ultimately be of great value to the world at large, the patents, secrets, experience and profits were all Germany's (until after the war). The first secretary omitted to state that the Haber process made Germany independent of Chile saltpeter (sodium nitrate), not only for agricultural purposes, but also for the manufacture of chemicals, dyes, and especially explosives.

3. The address of Professor Bernthsen in 1912 before the eighth International Congress of Applied Chemistry in New York, was notice to the world at large that Germany could carry on war even if the British fleet cut off the Chile nitrate supply. While giving much general information, Bernthsen did not disclose all of the essential details necessary to the successful manufacture of ammonia, and of nitrates from ammonia. Therefore during the war when this country wished to use the Haber process, it became necessary for one of our large American corporations to work out the details in connection with the War Nitrates Board.

4. The statement that "the Haber plants in Germany were erected with a view to producing agricultural fertilizers" is a half-truth. This naturally was an important object, for in war as well as in peace the army and the nation must be fed, and business go on; but even more vital to Germany's purposes was the fact that ammonia meant nitrates, and nitrates meant explosives necessary for the carefully planned war, which so soon followed the perfection of the Haber process.

5. Although the first secretary disclaims knowledge of the manufacture of gas masks in Sweden, it is probable that Germany got wood or charcoal from Sweden for gas mask purposes, just as she got iron ore. No criticism attaches to Sweden for this, and her fear of Russia and proximity to Germany across the Baltic (a "German lake") readily explain her attitude toward her powerful neighbor.

However the pro-German activities of certain Swedes and Swedish-Americans, and especially the abuse of Swedish diplomatic privileges by such Germans as Count Luxberg, of "spurlos versenkt" fame, have naturally created among the Allied people an atmosphere of suspicion against Sweden; so that, especially since Professor Haber is understood to be one of those who advised and helped develop gas warfare, it is easy to understand how many believe that the award of the Nobel Prize to him was, *at this time*, ill-advised and undiplomatic.

Jerome Alexander

Ridgefield, Conn.

SCIENTIFIC BOOKS

A Handbook of Physics Measurements. By Ervin S. Ferry in collaboration with O. W. Silvey, G. W. Sherman, Jr., and D. C. Duncan. Vol. I. Fundamental Measurements, Properties of Matter and Optics. Pp. ix + 251. $2.00. Vol. II. Vibratory Motion, Sound, Heat, Electricity and Magnetism. Pp. x + 233. $2.00. New York, John Wiley & Sons, Inc. 1918.

Manuals for use in the physical laboratory have been designed from two quite distinct points of view. On the one hand, an attempt has been made to develop a series of experiments that would serve to illustrate the general principles of physics and give the student a first-hand contact with the notions discussed in text-books, lectures and recitations. The emphasis is on the underlying ideas and the discussion of methods and accuracy of measurement is purely incidental. Books of this type are eminently suitable for students in elementary physics. On the other hand, the purpose of the manual may be to develop the theory and practise of physical measurements and to describe the construction and operation of standard measuring instruments. Such manuals are essential to the advanced student in physics and, if sufficiently comprehensive, they are useful to the student in chemistry or biology.

Professor Ferry's work belongs to the second category although a few of the experiments described would not be out of place in a manual of the first type. It is a thorough revision and rearrangement of an earlier book on "Practical Physics," by Ervin S. Ferry and Arthur T. Jones, to which chapters on sound, optics, electricity and magnetism have been added. The scope and method of the work are adequately indicated by the following quotations from the author's preface: "Only those experimental methods have been included that are strictly scientific and that can be depended upon to give good results in the hands of the average student. Although several pieces of apparatus, experimental methods and derivations of formulæ that possess some novelty appear, our fixed purpose has been to use the standard forms except in cases where an extended trial in large classes has demonstrated the superiority of the proposed innovation." "It has been assumed that the experiment is rare that should be performed before the student understands the theory involved and the derivation of the formula required. Consequently the theory of each experiment is given in detail and the required formula developed at length. The more important sources of error are pointed out, and means are indicated by which these errors may be minimized or accounted for."

Several of the methods of measurement described involve the use of instruments of special design not likely to be found outside of the author's laboratory but the greater part of them can be carried out with the apparatus that should be found in any well-equipped laboratory. The theory and manipulation of the more important modern instruments of precision are comprehensively treated and any student who has occasion to use such instruments will find these sections of the work very useful. The work is well adapted for use as a text in second- or third-year laboratory courses in physics. It should also find wide use as a reference book, in any laboratory where physical instruments and methods are occasionally used.

A. DEF. P.

SPECIAL ARTICLES

NOTICE OF A RECENT CONTRIBUTION TO STATISTICAL METHODS

PROGRESS in science is measured, among other things, by the extent to which the qualitative treatment of problems is supplemented by a more rigorous quantitative treatment. The introduction of quantitative methods into the biological sciences, however, is beset with unusual difficulties. The highly complex and variable nature of the subject matter generally demands the empirical procedure of the statistician rather than the deductive one of the mathematician, and this is true of many problems of physical science as well, for example, those of meteorology. One of the main difficulties to be overcome arises from the simultaneous variation in the magnitudes of the many variables concerned. Especially is this true in "field" investigations where artificial control over the variable is impossible; as, for example, in marine ecology. In order to meet this difficulty the authors have prepared a paper entitled: "The functional relation of one variable to each of a number of correlated variables determined by a method of successive approximation to group averages." The introduction is written by Wm. E. Ritter under the title: "A step forward in the methodology of natural science."

[1] *Proc. Amer. Acad. Arts. Sci.*, Vol. 55, Dec., 1919, pp. 89–133.

This paper presents the development of a general method of ascertaining the relation between a dependent variable and each of a number of mutually correlated ones *without being compelled to employ an assumed or predetermined mathematical function.* This is accomplished by applying to the observed values of the dependent variable successive corrections based upon each value of all the independent variables. In this way is obtained a series of averages of the dependent variable corresponding to a series of averages of each one of the independent variables in turn and corrected to a constant value of each of the remaining ones. The method is concretely illustrated by an application to a bioclimatic problem; that of predicting the yield of South Dakota wheat from temperature and precipitation.

A limited number of reprints are available for distribution. Requests for them should be mailed to the Scripps Institution, La Jolla, California.

GEO. F. MCEWEN
ELLIS L. MICHAEL

THE AMERICAN CHEMICAL SOCIETY VII

Calorimetric determinations of the energy in yolk-protein and yolk-fat of doves and pigeons: OSCAR RIDDLES. Individual entire egg-yolks were separated into (boiling) alcohol-ether soluble and insoluble fractions. These moisture-free portions considered as yolk-protein and yolk-fat were burned in a Riche bomb calorimeter. Determinations were separately made upon yolks from various pure species and hybrids. The energy per gram of the yolk-protein of pure species averages 5,497 (small) calories; for hybrids practically the same (5,457). The energy per gram of yolk-fat of pure species averages 9,020 calories; for hybrids probably it is less (8,897). The range of variability for yolks from individual hybrids is plainly greater than for yolks from pure species.

Some properties of the placental hormone: PAUL M. GIESY. This substance, injected subcutaneously into the female animals, causes growth of the mammary glands and uterus. It was extracted by treating ground placentas with alcohol. In water, some, but not all, of the substance dissolves. It is dissolved by benzene, chloroform, carbon tetrachloride, absolute alcohol, ether and ethyl acetate, but not by petroleum ether. If the extract is shaken with a mixture of water and benzene, the benzene solution alone is physiologically active. Alcoholic solutions and aqueous emulsions lose their activity on standing. The activity appears to be destroyed by continued heating.

The preparation of fatty acid esters of cholesterol: G. D. BEAL AND J. B. BROWN. (By title.)

Comparative analysis of fibrin in the presence of various aldehydes: GEORGE E. HOLM AND ROSS AIKEN GORTNER. The comparative action of various amounts of paraldehyde, benzaldehyde, butyl and isobutyl aldehydes to that of formaldehyde when present in the acid hydrolysis of fibrin and gelatin was studied. In all cases the acid insoluble humin nitrogen increase is greater than with $(CH_2O)_3$ and a maximum is reached and maintained even in the presence of large excesses of these aldehydes. The ammonia nitrogen, soluble humin nitrogen and total amino nitrogen of the filtrates from the "humin" do not alter significantly. Using trioxymethylene, the increase in insoluble humin nitrogen is due to the presence of the indole nucleus, while with the other aldehydes tyrosin also enters into this reaction.

The preparation of cholesterol in quantity: PAUL M. GIESY. One hundred pounds of cattle spinal cords were ground, dehydrated with alcohol and extracted fourteen times with ether. The ether was evaporated from the extract, and the residue saponified by boiling with alcoholic sodium hydroxide. After evaporating the alcohol, the residue was taken up in water and extracted with ether. The ether was evaporated from the extract, and the cholesterol crystallized from alcohol. The first crop was cream-colored and melted at 147.1° corrected. The second crop was brown, and melted at 146.4°. The total yield is about two pounds. The color can be removed by recrystallization from alcohol.

The influence of aspartic acid and asparagin upon the enzymic hydrolysis of starch: H. C. SHERMAN AND FLORENCE WALKER. (By title.)

An improved technic for measuring lipase activity in animal or plant extracts or tissues: LEROY S. PALMER (By title.) The material to be tested is added in the form of an extract or finely minced paste to at least 75 c.c. of artificial "milk," prepared by grinding a suitable oil into hydrated acacia and diluting the emulsion with water. HCHO 1: 1,500 is added to the "milk" as preservtive. The initial acidity is determined by withdrawing a 25 c.c. aliquot and adding it to 100 c.c. of acetone-ether (2: 1), and titrating with 0.1 N alcoholic KOH solution, using phenolphthalein as indicator. The remainder of the "milk" is incubated for 24 hours at 38° C., with occasional rotation of the flask, and the titration repeated on another 25 c.c. aliquot. The features of the method are, (1) the use of an artificial "milk" containing no acid producing substances other than the emulsified oil, (2) the determination of the acidity on aliquot portions of the emulsion.

The influence of various antiseptics on the activity of lipase: Leroy S. Palmer. (By title.) The activity of a commercial lipase was tested using the technic described in the previous abstract. Chloroform, iodoform and acetone were found to have a marked retarding influence on the lipase, depending on the concentration of the antiseptic. Very small quantities of mercuric chloride and iodine, each completely paralyzed the lipase activity. Formaldehyde had no retarding effect up to one part in 250, concentrations between 1: 1,000 and 1: 2,000 actually having a noticeable accelerating effect on the lipase activity.

The activity of phytase as determined by the specific conductivity: F. A. Collatz and C. H. Bailey. (By title.) The hydrolytic cleavage of phytin by phytase results in the appearance of salts of phosphoric acid in the digestion mixture. The electrical conductivity of the latter is thereby increased, and may be employed as a measure of the progress of the reaction. To a water solution of phytin was added crude phytase prepared from wheat bran, and several such preparations were incubated at temperatures differing by 5° intervals from 25° to 60°. The electrical conductivity was measured every 15 minutes until it ceased to change materially. The rate of hydrolysis was accelerated by increased temperatures up to 55°, which appeared to be the optimum for this enzyme. Plotting the data, calculated to conductance at 30° in order to compensate for increased mobility of the ions at higher temperature, the curves have different shapes at each temperature. As the temperature increases to the optimum, the increase in conductivity per unit of time is more rapid at the outset, but also reaches approximate equilibrium more promptly.

The fermentation of fructose by a group of pentose-fermenting bacteria: W. H. Peterson, E. B. Fred and A. Davenport. In the fermentation of fructose by these organisms acetic and lactic acids are the chief end products. Coincident with the production of these acids is the formation of mannitol to the extent of about 20–30 per cent. of the fructose. The mannitol thus formed can be fermented to acetic and lactic acids by the same bacteria that produced it. It is suggested that the fructose first breaks down into acetic and malic acids and the latter then undergoes decarboxylation yielding lactic acid. Evidence for regarding malic acid as an intermediate product is the fermentation of malic acid to lactic acid. The strong reducing conditions set up in the breaking down of fructose into acetic and malic acid probably brings about the reduction of another portion of the fructose to mannitol.

Factors influencing the invertase activity of mold spores in sugar: Nicholas Kopeloff and S. Byall. (By title.) The invertase activity of the spores of *Aspergillus* S. Bainier, *Aspergillus niger* and *Penicillium expansum* is exhibited at concentrations of sugar varying from 10 to 70 per cent. It has also been found that the maximum invertase activity of these mold spores occurs between 50 and 60 per cent. concentrations. It was noted that an increase in the number of mold spores is responsible for increased invertase activity in a saturated sugar solution. However, the least number of spores per c.c. of *Penicillium expansum* and *Aspergillus niger* required to produce inversion in saturated sugar solution is between 50,000 and 110,000. About 5,000 spores of *Aspergillus* S. Bainier are needed to cause inversion. The evidence that mold spores alone are capable of deteriorating cane sugar is corroborated by the data herein presented.

Carbon nitrogen ratio in relation to plant metabolism: A. M. Gurjar. (By title.) The supply of nitrogen determines the relative proportion of carbohydrates and proteins in the tomato plant. Changes in these proportions are accompanied by very marked changes in the metabolism of the plant, as follows: (*a*) Although the C: N ratio may be as high as 19 and as low as 2, the fruiting takes place only between the ratios 4 and 6. (*b*) respiration varies directly as the value of C: N ratio. (*c*) Photosynthesis varies inversely as the value of C: N ratio. (*d*) In nitrogen starved plants, catalase activity is *not* parallel to respiration, but varies inversely with it. (*e*) Under etiolation, the high carbohydrate plants are reduced to protoplasmic respiration sooner than the low carbohydrate plant, which means that the enzyme system of the former fails to make available the starch reserve. (*f*) The high carbohydrate plants have higher respiration at 20 c.c. C., but this is not the case at 10° C. and 30° C. The above observations on tomato, together with confirmatory data on turnips and radishes, emphasize the importance of determining the proper C: N ratios for all our economic plants.

Vanillyl acyl amides: E. K. Nelson. (By title.) Following the demonstration of the structure of capsaicin, the pungent principle of red pepper, which proved to be a condensation compound of vanillyl amine (4-hydroxy-3-methoxy benzylamine) with a decenoic acid, a number of analogous derivatives of vanillyl amine were prepared by the interaction of that substance with acyl chlorides. Derivatives of the following acids were obtained: acetic, propionic, butyric, isobutyric, n-hexoic, n-heptoic, n-octoic, n-nonoic, n-decoic, n-undecoic, n-dodecoic, crotonoic, undecenoic and benzoic. As the molecular weights of these substances rise, the solubility in water decreases, while that in ether increases. Pungency, first noticeable in the propionyl compound, increases to a maximum in vanillyl octoyl amide, which is almost as pungent as capsaicin. One eight-thousandth of a milligram of this substance causes a distinct burning on the tongue. The crotonyl compound is slightly, the undecenoyl compound extremely, and vanillyl benzoyl amide very slightly pungent.

On a phenol produced by growing aspergillus tamari: J. F. Brewster. (By title.)

Climatic control in relation to plant growth: W. E. Tottingham. (By title.) Consideration of the profound effects of climate upon the growth and composition of plants, together with the difficulties of interpretation of these effects imposed by fluctuations of climatic factors, makes evident the desirability of experimental control over the latter. A fair degree of success has been realized in the installation of a small plant culture chamber for climatic control within a greenhouse. The atmosphere is conditioned for this chamber by forcing it through a humidifying chamber moistened by wet towelling, the latter being wet by water of controlled temperature. Before entering the culture chamber the air is heated somewhat, to bring both its temperature and degree of saturation with water vapor to desired values. The conditioned air enters the culture chamber beneath the flanged surface of a rotating table, which distributes it about the chamber, and escapes through orifices at the top. The rotating table also serves to equalize climatic differences for the different plant cultures carried by it. With the limited capacity of such an apparatus, it is necessary to maintain a considerable degree of control over illumination, temperature and humidity of the surrounding greenhouse, in order to realize a reasonable degree of control over climatic conditions within the culture chamber.

Studies in the translocation of nitrogenous and carbohydrate material into the wheat kernel: G. A. Olson. (By title.)

Physical and chemical studies of wheat gluten: G. A. Olson and Charles H. Hunt. (By title.)

Charles L. Parsons,
Secretary

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION B—PHYSICS

Section B was in session, in affiliation with the American Physical Society, at St. Louis, December 30, and 31, 1919, and January 1, 1920. The program of papers presented through the American Physical Society are elsewhere announced and abstracted by the society. On the afternoon of December 31 occurred the annual session of Section B, the retiring vice-presidential address of Dr. Gordon F. Hull and a Symposium on "Phenomena in the Ultra-violet Spectrum, including X-rays," the papers of which will be abstracted elsewhere in Science under the above title. Dr. Hull's address on the subject, "Some Aspects of Physics in War and Peace," was printed in the issue of Science for February 5.

The Sectional Committee nominated as chairman of the Section, Professor J. C. McLennan, of the University of Toronto.

G. W. Stewart,
Secretary

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CONTENTS

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THE DIVISION OF ANTHROPOLOGY AND PSYCHOLOGY OF THE NATIONAL RESEARCH COUNCIL[1]

A general of the regular army listening to a description of the National Research Council remarked, "You are the General Staff of the army of American men of science." The analogy is suggestive. Our war against the realm of the unknown calls for a determination of broad policies of strategy, as well as for skill in the tactics of attack. Ample resources must be planned for. The relative need for men trained in the various specialized duties of a complex organization must be ascertained. The most effective plans for employing both men and materials must be blocked out. Programs for meeting possible contingencies must be thoughtfully elaborated. New suggestions of method in organization must be pondered and tested. The Division of Anthropology and Psychology of the National Research Council should serve the army of research workers in ways similar to these.

But the analogy breaks down absolutely in one respect. The National Research Council must not, will not, be autocratic. With a representative membership democratically constituted by election from the scientific societies of America it is in no sense our province to dictate, but only to serve. A better analogy compares the National Research Council with the Coordination Branch of the General Staff.

The Division of Anthropology and Psychology of the National Research Council aims to be of service chiefly in three directions: first, assistance in the coordination of research activities already in progress or in contemplation, to encourage team work, minimize duplication of effort, and decrease the magnitude of

[1] Address delivered at Cambridge, December 30, 1919, before a joint session of the American Anthropological Association and the American Psychological Association.

the gaps in our front line of attack on the most vital problems of scientific investigation; second, assistance to the representatives of industries, museums, government departments and other agencies, in the definition of their research problems; and, third, assistance in bringing these agencies into touch with the scientists who are in a position to aid in the solution of their problems.

As Mr. Elihu Root has pointed out, men of science have given to American business and industry the principles underlying a marvellously economical and effective organization; but they have hitherto failed to apply these same principles of organization to their own research activities. While conceding that the production of research output is in essential respects a radically different undertaking from the production of railway equipment or the manufacture of automobiles, we may still insist that in other respects the fundamental principles of organization and of cooperative effort may wisely be directed toward scientific productivity. Such an effort toward multiplication of valuable output is the aim of the Division of Anthropology and Psychology of the National Research Council.

The Division was organized on October 20, 1919, with the following personnel:

Elected by the American Anthropological Association: Franz Boas,[2] Columbia University; Roland B. Dixon, Harvard University; J. Walter Fewkes, Smithsonian Institution; A. L. Kroeber, University of California; Berthold Laufer, Field Museum of Natural History, Chicago; Clark Wissler, American Museum of Natural History, New York City.

Elected by the American Psychological Association: James R. Angell, University of Chicago (chairman, National Research Council); Raymond Dodge, Wesleyan University; Walter D. Scott, Northwestern University and The Scott Company, Philadelphia; C. E. Seashore, State University of Iowa; E. L. Thorndike, Columbia University; G. M. Whipple, University of Michigan.

[2] Dr. Boas resigned his membership in the National Research Council December 30, 1919.

Anthropologists, members at large: A. Hrdlička, United States National Museum; A. M. Tozzer, Harvard University; P. E. Goddard, American Museum of Natural History.

Psychologists, members at large: S. I. Franz, Government Hospital for the Insane; L. M. Terman, Leland Stanford, Jr. University; M. F. Washburn, Vassar College.

Chairman of the Division: W. V. Bingham, Carnegie Institute of Technology; Vice-chairman, Clark Wissler, American Museum of Natural History.

Executive Committee: W. V. Bingham, chairman, Clark Wissler, Franz Boas,[2] J. W. Fewkes, W. D. Scott and C. E. Seashore.

A brief sketch of some of the activities of the Division since its chairman assumed his duties in Washington, November 17, will help in understanding the aims, possibilities and limitations of the Division.

The chairman found himself plunged at once into a swirling eddy of scientific enterprises under discussion by the other scientific and technical divisions of the council. These divisions, with the advantage of several months start over us, had already surveyed their fields, created committees, gone after funds, and settled down to hard work.

On the formulation of some of their projects they sought and welcomed our help. The Division of Biology and Agriculture, for example, had a committee for the formulation of an enormous project for research in South America. Any such project for scientific expeditions and the establishment of research stations might advantageously include in its program plans for archeological, ethnological, and linguistic investigations. Another similar project for oceanographic research among the northern islands of the Pacific was being formulated by the Division of Geology and Geography.

The Division of Biology and Agriculture asked for suggestions of psychological personnel to be included on its Committee on Eugenics. From another source came an inquiry for a consultant competent in the psychology of sex.

The Engineering Foundation had for several months been formulating a comprehensive program of research on industrial personnel, and welcomed suggestions regarding psychological aspects of the problem.

From two branches of the War Department had come requests for advice and suggestions with reference to the psychological service in the army and the development of tests and standards for use in the new army educational system. An Advisory Committee on Problems of Military Psychology was at once appointed, consisting of Colonel Walter Dill Scott, Major C. S. Yoakum, and Major G. F. Arps. This committee has already been of service, in conference with officers of the General Staff.

These activities of the Division of Anthropology and Psychology are illustrative of a type of usefulness which does not entail the raising or the expenditure of funds. This also holds true of our assistance in formulating a research program for the Washington Diet Kitchen Association, an agency which maintains eight stations to which are brought for examination some 2,000 infants a month. While its research, past and future, focuses primarily on psychological problems of nutrition and growth, it was recognized that here is an exceptional opportunity to gather also data of value in the study of infant psychology, anthropometry and eugenics.

Meanwhile we have been assembling suggestions regarding scientific enterprises toward the promotion of which the Division might wisely bend its efforts. Improvement of facilities for prompt publication of research is a need which several have advanced. Others, particularly among the psychologists, have stressed the growing necessity for a journal to publish a cumulative system of analytical abstracts, such as are available in chemistry, botany and some of the other sciences.

Development of the supply of competent research personnel is another need of our science. This might be accomplished by urging the establishment of more and better fellowships with which to attract and hold for our science the abler minds. Parallel with such a program should go a systematic search for promising student material in the senior classes of the colleges. Such an inventory of talent would be a matter of interest to all the sciences, and should be administered by the Division of Educational Relations. The contribution of our own Division should be merely in supplying the technique of the student survey.

Suggestions regarding specific research projects are being considered. From among them, the Division will select a few of the most promising and important, and bend its efforts toward promoting these. One or more of these projects are to be cooperative undertakings which do not cost money, because the Division wants early to demonstrate its usefulness simply as an agency for correlation of effort. The standardization of procedure in making anthropometric measurements of college students may be a project of this sort.

Other projects of limited scope will require the raising of certain funds as well as the cooperative effort of research workers, such as the determination of the predictive value of various forms of examinations and tests for students entering colleges and engineering schools; or the recording by means of motion picture films of the industries and ceremonies of the North American Indians, to insure a permanent record and permit analytical study of actual movements.

Other proposals are still more elaborate and would call for larger funds. A systematic survey of archeological material and sites in Indiana, Illinois, Iowa and Missouri is an undertaking which could be completed within five years at an annual cost of from \$5,000 to \$7,000. The function of this Division in such an enterprise would be, first, through a special committee to map out the program in detail, and then, probably through the Division of States Relations on which we are represented by Dr. Fewkes, to encourage state legislatures, historical societies, universities and museums to supply the requisite funds and personnel.

It is intended to select and concentrate on some one major research which is of interest to both anthropologists and psychologists, which can be brought to completion within a relatively short period of one or two years and which gives promise of substantial scientific results, whose practical value would be generally appreciated. The research problems which best meet these specifications are found within the field of racial differences among the people of the United States. Illustrative of such a project, let me quote from a memorandum by Terman, who suggests securing

Mental and physical measurements of as nearly as possible unselected representatives of two to four racial stocks represented in the United States, with supplementary social and educational data.

By ordinary methods of selection large numbers would have to be measured in order to insure representative results. The number it would be necessary to measure could, however, be enormously reduced by confining the measurements to children of a given age, say 12-year-olds. Such a group would give more nearly one hundred per cent. availability than any other group that could be selected. Entire villages, counties, or other civil units could be covered in selected parts of the country. The investigations ought to involve measurements of at least 3,000, and preferably 5,000 individuals of each race group. The results would give a fairly reliable cross-section picture in the race groups chosen for study.

Incidentally, also, the study would go beyond any investigation that has been made in the direction of determining the relationship between intelligence and important physical traits *within a given race group*. The method indicated is, I think, the ideal approach to this latter problem, all previous investigations of the problem having utilized faulty methods of selecting subjects.

Other projects similar in scope and promise include a study of the inheritance of intellectual ability; a study of mental and physical variability in selected traits, and the correlation of mental and physical measurements; culture studies of representative community groups as a basis for a rational Americanization program, etc.

Committees of the Division have just been designated, to proceed with the elaboration of specific proposals. One of these committees, on anthropological and psychological study of the people of the United States, will designate subcommittees on specific projects which are deemed most promising and important. Another committee will determine what most needs to be done in order to utilize the immense accumulations of army data which have hitherto been only meagerly studied. A third will formulate programs for specific researches outside the United States, particularly in Tropical America, and in Polynesia where the effects of racial intermarriage are most readily determinable.

It will then be the duty of the Division to see what research agencies, governmental or educational, can be brought to concentrate their efforts toward a concerted attack on these major problems, problems which could not be treated with adequacy by investigators working individually.

These samples will serve to illustrate the major functions of the Division of Anthropology and Psychology; but its usefulness will, I trust, be demonstrated partly in the minor and perhaps incidental services it can render from time to time to individual workers. Requests for aid are frequent and varied. For example, one investigator who has been engaged on plethysmographic research on stutterers has succeeded through wide advertising in locating in another city a trephined stutterer. Two hundred dollars is needed to transport the subject to the laboratory, in order to secure records of fluctuation of blood pressure in the brain during stuttering. Another investigator, studying the phenomena of memory, habit formation and glandular activity under hypnotism, has found a senior medical student with exceptional skill as a hypnotist, who can at will make the hypnotized subject weep out of the right or the left while the other eye remains dry. A thousand dollar fellowship would make it possible to retain this student for a year of service in research.

Unfortunately the council has no permanent funds from which grants and subsidies can be made. Such financial aid as it extends to important projects ordinarily takes the form of an effort to interest a donor in a specific undertaking which has been selected from among many projects, for endorsement by the division concerned.

Nor is the council in a position always to lend its official approval and moral support to every worthy research undertaking, unless its opinion of the enterprise has first been sought by the government or other agency concerned. But this division will always hold itself in readiness to help any member of these associations, so far as it can, by supplying desired information and particularly by bringing the research worker in touch with other investigators who are engaged on identical or overlapping problems.

One reason why Germany, fighting against the world, was able to stave off defeat for four long years, is that she had to a remarkable degree mobilized her scientific brains. To the same marvellously planned and coordinated development of science in its applications to production, is traceable the world leadership she had won in many phases of industry.

What Germany was able to do under an autocratic régime in the way of fostering scientific investigation and making the results of research in pure and applied science of value to government and industry, it is distinctly up to America to do in a democratic way.

E. B. Woods, the distinguished sociologist, observing the trends of human progress, recently remarked, "The past fifty years have belonged to the men who could organize material production, but the present and the future belong to those who can organize men." He was evidently thinking of the organization of activities in public affairs, in religion, in business and manufacture, in labor relations, and in all movements for human betterment. A third group of leaders to whom both of these groups will turn for guidance consists of those who can organize ideas. I conceive it as a prime function of the National Research Council to organize American men of science for multiplied productivity in the organization of ideas. To such a program of cooperative effort within the enormously important branches of the sciences of man, the Division of Anthropology and Psychology of the National Research Council is dedicated.

W. V. Bingham

Washington, D. C.

THE TECHNOLOGY PLAN

The Technology Plan is an organized attempt to effect a closer cooperation between scientific and industrial effort; between the technical school and the individual industry throughout the country. Although a working relationship between educational institutions and industrial organizations has been discussed at great length, and on many occasions, little real practical progress has as yet been made.

The Technology Plan recognizes that for the present, at least, there must exist somewhere in this scheme of cooperation an element of individual and mutual responsibility on the part of those engaged in it. It recognizes that a purely philanthropic enterprise does not engender in the managers of industry that confidence which is an essential element in its success. Such men are not yet deeply interested in a strictly *pro bono publico* method of cooperative work. Hence, the Technology Plan is neither eleemosynary in organization nor philanthropic in its aims and methods.

The essential feature of the plan is an agreement, expressed as a contract, between individual industrial organizations and the Massachusetts Institute of Technology, under which the industry pays an annual retaining fee to the institute, in return for which the institute assumes certain definite obligations of such a character as it is in position to meet. These obligations are in very general terms as follows:

The great demand of the industries to-day is for men trained to solve the many problems with which these industries are confronted. This requires, first, a knowledge of the principles of science, and second, a training in the application of this knowledge to the solution of the ever-recurring difficulties. While the first requirement is reasonably well met by the undergraduate courses of instruction at the institute, only to a limited extent can the second be obtained in the four years allotted to undergraduate work. The student must be encouraged to spend an additional year or more in a research laboratory or advanced study. Since the best way to learn an art is to practise it, the student is best taught to solve industrial problems by having him attempt the solution of such problems under able and experienced guidance. These problems, however, have their origin in, and owe their existence to, the industries themselves. The first point of cooperative contact, therefore, in this arrangement between industry and the Institute of Technology is that the institute agrees to use, so far as it can, such problems as the industry will submit to it as basic material for its research work for those graduate students interested in industrial development; to give men already well grounded in science the benefit of the opportunity of working under experienced instructors upon the type of work for which they are urgently required. It is true also that much investigation in "pure science" can be conducted as profitably in fields of research which are closely akin to industry as in those realms of science far remote from general interest. This does not mean that the search for knowledge for its own sake will not continue to subtend a large arc of the activities of the Institute of Technology; but rather that such search will be activated and inspired by the realization that the hard work involved and the results obtained are recognized as an essential part of a comprehensive whole. Hence, the institute agrees in its contract to maintain a steady stream of trained men constantly flowing into industry with the best preparation for scientific work which it is possible for it to give. At the same time, the results of the research work thus obtained will swell the store of knowledge on which the scientific progress of the community, as a whole, depends.

But a corollary of this duty of preparing educated men is the duty to see that, as far as possible, these men take positions for which their natural ability and aptitude most nearly fit them. Further, it is desirable that, as these men develop into specialists in any particular field, their sphere of usefulness be made wide as is practicable. Hence the institute undertakes to maintain a record of the qualifications, experience and special knowledge of its alumni; to advise the contractor where such knowledge and experience as it seeks is available; to assist the contractor to obtain the technical help he requires, whether from its own alumni, or from available engineers elsewhere. While this service has been rendered to some degree in the past, it has been a minor part of, and incidental to, other activities. It will now become a contractual obligation.

Coincident with the education of scientific men, there exists the necessity of educating the executives of the industries in the great economic value of science when applied to the business of their organizations. The sporadic "Yankee genius" of the past, productive though it was, must be replaced by the methods of scientific research. Genius must be provided with that most efficient tool yet produced —scientific method. While it is true that the world will ever need more knowledge, the pressing duty of industry for the present is to apply the knowledge now available. To meet this situation, the institute provides for conferences with members of its staff, not only in its own building but also at the factories of the contractor. It is hoped that the contractor will be so imbued with the possible benefits to be derived by the application of science that he will avail himself of one of the sources of technical aid readily accessible, not only at the institute, but among consulting engineers and industrial scientists throughout the country. A realization of that close cooperation between the industrial interests and the educational institutions of the country, which in Germany was made so effective by the domination of both by the state, can, in America, be brought about only by a voluntary personal relationship between the executives of the companies and the instructing staffs of the institutions. The Technology Plan aims to make this relationship more easily possible; to provide a point of contact between the two interests; to open a channel of communication through which the manufacturer and the technical consultant can more easily meet. The contractor can obtain the value of his retainer only by utilizing the facilities thus made available. There will, therefore, be present in the Technology Plan this incentive, to at least try.

The instructing staff of an educational institution is made up, at least theoretically, of men peculiarly adapted to render great public service by conducting research of a fundamental character, *i. e.,* they are seekers after new knowledge, and yet, at the same time, are teachers and trainers of young men. It is important that these men be not withdrawn into purely industrial work by reason of the greater financial return offered by great corporations, or the acute pleasure which many red-blooded men feel in being professionally connected with great technical developments. Hence, the Technology Plan provides a method by which the staff is enabled to profit by contact with men of affairs and receive the inspiration which comes from the capitalization of effort, and, at the same time, fertilize and capitalize the instructional work of the teaching staff.

The institute, therefore, agrees that if the contractor has special technical problems requiring extended consultations, investigations, test, or research work, it will advise the contractor where and by whom such service can best be rendered. When one considers the splendid laboratories with which the Institute of Technology is equipped, covering as they do, almost every department of applied science, and its staff, trained in the use of such laboratories, it is obvious that much of the work will be done within its own organization. But it is neither the desire nor the intention of the Technology Plan to limit the contractor to the facilities of the institute. It is the hope of the Division of Industrial Cooperation and Research, the organization set up to handle the one hundred and ninety contracts already made, that it can enlist the interest of the great body of able consulting engineers throughout the country. When, therefore, consultations, tests, investigations, or research work are of such a nature as can be best furnished by established commercial organizations, the institute will advise the contractor where, in its judgment, the work can best be cared for.

The Technology Plan is, therefore, a more effective means of introducing technical research to the manufacturer; of making the application of science to industrial problems popular; of creating an appreciation on the part of the leaders of industry of the value of science and the necessity of providing, not alone for its application, but for its continued growth and development.

It is earnestly hoped that the plan here outlined will be adopted with improvements by other educational institutions for the benefit of both education and industry.

William H. Walker
Massachusetts Institute of Technology

DOLOMIEU

We have again to thank Professor Alfred Lacroix, of the Académie des Sciences, for the publication of a manuscript account by the French mineralogist Déodat Dolomieu of his travels in Sicily in the year 1781.[1]

Dolomieu, who was a Knight of Malta, had in 1771 incurred the displeasure of the Grand Master of the Order on account of his participation in a duel, and was obliged to absent himself from the island for several years. During this time he came to Paris, where he became acquainted with many of the leading scientists of the period, and frequented much the Jardin du Roi, the forerunner of the present Jardin des Plantes. The mineralogist Daubenton urged him to undertake a geological trip to the island of Sicily and gave him much valuable advice as to the observations he could make there. In a letter written June 9, 1776, to his patron, Duke Alexandre de La Rochefoucauld, Dolomieu says that by pursuing his investigations under the guidance of Daubenton's notes, he believes that he would be able to make a collection of characteristic marbles, which he would gladly share with the duke (p. 7).

By 1779, Dolomieu had made his peace with the Order of Malta, and had returned to the island, whence he started in 1781 for his trip to Sicily (p. 8). In a letter of August 6 to his friend Chevalier Gioeni, a distinguished nat-

[1] "Un voyage géologique en Sicile en 1781, notes inédites de Dolomieu," by Alfred Lacroix, Secrétaire Perpétuel de l'Académie des Sciences, Paris, Imprimerie Nationale, 1919, 190 pp. 8vo.

uralist of Catania, Sicily, Dolomieu gave in the following brief paragraphs the main results of his explorations (pp. 10, 11):

1. I found no trace of volcanoes anywhere in the Val Demona. The neighborhood of Ali does not offer any volcanic material; the waters which supply the hot baths established on the coast are the only indications I have found of subterranean fires.

2. The Liparian Islands are exceedingly curious, and they well merit the attention of naturalists. An interesting collection could be made here of lavas and other volcanic products, but I did not have time to accomplish this.

3. The mines of Val Demona are grouped in a triangle of mountains which occupy the promontory of Sicily; all the veins traverse schist. They contain silver, copper, lead, antimony, zinc and mercury. But none of these mines have been exploited and it is almost impossible to get specimens. In my whole journey through these mountains I was only able to pick up a few pieces which I took from the outcrops of the veins.

4. The granites are present in great quantity in the mountains of Messina, and I believe that a part of the columns made of this rock which one sees in Sicily were quarried in these mountains.

5. I do not know whether there are real coal mines at Messina. I have only found a bituminous earth very common throughout Sicily.

We may note that Dolomieu was enough interested in the report that there was a deposit of beryls near the village of Gratteri, to visit the place. The locality was in a ravine which traversed a hill. Here a number of geodes had been found, resembling those of Grenoble in France. They had a triple envelop of black iron-ore, brown iron-ore and gray clay, and some of them displayed within polyhedral, transparent crystals. Dolomieu could only find a few unsatisfactory specimens, and was forced to buy some at Gratteri, where he had to pay as much for them as for genuine beryls. In reality they were either hyalin quartz, or the light-blue strontium sulphate called celestine (pp. 90, 91).

Déodat Dolomieu was born at Dolomieu, near Tour-du-Pin, in Dauphiné, France, on June 23, 1750. He died at Châteauneuf, near La Clayette, department Saône-et-Loire, November 16, 1801. Regarding the disposition of his remains, the following information is given by Professor Alfred Lacroix in his biographical sketch of Dolomieu.[2]

Dolomieu was interred at Châteauneuf, near La Clayette (Saône-et-Loire). His body probably rests in the vault of the Drée family, but his heart was placed in an urn (39.2 cm. × 23.6 cm.) of black porphyrite with large crystals of white feldspar, which surmounts a fine prism (1 m. 29.8 × 21.6 cm.) of basalt from Auvergne, itself supported by a pedestal of Albanese peperino and marble (violet breccia). This little monument, which formed part of the collection of his brother-in-law (Catalogue of the eight collections composing the Mineralogical Museum of the Marquis Etienne de Drée, Paris, 1811, p. 249), finds itself to-day placed at the entrance of the mineralogical gallery of the Muséum d'Histoire Naturel in Paris.

At the request of the Marquise de Drée, her brother's heart was, at the time of her demise, transported to her own tomb at Dolomieu. In the park of the chateau of Châteauneuf, she had caused to be erected a small monument formed by a block of the red granite of the country.

George F. Kunz

SCIENTIFIC EVENTS

THE MACKENZIE DAVIDSON MEMORIAL

An influential English committee has issued an appeal which in part says:

The death of Sir James Mackenzie Davidson in the prime of life has deprived radiology of one of its most distinguished exponents, whose name is specially associated with the development of radiographic technique, and particularly that of stereoscopic radiography, and with the introduction in this country of the method of the localization of foreign bodies to which so many thousands of wounded men owe a deep debt of gratitude.

Mackenzie Davidson's reputation was international. In this country he was rightly regarded as the head of his profession, and throughout his career he was unsparing in his efforts to raise the

[2] "Notire historique sur Déodat Dolomieu," Paris, 1918, p. 83, note 85; Institut de France, Académie des Sciences.

status of radiology among the sciences. He was especially insistent on the fundamental value of physics to radiology, particularly in regard to methods of measurement and the designing of equipment, subjects in which he was deeply interested up to the time of his death.

Many in his own branch of the profession and a number of his friends and former patients, wishing to keep his memory green, have suggested that an appeal for funds should be made to found a Mackenzie Davidson Chair of Radiology at some university.

Had Mackenzie Davidson lived he would have been among the first actively and generously to support the foundation of an institute for teaching and research in radiology, of which he was one of the earliest pioneers. If funds permit, it is hoped to found such an institute, to which possibly the chair could be attached, and of which the personnel and equipment would be beyond reproach. The benefit accruing to the British School of Radiology would be incalculable.

Till quite recently radiology has been regarded as a purely medical subject, but experimental research has shown that X-rays may be profitably employed commercially in a number of industries. A new subject, radiometallography, has, for example, come into being, which offers great possibilities for examining the internal structure of metals and other materials. In this connection radiology has already beeu turned to account by the steel manufacturer, the metallurgist, the engineer, the manufacturer of explosives, the aircraft constructor, the glass manufacturer, etc.

The future of radiology will therefore lie, not only in the fight against disease and suffering, but also in the increase of commercial and industrial efficiency. But these new branches of radiology need much investigatory work before they can come fully into their own, and a chair of radiology associated with an X-ray institute should play a worthy part in such development.

THE ENGLISH UNION OF SCIENTIFIC WORKERS

Nature reports that the half-yearly council meeting of the National Union of Scientific Workers, presided over by Mr. G. S. Baker, of the National Physical Laboratory, was held at University College on March 6. The rapid growth of the union has necessitated the appointment of a full-time secretary, and Major A. G. Church has been appointed to fill that office. The research committee in its report outlined the function of this body and that of the research council, which it is hoped will shortly be constituted. It will consider how best industry and public administration should be kept in close touch with the development of scientific knowledge, and ensure that the views and conditions of employment of scientific workers shall receive consideration from all bodies bringing forward schemes for research in science or for the administration of research. It was felt that the state should not subsidize industrial research associations unless such bodies display an anxiety to ensure that the direction of research shall be in the hands of those who have shown capacity for leadership in scientific work. A report on patent rights presented by Mr. A. A. Griffith emphasized the opinion "that the only satisfactory way of remunerating salaried inventors is to pay them adequate salaries; a salaried inventor receiving an adequate salary should have no claim whatever to any extra payment because his work proves unexpectedly remunerative." On the motion of Miss A. B. Dale, the council unanimously agreed to "protest against the differential treatment of men and women as regards the method of recruitment to the Civil Service and the salary scales offered therein as recommended by the Reorganization Sub-committee of the Civil Service National Whitley Council."

THE HARVARD ENGINEERING SCHOOL AND INDUSTRIAL COOPERATION

THE Harvard Engineering School has adopted a new plan of instruction for the junior year of the engineering course, whereby students will hereafter be given an opportunity to combine classroom work with six months of active engineering practise and industrial training. According to the new plan, which will be inaugurated in June and will apply to the instruction in mechanical, electrical, civil, sanitary and municipal engineering, every student who wishes to take the industrial training work will spend half his time during his junior year working in industrial or engineering plants within easy reach of Cambridge.

Professor Hector J. Hughes, chairman of the administrative board of the engineering school, has made the following statement:

One of the first problems which the staff of the new engineering school set itself to solve was to find an effective way of getting the new school and its students into closer relations with industrial and engineering work before they graduate. The need for such relations has been increasingly evident in the past few years. The object of such coordination is manifold: to stimulate interest in the classroom work; to keep the teaching staff well-informed of the needs of industry and how to train engineers to meet them; to give the students some intimate knowledge of the great problems of labor and industry which they have to meet after they graduate, and thus to anticipate to some extent the period of initiation which all students must go through and better to fit them to begin their careers; to give them an opportunity to discover how intricate and interesting the basic industries are and to what extent scientific knowledge may be used in work which is too frequently looked upon as non-technical; in other words, to find out how many kinds of careers are open to technically trained men and how wide is the opportunity for such men. Another object of the new plan is to stimulate the interest of the industries themselves in the adaptation to their special needs of education in engineering.

The most promising solution of this problem seemed to the staff to lie along the lines of the highly developed and successful plan of industrial cooperation which was initiated by Dean Schneider at the University of Cincinnati and has been carried on there so successfully for many years, and has been applied in a modified form at the University of Pittsburgh also. This plan has been modified still further to meet the different conditions and needs at Harvard. It is significant that other universities are now moving in the same direction, and within only a few days a large movement has been inaugurated to put such a plan ultimately into effect in most of the large technical schools.

After a thorough study of the situation, the staff came to the conclusion that it would be highly desirable to offer our students an opportunity to get some industrial experience and engineering practise while undergraduates but without sacrifice of classroom instruction and without depriving them of the many advantages which attach to residence and study under teachers interested in other subjects than science, and among students of widely differing interests. In other words, we feel that our students should have as many as possible of the benefits which we know will come from connection with the college, while they are at the same time carrying on their engineering studies. For this reason, and because it does not seem desirable to lengthen the period required for a first degree beyond four years, we shall be limited at the outset to less industrial experience than perhaps would be desirable. The amount offered, however, should be looked upon as a minimum and we have no doubt that many of our students will be glad to avail themselves of the opportunity to take more of this work after the plan is in operation.

Mr. H. V. Drufner, of the University of Cincinnati, has been secured to take active charge of the technical work of putting the new plan into operation.

THE FOREST CLUB CONVENTION IN NEW HAVEN

The fourth annual convention of the Intercollegiate Association of Forestry Clubs was held in New Haven on Friday and Saturday, February 27–28, under the auspices of Yale, the present president club. There were twelve delegates present of whom two were from the Pacific coast. The meeting was in every way a distinct success and the sessions were well attended. Owing to the number of Yale alumni present the occasion partook of the nature of a reunion.

Among the business transacted at the meeting was the adoption of insignia for the association, the provision for a quarterly publication to be issued by the president club, and the election of the University of California as president for the coming year. The next convention will accordingly be held in Berkeley.

The following is the list of speakers and the subjects of their papers:

February 27

The profession of forestry: Professor H. H. Chapman, New Haven, Conn.

How can the forester help the lumberman? T. L. Bristol, Ansonia, Conn.

The work of the consulting forester: J. T. Rothery, New York City.

Speakers at the Banquet

Dean Toumey, Colonel Woolsey, Major Marston, E. C. Hirst and Mr. Rogers, of the Indian Forest Service.

February 28

The undergraduate student of forestry: J. H. Briscoe, Orono, Maine.

The student of forestry and state service: E. C. Hirst, Concord, N. H.

The student of forestry and research: S. T. Dana, Washington, D. C.

MEETING OF THE INTERNATIONAL EUGENICS CONGRESS IN NEW YORK CITY

The National Research Council has appointed a committee on eugenics, under the division of biology and agriculture, consisting of the following members: L. F. Barker, A. G. Bell, E. A. Hooton, Daniel W. LaRue, Stewart Paton, Raymond Pearl, R. M. Yerkes, H. S. Jennings and C. B. Davenport, chairman. The committee met on March 20 and voted to hold the Second International Eugenics Congress in New York City, September 22 to September 28, 1921, inclusive. The invitation of the American Museum of Natural History to hold the meetings of the Congress was gratefully accepted. Dr. Alexander Graham Bell was elected honorary president and Dr. Henry F. Osborn, president. Madison Grant is treasurer and Mrs. Sybil Gotto, secretary of the Eugenics Education Society, in view of her activity in organizing the First Eugenics Congress, was named as honorary secretary of the Second Eugenics Congress. The nucleus of a general committee for the Second International Congress was elected. This general committee is to meet in New York on Saturday, April 10. To this general committee are entrusted the details of organizing the congress, of arranging the program of the meeting, of providing for the entertainment of guests and the raising the necessary funds. The national consultative eugenics bodies in the various allied and associated countries will be informed of the action of the eugenics committee of the National Research Council and invited to send representatives. A general invitation will be sent to universities in different American countries and in various countries of Europe.

SCIENTIFIC NOTES AND NEWS

The American Institute of Electrical Engineers will confer the Edison Medal, awarded each year for the most noteworthy advance in electrical engineering, on Mr. William Leroy Emmet, consulting engineer of the General Electric Company, for his work on the electric propulsion of ships.

Dr. E. W. Brown, professor of mathematics in Yale University, received the Bruce Medal of the Astronomical Society of the Pacific, at a meeting in San Francisco on March 26.

The University of Dublin has conferred the degree of doctor of science on Professor R. A. Millikan, of the University of Chicago.

Dr. J. M. T. Finney, Johns Hopkins University, and Dr. Charles H. Mayo, Rochester, Minn., have been elected honorary fellows of the Royal College of Surgeons. It is hoped that they may be able to attend the meeting of the council in July for the presentation of diplomas.

Sir James Dewar has been elected a corresponding member of the French Academy of Sciences in the section of general physics in succession to the late Professor P. Blaserna.

Professor Horace Lamb, Sir Thomas L. Heath, Professor W. H. Bragg and Dr. Henry Head have been elected honorary fellows of Trinity College, Cambridge.

Dr. Bradford Knapp, chief of extension work in the South, States Relations Service, U. S. Department of Agriculture, since 1911, has been appointed dean of the college of agriculture, of the University of Arkansas and director of the experimental station, and chief of the department of rural economics. Martin Nelson has been appointed vice-dean and vice-director and chief of the department of agronomy.

Dr. J. Stanley Gardiner, F.R.S., professor of zoology in the University of Cambridge, has, at the request of the deputy minister of fisheries, undertaken temporarily the direction of the scientific work of the Fisheries Department of the British ministry.

Mr. H. F. Fish, formerly in the research department of the Great Western Sugar Co., Denver, Colorado, has been appointed by the board of trustees of the University of Illinois as special research assistant in the joint investigation of the fatigue of metals.

Mr. Harvey Bassler, who has held a temporary appointment on the U. S. Geological Survey since 1911 while a student at Johns Hopkins University, has joined the permanent staff of the survey as assistant geologist, and has been engaged in field work in the Virgin River Oil Field, Utah.

Mr. Albert D. Brokaw, formerly associate professor of economic geology and mineralogy at the University of Chicago, has opened a New York office for the practise of his profession as consulting geologist.

Mr. Philip A. Macy, assistant chemist at the Florida Experiment Station, has accepted a position with the Florida Agricultural Supply Co.

The following officers and council of the Geological Society, London, have been elected for the ensuing year: *President,* R. D. Oldham; *Vice-presidents,* Professor E. J. Garwood, G. W. Lamplugh, Colonel H. G. Lyons and Professor J. E. Marr; *Secretaries,* Dr. H. H. Thomas and Dr. H. Lapworth; *Foreign Secretary,* Sir Archibald Geikie; *Treasurer,* Dr. J. V. Elsden; *other Members of Council,* Dr. F. A. Bather, Professor W. S. Boulton, R. G. Carruthers, Dr. A. M. Davies, J. F. N. Green, R. S. Herries, J. Allen Howe, Professor O. T. Jones, Professor P. F. Kendall, W. B. R. King, Dr. G. T. Prior, W. C. Smith, Professor H. H. Swinnerton and Professor W. W. Watts.

Friends of Professor Chandler presented in 1910 to Columbia University a sum of money which constitutes the Charles Frederick Chandler Foundation. The income from this fund is used for a lecture by an eminent chemist and to provide a medal to be presented to the lecturer in further recognition of his achievements in science. Previous lecturers on this foundation were L. H. Baekeland, Sc.D., and W. F. Hillebrand, Ph.D., The lecturer this year will be Willis Rodney Whitney, director of the Research Laboratory of the General Electric Company, a former president of the American Chemical Society and of the American Electrochemical Society. Dr. Whitney's subject will be "The littlest things of chemistry." His lecture will be in Havemeyer Hall, Columbia University, at 8:15 p.m., on April 27.

Dr. D. T. MacDougal, of the Carnegie Desert Laboratory, at Tucson, Arizona, gave a lecture in El Paso on March 10 on "Travels in the Lybian Desert," and on March 12 Dr. A. E. Douglass, of the University of Arizona, Tucson, gave a lecture in Albuquerque, N. M., on "The Big Tree and its Story." These lectures were given in connection with the proposed formation of a Southwestern Division of the American Association for the Advancement of Science.

Dr. Edgar T. Wherry, of the Bureau of Chemistry, U. S. Department of Agriculture, delivered an address before a joint meeting of the Washington Academy of Sciences and the Chemical Society of Washington on "Soil Reaction and Plant Distribution," on March 25.

At a meeting of the Aeronautical Society of America in conjunction with the American Museum of Natural History on March 25 brief addresses on aerial photography applied to exploration, map making and physical geography were made by Colonel Edgar Russell, U. S. Signal Corps, Sherman M. Fairchild, Carl E. Akeley and representatives of the U. S. Geological Survey.

A memorial meeting to the late Sir William Osler, regius professor of medicine at Oxford University and for many years professor of medicine at Johns Hopkins University, was held on March 15 in Johns Hopkins University. President Frank J. Goodnow presided and addresses were made by Henry Van Dyke, D.D., and Professor William H. Welch. A correspondent writes: In the *Wiener Klinische Wochensschrift* of February 26, 1920, Dr. K. F. Wenckebach has an admirable obituary of the late Sir William Osler, in which he emphasizes the genial cosmopolitan spirit of this great physician. It appears that Osler was the first physician to inquire into the rumors concerning the economic condition of the Viennese population after the war and the first to take measures for the relief of the starving Viennese.

DR. JAMES GAYLEY, past president of the Institute of Mining Engineers, has died at the age of sixty-five years.

PROFESSOR ERNEST M. JORDAN, a member of the faculty of the Boston University Medical School since 1913, and a specialist in nervous diseases, died on March 15.

PROFESSOR CHARLES LAPWORTH, for many years professor of geology and physiography in the University of Birmingham, died on March 13 at the age of seventy-seven years.

DR. PIER ANDREA SACCARDO, emeritus professor of botany in the Royal University of Padua, and long director of the Botanical Garden of that city, has died at the age of seventy-five years.

WORD has been received of the death on December 13 last, of Professor Woldemar Voigt, the eminent mathematical physicist of the University of Göttingen, at the age of sixty-nine years. Being a man of broad mind with friends in all the warring countries, he suffered keenly throughout the war and this is said to have aggravated the heart trouble which was the immediate cause of his death. His writings include papers and books in many fields of physics, but chiefly in magneto-optics and crystal physics.

THE Carnegie Corporation has given to the American College of Surgeons $75,000 to be used for hospital standardization. The present gift is the second which the corporation has made to the college. In 1916 it gave $30,000, making a total now of $105,000 for hospital standardization. This amount is supplemented by funds of the college.

THE Institute of Research in Animal Nutrition at Aberdeen has received a gift of £10,000 from Mr. J. Q. Rowett. The amount required from public sources for the establishment of the institution is £25,000.

THE Biological Laboratory of the Brooklyn Institute of Arts and Sciences will hold its thirty-first session during July and August. Investigators can find accommodation at any time during the summer. The usual courses are offered in field zoology by Drs. Walter, Kornhauser and Parshley, in comparative anatomy by Dr. Pratt, systematic and field botany by Drs. Harshberger and Stiteler and beginning advanced work under the direction of the various instructors. The Eugenics Record Office, Carnegie Institution of Washington, takes advantage of the arrangements for boarding students at Cold Spring Harbor to give its training course for field workers in eugenics at the same time with the session of the Biological Laboratory (Drs. Davenport and Laughlin.) The announcement for 1920 can be secured by addressing the Biological Laboratory, Cold Spring Harbor, L. I.

DURING the period of the Christmas meetings of the American Association for the Advancement of Science, an anthropological society was organized in St. Louis, largely under the stimulation of Dr. Aleš Hrdlička who visited the city at that time. The object of the society as stated in the constitution is the promotion of research in all branches of anthropology. The officers are: *president*, Professor R. J. Terry; *vice-president*, Dr. H. M. Whelpley; *secretary-treasurer*, Dr. C. H. Danforth, *councilors*, Drs. W. W. Graves, Albert Kuntz, R. Walter Mills, Sherwood Moore, Daniel M. Schoemaker and Mr. J. Max Wulfing. Two regular meeting have been held. At the first Dr. R. Walter Mills presented a paper on "Variation in Physicial Type and Visceral Function," and at the second Dr. H. M. Whelpley spoke on "Notched Indian Hoes, The Most Specialized of Indian Agricultural Implements."

UNIVERSITY AND EDUCATIONAL NEWS

THE Medical College of the state of South Carolina has received an appropriation of

$71,000 from the state for maintenance, as compared with $49,500 last year. An additional appropriation of $60,000 was made for a physiology building and equipment.

The proposal to admit women to be fellows of the Royal College of Surgeons of Edinburgh after examination, on the same conditions and with the same privileges as men, has been accepted.

Dr. H. Monmouth Smith, who is at present assistant director of the Carnegie Nutrition Laboratory in Boston, and who was formerly connected with Syracuse University, has been appointed a professor of inorganic chemistry at the Massachusetts Institute of Technology.

Professor Frank C. Whitmore, of the University of Minnesota, has succeeded Professor Harry A. Curtis as professor of organic chemistry in Northwestern University, Evanston, Ill.

Mr. J. D. Black has been appointed professor and chief of the division of agricultural economics at the University of Minnesota, in the place of W. W. Cumberland, whose leave of absence for service in Turkey as financial and economic adviser to the commission to negotiate peace between the Allies and Turkey has been continued for another year.

Mr. A. Amos, of Downing College, has been appointed lecturer in agriculture in Cambridge University.

Dr. Hugo Fuchs, professor of anatomy at the University of Königsberg, has been transferred to the University of Göttingen, succeeding Professor Merkel.

DISCUSSION AND CORRESPONDENCE

THE ATTAINMENT OF HIGH LEVELS IN THE ATMOSPHERE

In the March 19, 1920, issue of Science appeared an article by Alexander McAdie, entitled "The Attainment of High Levels in the Atmosphere." As certain incorrect statements which are detrimental to the Curtiss Aeroplane & Motor Corporation appeared therein the following correction is made. No criticism of Professor McAdie is intended, nor any desire on his part to misstate a fact is in any sense suspected.

Unauthorized statements are made in the press, the results of which are far reaching. One of these is the innocent acceptance of them by Professor McAdie as being correct and the corresponding reappearance of the incorrect values in the above mentioned article.

On September 18, 1919, Roland Rohlfs, the test pilot of the Curtiss Engineering Corporation, made an altitude flight, obeying in every particular the official rules laid down for such contests. It should be stated here that the compliance with these rules is a serious handicap and in justice the same conditions should be observed by all competitors.

The flight was made in a Curtiss triplane fitted with a K-12 motor without supercharger and without the use of special fuel. The result obtained from the barograph chart by the Bureau of Standards after all corrections for instrumental errors had been made was 34,910 feet, this value being, however, uncorrected for the average temperature of the air column. The instrumental corrections to the barograph readings were determined by subjecting the instrument to the same variations of pressure and temperature in the laboratory as those encountered during the actual flight.

The value of 34,910 feet, although uncorrected for air temperatures was homologated, this being strictly according to the 1919 rules and was of interest for comparison with the French altitude flight of Jean Casale made June 14, 1919, which was calculated by the same method.

It is well known that this way of expressing results, that is, without air temperature corrections, is not only unsatisfactory and unfair but also scientifically incorrect and the Curtiss Company has always admitted that the true (tape line) altitude reached by Rohlfs became 32,450 feet when the air temperature correction, also made by the Bureau of Standards, was applied. There is thus a large but proper reduction in the indicated altitude. This correction is the larger the colder the air encountered in the flight.

It may be noted here that the undersigned was at least partially instrumental in awakening interest in the unsatisfactory official rules, the result being that both the Bureau of Standards and the homologating body sent representatives to Europe with a view of putting the rules on a fairer and more scientific basis.

The outcome is that the rules are greatly improved but are still open to proper criticism and objection. It is necessary, however, for all either to accept the rulings of the official body or, if they are to be ignored, for all to work on the same unbiased scientific basis and abide by the decisions of an authoritative and independent scientific laboratory such, for example, as the Bureau of Standards at Washington.

In order to bring out clearly an important point in this matter, that is, the importance of the air temperature correction, assume that two identical perfect barographs with no instrumental errors are taken up, one in the summer time and the other in winter, to such an altitude that both read say 8 inches of mercury as the minimum pressure. Assume also that the average temperature of the air is in the first case —10° C. and in the second —30° C. which values correspond closely to actual observed figures.

The true altitudes corresponding to this pressure are in the first case 33,475 feet and in the second 30,929 feet, although the altitude uncorrected for air temperature is the same for both, *i. e.*, 36,020 feet. These figures are obtained from Circular No. 3 of the Aeronautic Instruments Division of the Bureau of Standards and are within ½ per cent of the true values. The correction for the first case is —2,545 feet and is twice as much for the second, or 5,091 feet. The value 36,020 feet assumes that the air is at a uniform temperature of —10° C throughout. As stated above Rohlfs' record reduced in this manner by the Bureau of Standards gave a true altitude of 32,450 feet.

We now quote from the Air Service News Letter No. 11, issued by the Information Group, Air Service, of March 9, 1920.

The purpose of this letter is to keep the personnel of the Air Service both in Washington and in the field informed as to the activities of the Air Service in general and for release to the public press. At an indicated altitude of 36,000 feet . . ., the temperature at his greatest altitude was 67 degrees below zero F. . . . The preliminary calibration of the barograph indicates that the airplane reached a pressure of eight inches of mercury which corresponds approximately to 36,000 feet on the Bureau of Standards altitude chart.

In commenting on this letter we note that it does not claim that a record was obtained. We ask then by whose authority a record is granted and published as such. We note also that approximately 36,000 feet corresponds almost exactly to the stated minimum pressure of eight inches of mercury, which shows that this value has not been corrected for air column temperature. The ground temperature is not stated but the Weather Bureau kindly furnished us with the values, max. + 18° F., min. + 13° F. for Dayton, Ohio, February 26, 1920. Using the most favorable value, *i. e.*, + 18° F., for the McCook Field flight, the average is —31.4° C., which gives a correction, using the Bureau of Standards tables of —5,269 feet and hence the true altitude is not 36,020 feet (as published) but is 30,751 feet.

This altitude does not reach that of Rohlfs by 1,700 feet, figured on the same basis, and as according to the rules for beating a record it should surpass it by 328 feet (100 meters) it lacks 2,027 feet to beat Rohlfs' record.

It is not surprising then that the Curtiss Company wished to protest the validity of this new record. The premature announcement in the press that Major Schroeder has beaten all altitude records with a flight to 36,020 feet, beating the previous one held by Rohlfs, is neither justified by the figures, nor authorized by the Army bulletin nor fair to the Curtiss Company's machine and motor nor just to its pilot, Mr. Rohlfs. Slightly modified results were given personally to the writer at a meeting which he had with Major Schroeder, showing an uncorrected altitude of 36,118 feet and a true altitude of 30,835 feet.

The Curtiss Company will be among the first to acknowledge a properly authenticated record beating the one it now holds and in a true competitive spirit and for the benefit of aviation attempt to better it at the first opportunity.

J. G. Coffin,
Director of Aeronautical Research
Curtiss Aeronautical & Motor Corporation,
Garden City, L. I., N. Y.

CONCERNING BALLISTICS

To the Editor of Science: For sufficient reasons I was unable to attend the meeting of the American Association, and so was not so fortunate as to hear Major Hull's very valuable and interesting address on ballistics, nor Professor Ames's extremely scholarly and clear address on Einstein's theory. However I have read Professor Hull's address in Science with great pleasure. In it he is good enough to speak of my pressure gauge for guns, but says that its use appears to be limited to the cases of guns that can be rigidly clamped during the explosion. I hope to demonstrate shortly that there is no such limitation. Over a year ago I was offered the use of a six-inch gun at Aberdeen to put my gauge on, and Admiral Earle has at last taken an interest in my results and has manifested a willingness to assist me. The coming of the armistice, however, removed so much money and personnel from Aberdeen that nothing came of it.

I should have been pleased if Major Hull could have seen fit to call attention to the fact that I was the first person to publish trajectories of "la grosse Berthi" that bombarded Paris two years ago. The bombardment began on March 23, 1918. The next week I began to deliver lectures on exterior ballistics, and in a few days we had a number of trajectories calculated. In four weeks from that date I read a paper at the meeting of the American Philosophical Society in Philadelphia, at which I showed a number of trajectories. I used the height function for the density as given in Major Hull's address, and at that time it had never been used by either the United States Army or Navy. I showed my results to Major Moulton, who was just beginning his distinguished service in the army, and he showed much interest. Later he advised me not to publish them, as such calculations were now "a matter of routine."

I reminded him that although they may be such now, they were not when I read the paper. I have also seen in French journals pictures with articles apparently written by experts which would lead one to believe that there are discontinuities in the atmosphere, or that it stopped suddenly a few miles up. In a recent letter from M. Henri Le Chatelier, regarding my paper, he says that the French had made guns with an initial velocity of 1,200 meters per second, but had not thought of using them for high fire, as they were intended for penetration of ships armor. We also constructed curves showing the decrease of density upon both the isothermal and adiabatic hypotheses, neglecting and taking account of the variation in gravity, as given in my book on Dynamics, and also the observed values as kindly furnished me by Professor Humphreys. Unfortunately I was requested to keep the number of figures down, and these were not printed. I should be glad to send the paper to any one interested. The gauge paper is unfortunately exhausted. I may say that M. Sugot, the chief engineer of the Commission de Gâvre, told me last summer that ballisticians had been waiting fifty years for my instrument, and that the publication of my curves had rendered useless all the theoretical work of ballisticians on interior ballistics. Of course that is not so, but I hope next month to show how this gauge answers all questions that can be asked on the subject. I think I was the first professor to give lectures on ballistics, both interior and exterior, at an American university.

My ballistic institute is having hard sledding. At first encouraged by a vote of the Naval Consulting Board, turned down by the Honorable the Secretary of the Navy (without a word of regret), financed by a great arms company for awhile, helped by the Bache and Rumford Funds, it looks as if it would have to be given up for lack of money. When we began I had one assistant, one machinist and three students, who all went to work vigorously. Last year I hired several assistants, and when I returned from France I had to put my hand in my pocket. That is I borrowed money at six per cent. This method of high finance may do for high trajectories, but it can not continue forever. I hear much of the National Research Council, but I do not see any money. I am an elderly man, and have experienced three disillusionments connected with the names of great millionaires. "Timeo Danaos et dona ferentes"—I fear organizations even when they offer me money—much more when they don't! Last year I gave a paper at the American Philosophical Society on the work of our ballistic institute, but I have never had the time to have it published.

I did not get to the front in the war—not till last summer. I had no uniform, and few helpers. So I got no glory, but some debts. A propos of Professor Wilson's letter about the University of Strasbourg, I should like to say that I visited it last year, and was shown all over it, and that the French are making it first class. Professor Pierre Weiss is going to have the best facilities in the world for the study of magnetism. I made about two hundred and fifty lantern slides of the places visited by our mission, and have been giving lectures on it ever since. Strasbourg figures largely in them.

Arthur Gordon Webster

SCIENTIFIC BOOKS

KNOWLTON'S CATALOGUE OF FOSSIL PLANTS[1]

In 1898 Dr. Knowlton published "A Catalogue of the Cretaceous and Tertiary Plants of North America." We now have from the same pen a work with the very similar title of "A Catalogue of the Mesozoic and Cenozoic Plants of North America." This is a far more comprehensive work than the former, or than its title indicates. To say that it about doubles the number of known species is but a slight indication of the way in which it mirrors the progress that paleobotany has made in America in the past twenty years, for while very many significant new forms are added, many others that existed in name only have disappeared from the literature. Botanical determinations in many cases have been placed on a firmer footing during the interval and geological occurrences are now given with much greater precision, in fact, in so far as the progress of stratigraphic and areal geology is concerned with plant-bearing units, the present work may be said to show the progress made in stratigraphy during the past two decades.

Only those who know the drudgery of such compilations can appreciate the vast labor that has gone into the making of this book. The author has been one of the most influential factors in the progress of paleobotany in this country during the present generation and that he should have found the time to place this epitome of its present status before the public is a cause for sincere congratulation, not alone to him but to all who may have occasion to refer to the work. Fellow geologists will probably not need to have its merits or usefulness called to their attention, but botanists are not so likely to scan the lists of publications of the U. S. Geological Survey.

There is a stratigraphic table, a bibliography, followed by the body of the catalogue arranged alphabetically. In this part references are given to the original description of each genus, type species are indicated and under each species the synonymy, principal citations and geological and geographical distribution are given. Following the body of the catalogue, the included genera are given in their biological arrangement. This is followed by floral lists for each of the North American Mesozoic and Cenozoic plant bearing formations—a most useful feature of wide interest.

Edward W. Berry

[1] Bulletin U. S. Geological Survey, No. 696, 815 pp., 1919 (1920).

NOTES ON METEOROLOGY

THE WEST INDIAN HURRICANE OF SEPTEMBER, 1919

This hurricane, which seems to have been the largest that has occurred in the Gulf of Mexico since the U. S. Weather service was established, has been the subject of much study. A rather full account of the storm and its effects is given in the *Monthly Weather Review* by Dr. H. C. Frankenfield, and others in the regions affected.[6] Appearing in the Bahamas on September 6, the hurricane passed through Florida Straits on the 9th, 10th, was lost in the Gulf of Mexico from the 11th to 13th, went ashore on the south Texas coast on the 14th and broke up in the southern Rockies. A surviving portion may have formed the germ for the cyclone with heavy rains[7] which passed from northern New Mexico to the Great Lakes from the 17th to 19th.

Although people in Key West had ample warning, and did everything possible to protect shipping and buildings, the losses sustained were estimated at $2,000,000. The Weather Bureau official in charge, Mr. H. B. Boyer says:

> Hurricane warnings were immediately displayed [on receipt of telegram from Washington at 1:05 P.M. September 8] and the information disseminated by every available means. The response to this warning was immediate and there followed a period of great activity, especially as regards shipping. Vessels were moved to safer anchorage or better secured, and all weak places in residences and buildings of all descriptions were strengthened as much as possible by nailing and battening doors, windows, roof hatches, etc. In the terrific gusts that prevailed during the height of the storm stanch brick structures had walls blown out and large vessels, firmly secured, were torn from their fastenings or moorings and blown on the banks. . . . Winds of gale force and over lasted continuously from about 7 A.M. on the 9th to about 9:30 P.M. the 10th.

The center of the storm passed about 30 or 40 miles south of Key West. The rainfall was estimated at over 13 inches. The Weather Bureau stationed at Sand Key, several miles nearer the path of the center was all but washed away, the island, and all outstanding and superstructures having been carried away or blown down by waves or winds. As the center passed over the Dry Tortugas the pressure fell to 27.36 inches[8] (as observed on the tank steamer *Fred W. Weller*), and the wind about the center was estimated at 125 mi./hr.

> With one or two unimportant exceptions no reports were received from the Gulf of Mexico after the morning of the 10th until after the storm had passed into Texas, which was during the day of the 14th. It was, therefore, absolutely impossible to forecast the intensity and progress of the storm, and the coast stations far from the center of the storm afforded but meager information. (Forecaster.)

As one newspaper put it, "The Weather Bureau suffered from its own efficiency," by holding vessels in port. Of the 10 vessels reported lost or missing, one with 488 people, and the other 25 reported damaged,[9] none had left port in spite of warnings, which were issued at Florida ports September 8 and other Gulf ports September 10. Later, such few logs as were received from vessels caught in the Gulf by the storm indicate that for a time the hurricane was curving toward the Louisiana coast, as surmised by the forecaster, and that it then renewed its course westward, apparently because of a rise in atmospheric pressure in its path, due to the approach of a high pressure area.

Although strong winds and a flood tide occurred at Galveston, Weather Bureau warnings saved three million bushels of grain and many cattle. The damage at Galveston was estimated at $60,000, and that in the vicinity at about $200,000 more.

At Corpus Christi and vicinity the weather on the 13th, the day before the storm was op-

6 September, 1919, Vol. 47, pp. 664–673, 639–641, 6 figs., 11 charts.

7 Very heavy downpours locally on the valley of the Solomon River in Kansas, September 17 and 18, caused a sharp rise in that river to 33.6 feet at Beloit—15 feet above flood-stage on the 20th. *Ibid.*, p. 674.

8 Some other very low barometer readings in other tropical cyclones have been: 27.06 in., Habana, Cuba, October 11, 1846; 26.85 in., Morne Rouge, Martinique, August 18 or 19, 1891; 24.76 in., Vohemare, Madagascar, February 3, 1899; and 26.16 in., S.S. *Arethusa*, lat. 13° 35′ N., long. 134° 30′ E., December 16, 1900.

9 *N. Y. Maritime Register*, September and October issues.

pressive in spite of a steady north wind and unusual, close-sticking swarms of flies were bothersome. On the Gulf coast the hurricane tide began to rise about noon on the 13th and the sea became very choppy. During the late afternoon a dark line widening into a band in the eastern sky was to be seen slowly rising. The story of 284 lives lost and $20,000,000 property damage at Corpus Christi and vicinity, as reported soon after the storm does not need to be repeated here. The extremely high tide, "15 feet," covered the low ground and allowed the great waves to demolish 900 houses, and numerous substantial commercial establishments.

A map shows that the heaviest rainfall, September 14–17, in Texas was 12 inches, and in New Mexico, nearly 10 inches. More seems to have fallen in the mountains of northern Mexico, for a great flood rise suddenly on the Rio Grande, at Eagle Pass the rise being 27.2 feet in the 24 hours ending at 7 A.M., the 17th. For about 100 miles above the mouth of the river it is said to have widened to 40 or 50 miles. In connection with the hurricane at least two tornadoes occurred—one at Goulds, Florida, and the other near Hobbs, in southeastern New Mexico.

Mr. R. H. Weightman made a study of the wind conditions over the United States, Central America and the West Indies preceding and during the hurricane, using cloud observations, pilot balloon and kite data for the winds aloft. There was a deep (6 km. or more) circulation of easterly or northeasterly winds throughout the southern states as the center of the cyclone approached and passed several hundred miles to the south.[10]

Charles F. Brooks

Washington, D. C.

SPECIAL ARTICLES

TECHNIQUE OF OPERATING ON CHICK EMBRYOS

During the past five years, a number of workers in the department of anatomy at the University of Missouri have studied problems which involved operations on chick embryos. Since, for many of these studies, it was necessary that the chicks should continue to live and develop to a late stage of embryonic life or to the time of hatching, it was most desirable to develop a satisfactory technique. This has apparently been accomplished and it therefore seems worth while to record these methods briefly for the benefit of other workers in experimental embryology.

Operations are carried out under the binocular microscope, enclosed in a warm box, heated by electric light bulbs. Light is furnished by a desk arc light. A flask containing dilute copper sulphate serves to concentrate, cool, and properly color the light.

The egg is taken from the incubator and candled. By this means the location of the embryo and the extent of the air chamber may be seen and these are marked with pencil on the egg shell. The egg is then placed in a dish containing water, warmed to 38°–40° C., and deep enough so that the air chamber is completely immersed. The egg may be held in place in the water by tucking gauze around it. Mr. E. C. Albritton has devised a simple and ingenious wire frame for this purpose which fits over the edge of the dish, with an inner suspended portion into which the egg fits, the egg being held in the desired position by rubber bands. He also devised a simple steam-heating apparatus for keeping the water warm which obviated the necessity of using a warm box.

The portion of the egg containing the embryo, which is exposed to the air, is swabbed with alcohol and allowed to dry. A small opening is then made in the egg shell by means of a needle or sharp pointed knife. The shell fragments are picked away with forceps, care being taken not to tear the shell membrane beneath. An opening 7 mm. in diameter is sufficiently large for most operations. A drop or two of sterile Ringer's solution is then dropped in the opening, after which the shell membrane may be stripped off with ease.

[10] *Monthly Weather Rev.*, October, 1919, Vol. 47, pp. 717–720, 11 figs.

Simple aseptic precautions are observed for all operations. The forceps, knives, needles, etc., for opening the shell are flamed before using. The more delicate instruments used for the operations proper are simply dipped in alcohol and allowed to dry. The Ringer's solution and other fluids introduced into the shell are boiled for a few minutes and allowed to cool to 38° C.

When the stage of operation is one in which the amnion already surrounds the embryo, the sac may be cut open and, after the desired operation has been performed, it can be "sutured" by pinching the edges together, and will heal rapidly and completely.

Various methods were tried for removing portions of the embryo and the details of these operations can not be given here as they were modified for each particular set of experiments. The electric cautery was tried and abandoned because of the difficulty of localizing the burn when the embryo is surrounded by fluid. The method of cutting and dissecting was the one most frequently employed. For dissecting away somites, spinal cord, etc., steel needles ground down to fine points were used. For removing a more prominent portion, such as the heart, the tail, or a limb bud, iridectomy scissors proved to be the most useful instrument. In removing a blood vessel it was found advisable to inject a small amount of Berlin blue, previously boiled, directly into the vessel. This material clumps on contact with the blood, stopping the circulation and effectively plugging the vessel and at the same time outlining the vessel wall. The vessel can then be dissected away rapidly, without causing hemorrhage.

Mr. E. C. Albritton made use of electrolysis for an extensive series of operations using a needle and a pair of forceps connected by wire to the two poles of a weak dry battery. The needle is placed on the region to be removed, and the forceps a short distance away, in the fluid surrounding the embryo.

After the operation a small window of thin mica is flamed and placed over the opening and sealed down with heated Gerlach's mixture (beeswax 2 parts, lump resin 3 parts). The egg is then returned to the incubator. The egg is turned so as to keep the window at the side or below in order to prevent sticking of the embryo to the jagged edges of the shell. A ring of filter paper placed over the exposed wax prevents its sticking to the floor of the incubator. It is well to rotate the egg slightly several times during the first few hours after its return to the incubator. This may be done automatically by a cradle rocked by an attachment to an ordinary alarm clock. If this is done the yolk remains freely movable and the embryo can be brought around under the window, when desired, for observation.

The method of keeping the air chamber immersed in water at incubator temperature during the operation has only recently been adopted and it has greatly reduced the mortality of chicks operated on at the age of forty-eight hours and over. Formerly, when the shell was opened, without this precaution, the yolk always sagged away from the opening and before the operation could proceed it became necessary to add Ringer's solution, drop by drop, in order to bring the embryo back to the level of the opening. This usually consumed more time than the operation proper. On opening such an egg immediately after the operation it is found that the air chamber has been completely obliterated. Evidently, this sagging away of the yolk from the opening is caused by the gradual forcing out of air from the air chamber. When such an egg with the air chamber obliterated and filled with Ringer's solution is returned to the incubator it forms an inelastic chamber with no room for expansion of the contents. Any slight increase in temperature, in such an egg, would seem to be sufficient, as a result of the increased pressure, to cause embarassment to the heart beat, in embryos in which the circulation has started. Whether this is the correct explanation or not, many chicks died, when this method was used, within a few hours after their return to the incubator.

However, in the embryos in which the air chamber is immersed during the operation, almost no sinking of the yolk takes place upon opening the shell, and, on candling such eggs after sealing, it is found that the size of the air chamber remains unchanged. With the old method we frequently had a mortality of 50 per cent or higher in the first twenty-four hours. With the new method the deaths during the first twenty-four hours are reduced almost to zero.

Embryos may die three to five days after the operation and for these later deaths we have not yet found the cause or causes.

Eliot R. Clark

University of Missouri

THE AMERICAN CHEMICAL SOCIETY. VIII

The composition of okra seed oil: George S. Jamieson and Walter F. Baughman. (By title.) Several lots of the seed of the okra (*Abelmoschus esculentus*) were received at various times from E. A. McIlhenny of Avery Island, Louisiana. The seed were found to contain about 15 per cent. of oil. The oil expressed from the seeds by means of the expeller had a greenish yellow color. The results of the analysis of the four expressed okra seed oils are given in the following table:

Sample No.	1	2	3	4
Iodine No. (Hanus)	93.2	100.3	95.5	95.2
Saponification value..........	195.5	195.6	195.6	195.2
Polenske No......				0.23
Reichert Meissl No............				0.26
Acetyl value	23.9	16.2	11.5	21.4
Acid value.......		0.66	0.34	1.42
Specific gravity at 25° C..........	0.9187	0.9182	0.9160	0.9172
Refractive index at 25° C..........	1.4692	1.4693	1.4695	1.4702
Unsaponifiable matter, per cent.				0.37
Soluble acids.....		0.12	0.09	0.14
Insoluble acids, per cent........		95.90	96.27	96.20
Unsaturated acids, per cent........				67.33
Saturated acids, per cent........				29.22
Titer insoluble acids..........				38.5° C.

From the data obtained by a separation of the various fatty acids the percentages of the acid glycerides in the oil were calculated. The composition of the okra seed oil was found to be as follows:

		Per Cent.
Glycerides of	Palmitic acid	27.23
	Stearic acid	2.75
	Arachidic acid	0.05
	Oleic acid	43.74
	Linolic acid	26.62
	Unsaponifiable matter.	.37

The composition of the oil from the seed of the Hubbard squash: Walter F. Baughman and George S. Jamieson. (By title.) The oil for this investigation was expressed from the seed of the Hubbard squash (*Curcurbita maxima*) by means of the expeller. A portion of the oil was refined by the well-known alkali process and bleached with fuller's earth. The crude oil had a brownish red color and the refined portion had a yellow color. Both crude and refined oils had a bland fatty taste. The following are the chemical and physical characteristics:

Specific gravity at 25°	.9179
Refractive index at 25°	1.4714
Iodine number (Hanus)	121.0
Saponification value	191.5
Reichert Meissl no.	0.37
Polenske no	0.39
Acetyl value	27.8
Acid value	0.5
Unsaponifiable matter	1.06
Soluble acids %	0.33
Insoluble acids %	94.66
(Solid) saturated acids %	18.37
(Liquid) unsaturated acids %..	76.45
Titer (insoluble acids)	29.8° C.

The composition of Hubbard squash seed oil was found to be as follows:

		Per Cent.
Glycerides of	Palmitic acid	12.73
	Stearic acid	6.12
	Arachidic acid	0.04
	Oleic acid	36.58
	Linolic acid	43.34
	Unsaponifiable matter.	1.06

Notes on the composition of the sorghum plant: J. J. Willaman, R. M. West, D. O. Spriestersbach and G. E. Holm. (By title.) The juice of sorghum cane contains a high percentage of nonprotein nitrogen compounds which give much trouble in the defecation of the juice for sirup. l-leucin, d-l-asparagin, glutamin and aspartic acid have been identified. The acids found in the juice are aconitic, citric, oxalic, tartaric and malic. The hexoses decrease, and sucrose increases, as maturity approaches. In northern-grown cane the sucrose-hexose ratio is considerably lower than in southern-grown cane, and the total sugars are also much less. During the pre-maturation period the sorghum plant lays down a protein-cellulose framework, which is filled in with carbohydrate during the final maturation period. This carbohydrate is starch in the case of the seed head, and sucrose in the stalk. The removal of the seed heads prior to maturity hastens the production of sucrose in the stalk, but does not affect the total amount formed.

The physiology of germinating Juniperus seeds: D. A. Pack. (By title.) The *Juniperus* seed fails to germinate when put under ordinary germinating conditions. The changes, that prepare this seed for germination, are brought about by storing at 5° C. These changes are characterized as follows: an early and complete imbibition of water; a slow increase of the H^+ concentration and total acid; evident changes in the stored food material; very slight increase of the respiration and oxidase activity; slow enlargement of the embryo with the development of internal stress; steady decrease in the viscosity of the seed coat; marked increase in catalase activity; and an increase in the vitality of the seed. A good percentage of germination follows at once upon the completion of these changes.

The biochemist on the hospital staff: Frederick S. Hammett. The paper pointed out the advantage which would accrue to medicine if the hospital biochemist were regarded as a coordinate member of the hospital staff, a specialist in a special field, rather than as a mere technician who makes routine analyses.

A spectrographic study of certain biochemical color reactions: G. L. Wendt and T. Tadokoro. (By title.)

Studies of wheat flour grades. I. Electrical conductivity of water extracts: C. H. Bailey and F. A. Collatz. (By title.) The studies previously reported by one of us (Science, Vol. 47, pp. 645–647) were continued, and it was found that time and temperature of extraction affected the electrical conductivity of water extracts of wheat flour. The conductivity increased with the period of extraction, the proportional increase being greater when the extraction was conducted at lower temperatures, and also with the lower grades of flour. The relative conductivity increased as the temperature of extraction was raised above 0° until 60° was approached, when it began to diminish. A standard procedure was adopted for comparing a number of flours containing from 0.40 per cent. to 2.38 per cent. of ash. The flour: water (1: 10) mixture was held at 25° for exactly 30 minutes, centrifuged, and the conductivity of the clear liquid determined by means of a dipping electrode constructed for the purpose. When examined in this manner a remarkably close parallelism was observed between the conductivity and the ash content.

Studies of wheat flour grades. II. Buffer values of water extracts: C. H. Bailey and Anna Peterson. (By title.) The hydrogen-ion concentration of water extracts of various grades of wheat flour varies between rather narrow limits. Flours with an ash content of 0.45 per cent. yielded an extract (prepared by extracting a 1: 5 mixture for 60 minutes at 25°) of Ph = 6.1, while the extracts of flours containing from 1.2 per cent. to 1.6 per cent. of ash had a Ph = about 6.4. The buffer values of the extracts of these flours varied greatly, however. Thus the addition of 10 c.c. of N/50 NaOH increased the Ph of patent flour extracts 3.3 (*i. e.*, to about 9.4) while the extract of lower grades was increased in some instances only 0.6 to .9 in terms of Ph. The increase in Ph is thus inversely proportional to the ash content, and the ratios are quite exact. The buffer value of extracts uniformly prepared is indicative of the grade of sound flours milled from normal wheat.

The preparation of certain monocarboxylic acids from sugars: I. K. Phelps and W. T. McGeorge.

Charles L. Parsons,
Secretary

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CONTENTS

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SEXUALITY IN MUCORS[1]

The keywords of the vice-president's address and the symposium which followed it last year were *Organization, Coordination* and *Cooperation* in botanical research. It is not my purpose at this time to discuss these topics further. A botanical committee of the National Research Council has been selected for this purpose. A second committee was chosen by the Botanical Society of America two years ago to help the first committee and last year a third committee was appointed to help the other two. The organization seems sufficiently complete unless I might suggest as a humble member of this last-named committee that a new committee be formed at this session to help us also in our deliberations which have not as yet taken place.

One of last year's speakers, in distinguishing types of true research worth while from investigations unworthy of the name, held up to ridicule a hypothetical investigation of a ham sandwich and the pseudo-scientist who would attempt a monographic treatment of such a subject. In defence of the maligned sandwich, a correspondent has offered the following lines:

> Sandwich perched by the lunchroom wall,
> I lift you down from the perches.
> Hold you here, ham and all, in my hand.
> Little sandwich! But if I could understand
> What you are, ham and all, and all in all,
> I should know what true research is.

It is not of so broad a subject as the sandwich in its entirety, neither of the ham nor of the bread between which it nestles that I wish to speak. Rather it is the mold that sometimes grows on the bread that encircles the ham, or more especially the less commonly

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, St. Louis, December 30, 1919.

observed sexual reproduction of the bread mold and its relatives that I have chosen as my theme.

It will not be possible in the time available to enter into any detailed discussion of many questions that might suggest themselves in this connection. I shall instead give an outline merely of some of the investigations of the last fifteen years, both published and unpublished and shall attempt to show that the sexual relations of the mucors may have possible bearings upon our conceptions of sexuality in other diverse groups of the biological world.

The chart (9, Tafel VI.)[2] shows the typical vegetative condition of a mucor. A vegetative spore, usually multinucleate though sometimes uninucleate, sends out in germination a branching tube which forms the mycelium and rapidly covers the available substratum. This mycelium is multinucleate and, in the early stages at least, without cross walls—forming thus an enormous, much-branched, single cell—if a cell is defined in terms of the limiting cell walls. Multiplication is brought about chiefly by various types of nonsexual spores. The commonest are endogenous spores produced in sporangia, upwards of 70,000 individual spores being formed in a single sporangium. They may be apparently exogenous, formed singly or in chains on terminal swellings of fertile filaments and may be produced as chlamydospores by septation of the vegetative filaments. More than a single type of nonsexual multiplication may occur in a given species.

As regards their sexual reproduction, there are two groups of species. In the first group, represented by *Sporodinia,* a form common on fleshy fungi, the sexual spores known as zygospores are common and may be obtained from the sowing of a single vegetative spore. Such forms are therefore hermaphroditic or homothallic since their thalli or mycelia are alike sexually. In the second group, represented by *Rhizopus,* the bread mold, the zygospores are rarely observed and can never be obtained in pure cultures from the sowing of a single spore. In these diecious or heterothallic forms there are needed two plants of opposite sex growing in contact in order that sexual reproduction may take place. The two sexual groups mentioned are represented in the adjoining diagram (Fig. 4). Since in the three lower figures the two gametes (which later unite to form the mature zygospore) arise from branches of a single filament, these three forms are hermaphroditic. In the upper figure the gametes are represented arising from sexually different plants designated by the signs plus and minus which will be explained later. These therefore belong to the diecious group. The line of zygospores, which results when the opposite sexes of the diecious species *Mucor Mucedo* are grown in contact, is shown in the chart. The swollen heads produced on erect filaments from the plant on the right of the line are sporangia containing numerous nonsexual spores by which the plant may be propagated as distinct sexual races in much the same manner in which races of potatoes may be propagated by non-sexual tubers. The process of conjugation may be followed from the figures in the chart (9, Tafel VII.). Filaments of opposite sexual tendencies grow together and by the stimulus of contact produce swellings which push them apart. These swellings develop into the *progametes* from which by cross walls the sex cells, or gametes, are cut off. The dissolution of the intervening cross wall allows a fusion of the gametes and the zygote thus formed increases in size and becomes the mature zygospore. The gametes are typically equal in size in the diecious group and also in the hermaphroditic group except for certain forms to be discussed later. They are miltinucleate and hence have been called cœnogametes.

In the first lantern slide (1, Pl. IV.), we can see photographs of Petri dish cultures of certain of the mucors experimented with. The opposite sexes of the diecious species have been termed plus and minus for reasons

[2] Citations in parentheses throughout the text refer to the sources for the charts and lantern slides used in the original presentation of this paper.

to be explained shortly. By inoculating plus and minus spores in appropriate spots in the culture dish definite patterns may be obtained by the lines of zygospores formed where the opposite sexes meet as shown in Figs. 52–55.

IMPERFECT HYBRIDIZATION

It was soon established that in any given diecious species there are only two sexes present but at first there was no assurance that the two sexes of a given species were the same as those of any other. It has been discovered, however, that the opposite sexes of different species are capable of showing an imperfect sexual reaction when grown in contact. The photograph on the screen (Fig. 1,

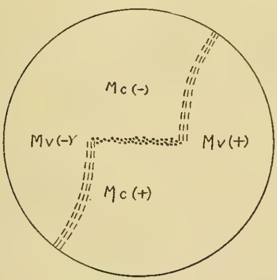

Fig. 1. Diagram of Petri dish culture showing zygospores (dots) between the (+) and (—) races of the same species, *Mucor* C and lines of "imperfect hybridization" (dashes) at contact between opposite sexes of different species, *Mucor* C and *Mucor* V.

which is taken from photograph in 7) represents a culture of the sexual races of two different species *Mucor* V and *Mucor* C. Where the two sexes of *Mucor* C meet a line of zygospores is evident as might be expected. The sexual race of *Mucor* V on the right shows a reaction only with *Mucor* C minus as indicated by the white line where the two meet and must be considered the opposite sex from *Mucor* C minus, or plus. In like manner the other sex of *Mucor* V on the left shows a reaction only with the plus race of *Mucor* C and must therefore be considered minus. A microscopic investigation of the appearance of the white lines of sexual reactions shows the condition represented in Figs. 36–39 (1). The stimulus of contact leads to the formation of progametes. Sometimes the gamete is formed by one and more rarely by both the reacting filaments. In one strong reacter the gamete which is formed in this reaction transforms itself frequently into a thick-walled a-zygospore. The stimulus which leads to a dissolving away of the wall between the two gametes and their consequent fusion is constantly lacking. Since the sexual reaction between opposite sexes of different species is incomplete it has been termed *"imperfect hybridization."*

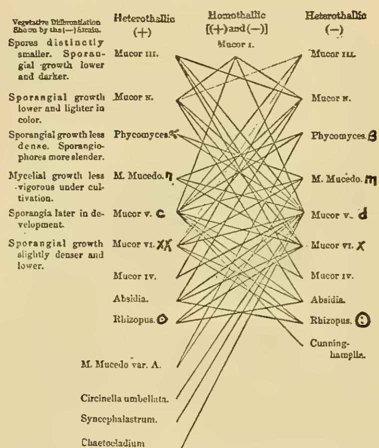

Fig. 2. "Imperfect hybridization" reactions shown by solid lines between sexual races of different species.

At first the paired races of different species were designated by letters and symbols. Lines in the diagram (Fig. 2) indicate some of the reactions that have been obtained between races of different species. All races that show a reaction with the "c" race of *Mucor* V used as a standard but not with its "d" race, are placed in the right column, while those that show a reaction with the "d" race of *Mucor* V and not with its "c" race are placed in the left column. In no case has the position of any of the races been determined by less than two positive reactions. Any race in the left column is theoretically capable of showing a reaction with any in the right column, while incapable of reacting with those in its own group and vice versa. Certain combinations, however, react with greater difficulty than others. It is obvious that in these two columns we have represented the two opposite sexes, male and female. There seemed, however, no way of determining which is to be considered male and which female since their gametes are typically equal in size.

In making the diagram, it was observed that of those species, in which there was evident a greater vegetative vigor of one sexual race over the other, the more vigorous race was always in the left-hand column. All those in the left-hand column were accordingly called plus and those in the other column minus despite the fact that in many species no vegetative difference between the sexes could be established. The most striking example of a difference in vegetative vigor is that of *Mucor* III shown in Fig 58 (1). In a considerable number of races in several different species, however, I have found that the plus race is not invariably more vigorous than the minus when a difference in vegetative vigor is observed, judging vigor by former criteria; but this fact does not detract in the least from the evidence that in the plus and minus races we have the two sexes represented.

The "imperfect hybridization" reaction is of convenience in determining the sex of unmated races. Thus when the diagram (Fig. 2) was made, a race of *Circinella umbellata* obtained from a curbstone in the shadow of Harvard University, by reacting with *Mucor* V plus and failing to react with *Mucor* V minus, was found to be a minus race and is so listed in the diagram. Later a race was obtained from a substratum sent by a missionary from China and was discovered to be its plus mate. It was a relatively easy matter then to obtain the zygospores by uniting these opposite races under suitable nutrient and temperature conditions. The last species in the minus column was found in 1903 in a culture of rat's whiskers gathered on an island in the Caribbean Sea. Perhaps somewhere, under some spreading palm, from India's coral strand, its mate is waiting; and another good missionary may help in spreading the gospel of a "form new to science."

I said a moment ago that it is theoretically possible to obtain an "imperfect hybridization" reaction between the sexual race of a given species and the opposite sexual race of any other species. In practise it has not always proved easy of accomplishment. Much depends upon the environmental factors such as the kind of nutrient—more, however, upon the sexual vigor of the reacting races. A race may react with the opposite sex of another species under temperature or nutrient conditions which will not allow it to form zygospores with its normal mate in its own species. Thus *Cunninghamella echinulata* will readily give "imperfect hybridization" reactions with species of the genus *Mucor* at temperatures below 20° C. but will not itself form zygospores at so low a temperature, while some species of the genus *Mucor* are weak in reaction when contrasted *inter se*. The vigor of the reaction, therefore, has no apparent connection with the taxonomic relationships of the forms involved. Cunninghamella it may be remembered is so distantly related to the genus *Mucor* that it was originally described as a Hyphomycete and assumed to belong to a group of fungi unrelated to the mucors.

Saito and Naganishi (13) report obtaining true hybrid zygospores between different *Mucor* species. They admit, however, that the species in question are very closely related. I have found, between what I have called the opposite sexes of a single species, differences sufficiently marked to be worthy of description as distinct species according to Bainier who has been one of the mycologists most prolific in fathering *Mucor* species. I, as well as others, have observed also considerable differences between the different strains of a single sex of a given species. It is possible that these Japanese investigators have been dealing with races with differences of the order just mentioned. The matter may be a question of what is a species. Burgeff, however, in his brilliant investigations of Phycomyces (10), has obtained a striking distinct mutant which he has been able to cross successfully with the normal stock.

It seems strange that the reaction initiated in the process of "imperfect hybridization" is, usually at least, unable to carry through to completion. We can assume something fundamental, common to all the plus races of the various mucor species, that causes a response when they are brought into contact with a minus race and something in addition that must be present peculiar to the same species in order to extend the reaction to a union of gametes and their development into normal zygospores.

These fundamental characteristics of plus and minus must be present also in the hermaphroditic or homothallic species since, as indicated at the top of Fig. 2, such hermaphroditic species may show sexual reactions with plus and minus races used as testers. The reaction is often strong enough to be indicated by white lines as shown in Fig. 56 (1) where the hermaphroditic *Mucor* I is reacting with both plus and minus races of *Mucor* V.

ZYGOSPORE GERMINATION

It will be of interest to note what occurs at the germination of zygospores formed by the sexual races. A zygospore at germination produces a short germ-tube, terminated by a germ sporangium. The condition is represented diagrammatically on the screen (4). In the hermaphroditic species investigated, all the spores in the germ sporangium are hermaphroditic and give rise to hermaphroditic plants as is to be expected. In the diecious species, however, there are two types of zygospore germination. In *Mucor Mucedo* the spores in a germ sporangium are all of the same sex—plus *or* minus, never mixed. In *Phycomyces,* on the other hand, the germ sporangium may contain spores of both sexes. The germ tube may be induced to grow out vegetatively before the formation of its germ sporangium. By this means its sexual condition can be tested. The germ tube of *Mucor Mucedo* has been found to be unisexual, of the same sign as its germ sporangium. Segregation or differentiation of sex in this species, therefore, must have taken place at or before the zygospore germinates. In *Phycomyces* sexual differentiation takes place in the germ sporangium and induced growth from a germ tube gives rise to a temporarily hermaphroditic condition. Such a hermaphroditic or homothallic mycelium is shown in the photograph (2). Its yellowish felted growth is strikingly different from the normal plus and minus races which are forming a line of zygospores where they meet at the upper right-hand corner of the culture. Occasionally spores in the germ sporangium of *Phycomyces* are hermaphroditic and produce such hermaphroditic mycelia. Burgeff has ingeniously produced them by mechanically mixing the protoplasm of plus and minus vegetative filaments and has given them the name of mixochimæras. He concludes that such mixochimæras are mixtures of plus and minus nuclei. That these sexual mixochimæras are bisexual is shown by their occasional production of hermaphroditic zygospores and by the fact that the scanty sporangia which they produce again divide up into plus and minus and occasionally hermaphroditic spores. Often they show a plus or a minus tendency by forming zygospores with the normal minus or plus test races of *Phycomyces.* If propagated by cuttings of the mycelium, they eventually revert to normal plus or minus races.

The diagram (4) has been shown in order to point out certain homologies between sexual differentiation in the mucors and that in other groups of plants. The mucor plant is the gametophyte, the flowering plant the sporophyte. The germ tube with its germ sporangium we have homologized with the sporophyte and Burgeff reports in *Phycomyces* a fusion of nuclei in pairs in the zygospore and a reduction division in the germ sporangium preceeding the formation of the spores. From the diagram it will be observed that the condition in the so-called hermaphroditic lily is homologous with that in the so-called diecious *Phycomyces* or *Marchantia* in which I have found a similar differentiation of sex in sporophytic sporangia. The forms just mentioned are of the same type of sexual differentiation and yet are termed hermaphroditic or diecious according to whether the sporophyte or the gametophyte is the more conspicuous. To insure greater precision, I have suggested the terms homo- and heterothallic as applied to the gametophyte and homo- and hetero-phytic as applied to the sporophyte. If in further discussion of the subject, I use the older terminology, it is only to avoid terms unfamiliar to the majority of my audience. The main point to be brought out is that diecious mucors are not to be homologized with diecious flowering plants and higher animals. More nearly are the sexual races of mucors to be compared with the gametes themselves of such higher plants and animals.

ENVIRONMENTAL FACTORS

Many investigators have succeeded in inhibiting the expression of one or both sexes on the gametophyte of ferns by varying the environmental factors to which they are exposed. The question arises as to the influence of environmental factors on sexuality in the mucors. Since gametes are formed only *after* the stimulus of contact between filaments with opposite sex tendencies and not independently, the question is reduced to the influence of external factors on zygospore formation and upon the sexual activity of the separate races. As a general rule, both for hermaphroditic and diecious forms it may be said that the limits within which zygospore formation is possible are narrower than those for non-sexual reproduction. Thus in *Cunninghamella echinulata,* non-sexual reproduction takes place in abundance at low and high temperatures while zygospores are formed only above 20° C. Certain other species will not form zygospores, although able to produce sporangia at a temperature as high as 26° C. Further examples of other factors than temperature might be given in support of the greater environmental requirements necessary for the sexual type of reproduction. So far as has been investigated, external factors have no influence in altering the inherent sex character in a given race, though they may change its power of showing a sexual response.

The plus and minus races of *Phycomyces* have been cultivated in separate test-tubes since 1903 and have now reached the 242d non-sexual generation of both plus and minus races. The plus and minus races of *Mucor Mucedo* have been cultivated for the same length of time. The minus race has gradually become weaker and has this year finally died out. There does not seem to have been any actual loss or change of sex in the process although the ability to respond sexually has weakened with the weakness of vegetative growth.

MUTATIONS

It is a question whether or not it will ever be possible to induce genetic changes in the mucors by changes in environmental factors. Such changes do occur in some forms, however, apparently spontaneously. In 1912–13, in an investigation as yet unpublished, I found numerous variants of various degrees of distinctness in the offspring of a single plant obtained by sowing non-sexual spores. Three forms from the hermaphroditic species *Mucor genevensis* will suffice in illustration. In the roll tube at the right is shown a number of mycelium colonies of a dwarf mutant. They are of about the same age as those in the tube at the left. The dwarf has no sporangia but is propagated by divisions of the thallus. Perhaps the weakness of its growth is responsible for the fact that it does not form zygospores as other races of this species do.

At the right of the Petri dish culture (Fig. 3) are shown two colonies of the normal parent race. The small dots scattered over the surface are zygospores formed by the hermaphrodite. (The large circles in the culture are the places where the races were inoculated.) Tests with plus and minus races show that this normal race is a hermaphrodite with a minus tendency. In the central vertical row, three colonies are growing of a mutant with a plus tendency. That it is also hermaphroditic is shown by the dark dots representing zygospores which it produces, larger and arranged

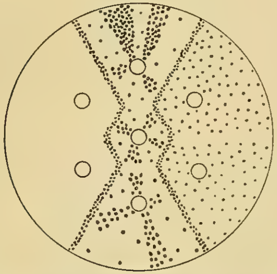

Fig. 3. Diagram of Petri dish culture of the hermaphroditic species *Mucor genevensis*. Circles represent points of inoculation, dots represent zygospores. Two colonies at right represent the normal parent stock; vertical row in center represents three colonies of a mutant with a (+) tendency; two colonies at left represent a mutant with (—) tendency.

in sectors more often than in the parent race. Since it has an opposite sexual tendency from the normal race, it forms a line of zygospores where it grows in contact with it. It also is forming a line of zygospores with the mutant on the left, two colonies of which are shown. This last mentioned mutant has, like its normal parent form, a minus tendency. Aside from its dense yellow growth, it is characterized by its well-nigh complete suppression of hermaphroditic zygospores on its own mycelium. If the suppression were complete and the race constant, we might be able to describe the origin of a diecious race from a hermaphroditic species. With the exception of the dwarf mutant which has been kept running since 1913, but which does not produce sporangia, and another possible exception, all the mutant variants found in this species eventually reverted to the normal type.

The tendency to reversion has been observed by Burgeff in his mutants of *Phycomyces* and attributed by him to a more rapid growth of the normal nuclei over the mutant nuclei in mixochimæras which he considers such variants to be. He was able to bring his mutants into a true-breeding condition by crossing them with the normal stock of opposite sex and obtaining the desired purity through segregation in the germ sporangia. Sex and mutant characters he found to segregate independently so that starting with a mutant in a plus race he was able eventually to obtain it in the minus condition.

DISTRIBUTION OF SEXUAL TYPES IN NATURE

A study has been made of the distribution in nature of the different sexual types. So far as the number of species is concerned, the diecious or heterothallic forms greatly predominate. If the table on the screen (5) were made to-day, we probably should have to more than double the list of species definitely known to have been mated. If unmated strains with sex determined by the "imperfect hybridization" reaction were added, the number would be still further increased. Of the homothallic (hermaphroditic) forms, very few would have to be added and the hermaphroditic forms it will be observed are those in which the sexual condition is readily determined by mere microscopic inspection and their zygospores therefore less likely to escape notice.

Table II. (3) above shows the distribution of races of *Rhizopus* obtained from different sources. As will be seen, the sexual strains are not at all local in their distribution. Those listed as neutral failed to give any reaction with the plus and minus test races. More extensive tests have recently been made with *Rhizopus* and other species as will appear in a later summary.

Collections of races of several different species have been made from diverse sources and the races within a given species tested for reactions *inter se*. Perhaps a form provisionally called "Dark" Absidia will serve as a convenient example. The collection of this species consists of 40 races. They have been contrasted with one another by twos in watch-glass cultures and all the possible combinations have been made as shown in the table. Grades A to D were assigned to the different strengths of sexual reaction measured by the number of zygospores produced in a given contrast. Each race was given a final numerical grade made up of the average of its reactions with all the other races and the races were arranged in the table according to their final grading. The plus and minus races were placed in series by themselves. There was no reaction when a plus was contrasted with another plus nor when a minus was contrasted with another minus. Whether they were of equal sexual vigor or one was weak and the other strong, the result of contrasting two races with the same sign was always negative. The collection of races therefore seemed dimorphic so far as sex is concerned. A race was either shown to be plus or minus or showed no reaction in a given combination and was provisionally classed as "neutral." There were no races evident that could be called sex intergrades.

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(*To be concluded*)

AN ANALYSIS OF AIM AND INCENTIVE IN A COURSE IN GENERAL ZOOLOGY

INCENTIVE AND AIM

That an incentive is necessary for the accomplishment of work is a postulate that needs no discussion. A review of my work as a teacher has led me to investigate the incentives that activate my students—mostly freshmen plunged into a course in general zoology. I have felt for some time that the aim of the course did not furnish an incentive for work.

Aim is confused with incentive because in some cases the two are equivalent. Aim is an aspiration for an ideal while incentive is an earthly motive. The statement of an aspiration may form an incentive for a few; but for most students the aim is soon forgotten.

INCENTIVE OF STUDENTS IN GENERAL ZOOLOGY

Since the motive that actually completes the work is not the aim, it is worth while to inquire what is the incentive. I recognize that the material with which I have to do shows a great deal of individual variation. In this "population" four classes can be discerned.

1. Those who work because the aim furnishes the incentive. In a so-called "general culture" course this is indeed a small class; in a technical school, however, the condition is reversed.

2. Those who work because of love for the subject, another small class. Although in some students this desire is inborn and probably hereditary, yet the proportion can be raised by an inspiring teacher.

3. Those who work for rewards. Our institutions, in their wisdom, through years of experience, have devised grades and honors. Some students have an inborn and probably hereditary ambition to seem better than their fellows and so react to this stimulus. Indeed competition can furnish a splendid incentive.

4. Those who work through fear. The same machinery erected to appeal to the ambitious reacts to prod the laggard. Under the threat of probation, condition, and exclusion, the victim struggles on. This is a large class and, in some ways, the most interesting. Although this group contains the dullards, yet the ranks are far from being homogeneous—the most brilliant member of the class may be buried in its ranks. How often have we seen a student, who, by constant threats, has just managed to scramble through our course, enter a technical school and not only lead his class but in time his profession. Lack of incentive is the key to his attitude toward the course in zoology. Being a more reasoning being than his fellows who work for love or rewards, and, feeling that the aim did not furnish an incentive, he gave his energies where, to his mind, results would be of more value.

THE AIM OF A COURSE IN GENERAL ZOOLOGY

It would be futile to list all the aims of a course in general zoology since two stand out in such bold relief that all others are cast into the shadow. These two are as follows:

1. To teach *science* which will give the student the method to gather zoological information and to use it.

2. To direct him to gather such information that will make him understand himself and his environment which in the end will make him review his moral and social responsibilities, leading to an intelligent selection of action in after life.

SCIENCE

These aims hinge on definitions and no definition will have more influence on the conduct of a course than the definition of science. Those teachers who define science as *knowledge* will have a different aim for their course than those who define science as *method*. While the students of the first class will get much information pumped into them they will get little training in method. Science, defined by Huxley as "common sense at its best," or organized common sense, can be analyzed as follows:

2. We observe (experiment).

3. We record our observations (experiments) clearly described in an *organized* form that others may repeat and confirm them.

4. We draw conclusions, at the same time discussing the results of others that have come within our experience.

Zoologists, botanists and even chemists feel that they have so much information to impart that they quite forget to teach science in the elementary course. It fell to the lot of the writer to get his first training in science out of a course of history. A problem was set, original sources of history were supplied, the data recorded, and conclusions drawn. Because his science teachers held that science was knowledge they made the imparting of information the most important aim.

OBSERVATION

To see one must be trained to see. He who is brought up on a diet of books alone is apt to be as "blind as a bat." As President Eliot and others have repeatedly pointed out, biology is preeminent among sciences in giving training in observation. Training in observation, therefore, is an important aim in a course in general zoology

THE RECORD

To record observations two methods of description are available, descriptions in words and descriptions by drawings. The former includes logical arrangement of matter organization and the clear use of the English language. Where the objects or processes to be described are complicated, words alone are too cumbersome, so the graphic method supplies a short-hand method of accurate description. Drawing is not an end in itself. It is not used as in art to express the impression of an object, but to indicate relationships that can not be briefly or clearly expressed in words. Therefore, a course in general zoology has for aims training in the use of the English language, organization and drawing.

THE CONCLUSION

In the conclusion the organized data and its relation to some logical principle is discussed; and inferences are drawn involving cause and effect. The importance of the biological principle justifies the drudgery of the work. The drawing of conclusions from organized data is an aim in a course of general zoology.

INFORMATION

To understand himself and his environment is an aim too abstract for a student to grasp without the background that the course is designed to give. This aim is not apparent until the course has been completed. It is, therefore, necessary to consider a series of minor aims that come, to some extent, within the previous experience of the student, such as phases of morphology, physiology, behavior, evolution, heredity, etc. Since morphology is so much easier to treat in the laboratory, we are apt to center on it and so fail to impress the student with its relation to the real aim of the course.

An aim of a science course is to give training in how to do with a background of knowledge which will allow of a selection in the matter of action. An aim of a biological course is to give training in how to use eye, hands, and brain in the control of ourselves and our environment, with a background of knowledge that will allow of a selection of action.

AIM, INCENTIVE AND CONTENT

Aims, as outlined above, furnish little incentive for work. The ultimate object is too big a picture to be "interpreted" by one so close as a student in a laboratory class. The needed perspective can only be acquired after the course has been completed. Minor aims, clearly within the experience of the student, selected with a thought not only to the principal aims but also with the available material in mind, must be presented. These aims must seem to the student clearly important. Experience has shown that a combination of the problem method as illustrated in Hunter's "Problems in Civic Biology" and the project method now being worked out by teachers in the high schools gives the most science and information with the most incentive.

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PHYSICAL METHODS AND MEASUREMENTS, AND THE OBLIGATION OF PHYSICS TO THE OTHER SCIENCES

Several months ago there appeared in Science a brief article[1] by the present writer in which he advocates a carefully planned course in physical measurements, supplementing the beginning course in college physics, to suit the needs of students of the chemical, biological and the related sciences. In response to the article, there have been received more than twenty communications from scientific workers in the colleges and in the industries, relative to the subject. They are unanimous in expressing their agreement with the views stated. At the same time they express doubt as to the existence of a college physics department which will offer a course designed especially for the science student outside of physics.

To those who are working in the various experimental sciences, or who are in position to see and judge the work in numerous laboratories, it is evident that the need for better training in physical principles, methods and measurements is an urgent one.[2] To secure evidence of the truth of this contention, one needs only to obtain the views of the heads of industrial laboratories in which the services of many science graduates of our colleges are required. Or let the physicist who is—and, more than anyone else, should be—interested, interview his scientific colleagues to learn how much the lack of familiarity with physics may have proved a handicap in their own work or in that of their graduate students. There is concrete evidence in the report that some of the industries are contemplating or have already taken steps towards establishing training schools for their young technical graduates, to give them the sort of training which the colleges should have provided.

It seems to me that here is clearly an obligation upon the physicist. It is also an opportunity. It is an opportunity in the sense that if he could be instrumental in providing the coming generation of scientific workers with adequate training in physics, greater progress in science might assuredly be looked for. This not because physics is at all more potent than the other sciences in exploring the unknown, but because it is so fundamental. At every turn we encounter a physical phenomenon; every experiment that is planned involves some sort of measuring instrument, some form of control device, some physical method. Physics plays such an obviously important part in the great majority of researches that it leads one to wonder why

1 Science, N. S., 50, 199, 1919.

2 On this point "Chemical and Metallurgical Engineer" says: ". . . we know from experience that an adequate familiarity with them (physical methods) is far too often lacking among young chemists, and Mr. Klopsteg's proposal would seem to cover an important gap."

this phase in the education of our science students has received so little attention. It leads one also to wonder why so little attention is paid to methods of instruction and to the proper coordination of the college science courses.

I have said that it is the physicist's obligation to see that the science student—in chemistry, in medicine, in biology, in psychology—may secure the fundamentals not only of general physics, but of the physical measurements and methods which will apply to his work. The obligation logically belongs to physics because the courses are courses in applied physics, and because the work of organizing such courses would unquestionably be easier for the physicist than for the non-physical scientist to whom physics is unfamiliar ground. The latter could not be expected to make a good teacher in physical measurements.

There are obstacles to the realization of what has been proposed. Some of them appear formidable, but where the results to be achieved seem so full of possibilities, let us hope that they may not be insurmountable. Some of the obvious difficulties may be mentioned. The method for their elimination is not so obvious.

Because of the rapid development of physical methods within recent years, and their rapidly increasing applications, their importance may not have impressed itself fully upon those in charge of the student's training. Perhaps they have thus come to value the time spent by the student upon courses in his own field as far greater than equal periods in the physical laboratory. Among their own specialties they see so many things which the student must have before he is fit for his degree. But is not this a biased view?

Let us suppose that a student has received a degree in chemistry, but that his work did not include several subjects in chemistry which might have value to him later. He takes a position in a chemical industry. He is surrounded by chemists; has access to an excellent library; his interest in chemistry is foremost among his interests. Under these circumstances his educational equipment will not long remain deficient in the subjects which he did not get in college. On the other hand, suppose—and this is usually the case—that he lacks knowledge of physical methods and experience with physical instruments. His environment and his interests make it exceedingly difficult to acquire this knowledge and experience, because he is now quite upon his own resources.

Conditions are much the same with the graduate in almost any science, continuing in post-graduate work. Although he is in position to request the information he wants, by applying to the physics department, the physicists have so many of their own problems that, unless his request is a very moderate one, he will have indifferent success in securing the needed information.

In both the cases just suggested, much time and effort would be saved, with better results, had a well-planned course been available for the student. The college physics laboratory is the place where such training should be given. Failing in this, the colleges must expect to see the industries adopt the alternative of usurping one of the functions of the college. This raises the question: why is not such a course of training in physics offered by every physics department? The answer is fairly apparent.

A course like the one suggested, in order to measure up to its fullest possibilities, would require painstaking preparation by the instructor having it in charge. It would be necessary for him to have an understanding of the problems. He would need to appreciate most fully that, in this particular case, physics is a means to an end, and that the student is interested in physics solely for what it can do for his own, more interesting science. To secure the necessary understanding of the problems, he might have to spend considerable time in going through the various scientific journals, to see where and how physical methods are used. Thus he would be compelled to sacrifice some of the time which otherwise he might devote to research. But, in giving up some of his research, would he not actually be rendering a greater service to science than he would in following the alternative course? Yet there are probably few physicists, engaged in teaching and research, who have more than a passing interest in the possible applications of physics to the other sciences. Perhaps it is only natural that the motive of early results of their work, in the form of publications, should far outweigh the motive of results greater and more lasting, but somewhat intangible and long deferred.

Under existing conditions there is undoubtedly another source of discouragement to the physics instructor who would otherwise gladly develop such a course. This is the tendency on the part of our educational institutions to make advancement in rank and salary depend almost entirely upon productive scholarship, sometimes measured in terms of volume rather than quality. Excellence in teaching and conscientious work upon a course of the kind here advocated would hardly be considered productive. The instructor, in doing such work, would be making a real sacrifice to the cause of science. Few can afford to make sacrifices of this kind.

Whatever the solution of the difficulties which have been pointed out, it will probably be satisfactory and acceptable to our educational institutions only if it comes as the result of cooperation on a large scale among the various sciences. Although the responsibility for making physics available in the manner suggested seems to me to belong to physics, the initiative in demanding of physics the kind of training that is wanted belongs to the other sciences. It is their duty to outline to physics what they need, and after the courses have been made available, to maintain an active interest in rather than a passive attitude towards them. And the common motive must be the vision of the significant but, perhaps, little appreciated contributions, through such efforts, to the advancement of science. To find the answer to the problems which are brought up by this aspect of the problem of properly training our science students seems a task worthy of a body like the American Association for the Advancement of Science. The accomplishment of such a task would give a new and fuller meaning to the name of this great organization.

Paul E. Klopsteg

Leeds & Northrup Company,
Philadelphia, Pa.

SCIENTIFIC EVENTS

THE OHIO COLLEGE AND EXPERIMENT STATION

In 1917 the College of Agriculture of the Ohio State University and the Ohio Agricultural Experiment Station entered upon a closer cooperation in their respective fields of work by the appointment of C. G. Williams, chief in agronomy at the station as non-resident professor of farm crops at the college; of Professor J. B. Park and Firman E. Bear, of the college as honorary associates, respectively, in agronomy and soils at the station, and of G. W. Conrey, instructor at the college as assistant in soils at the station. In 1918 Professor Herbert Osborn, of the college, was appointed honorary associate entomologist of the experiment station, and H. A. Gossard, chief in entomology at the station, was appointed non-resident professor of entomology at the college. In March, 1920, C. C. Hayden, chief in dairying at the station was appointed non-resident assistant professor at the college, and Professor Oscar Erf, of the college, was appointed honorary professor in dairying at the station.

In the actual working out of this cooperation the specialists at the experiment station's work by counsel, by lectures at the field meetings held by the station, and by conducting special lines of research which are reported in station bulletins.

The station's field experiments are widely scattered over the state, in order to bring under observation the various soil types and different industries, and these experiments are visited by the higher classes in agriculture at the college.

THE LOUISIANA ENTOMOLOGICAL SOCIETY

At New Orleans a meeting was held on March 5 to discuss the organization of an entomological society or club. The meeting was called by Mr. Edward Foster, who had received assurances of support from about twenty-five entomological workers. Ten persons were present. They heartily endorsed the plan, and favored the organization of a society to be known as the Louisiana Entomological Society, to be domiciled at the Natural History Building of the Louisiana State Museum, Jackson Square, New Orleans. A committee on constitution was elected, and the next meeting was placed at April 2.

On that date the first regular meeting was held and the constitution was adopted. The following officers were elected: President, Mr. Edward Foster, state nursery inspector; Vice-President, Professor O. W. Rosewall, professor of entomology, Louisiana State University; Secretary-Treasurer, Mr. T. E. Holloway, of the U. S. Bureau of Entomology. An executive committee composed of the officers with the addition of Messrs. O. K. Courtney, of the Federal Horticultural Board, and Charles E. Smith and T. H. Cutrer, both of the U. S. Bureau of Entomology, was provided. It was decided that meetings are to be held on the first Fridays of February, April, June, October and December, the June meeting to be a Field Day, and the December meeting to be the annual meeting. The dues were placed at $1.00 per annum. Any person interested in the science of entomology is eligible for membership.

Mr. Robert M. Glenk, curator of the museum, very kindly placed at the disposal of the society a large and well-lighted lecture room, library and laboratory space, a moving picture outfit, and financial assistance in publishing the proceedings of the society.

T. E. Holloway,
Secretary-Treasurer

THE SOUTHWESTERN GEOLOGICAL SOCIETY

At the annual meeting of the Southwestern Geological Society held at Dallas, Texas, on March 19, Robert T. Hill of Dallas was re-elected president of that organization. Other officers elected were Charles E. Decker, of the University of Oklahoma, and William F. Kennedy, vice-presidents; Ellis W. Shuler, of the Southern Methodist University of Dallas, secretary, and R. B. Whitehead, treasurer. Members of the council are John A. Udden, Jerry Newby, Dr. H. P. Bybee, of the University of Texas, W. E. Wrather and D. W. Ohern.

Following the meeting the annual dinner was held in the roof garden of the Adolphus Hotel. More than 100 members of the society were present. Dr. George Otis Smith, of Washington, D. C., director of the United States Geological Survey; Dr. I. C. White of Morgantown, W. Va., president of the American Association of Petroleum Geologists were guests at the dinner.

This organization now numbers over 130 members and is doing much good in getting together the various geological workers in the southwest.

THE AMERICAN ELECTROCHEMICAL SOCIETY

The American Electrochemical Society held its thirty-seventh meeting at Boston and Cambridge on April 8, 9 and 10. The members were welcomed by Professor H. P. Talbot, of the Massachusetts Institute of Technology. The annual address by the president, Dr. Wilder D. Bancroft, of Cornell University, lieutenant-colonel in the United States Army, was on "Contact Catalysis." It was followed by a symposium of "Colloid Chemistry."

Summarizing the report from the board of directors, the secretary, Professor J. W. Richards, said that the directors had protested against the abolition of the Chemical Warfare Service. The membership of the association has been materially increased during the year; it was 1,903 on January 1, 1919, and 2,209 on January 1, 1920, and is now 2,307. The treasury of the organization also is in a healthy condition, with $13,000 invested, largely in government bonds, and $4,000 cash assets.

Officers have been elected as follows: President, Walter S. Landis, chief technologist of the American Cyanamid Company of New York; vice-presidents, Dr. John A. Mathews, president and general manager of the Halcomb Steel Company of Syracuse.

N. Y., Lewis E. Saunders, vice-president of the Norton Company in Worcester, and Arthur T. Hinckley, chemist for the National Carbon Company at Niagara Falls, N. Y. Managers elected were Dr. Colin G. Fink, research director of the Chile Exploration Company of New York; Acheson Smith, vice-president and general manager of the Acheson Graphite Company of Niagara Falls, and H. B. Coho of the United Lead Company of New York; treasurer, Pedro G. Salmon, of Philadelphia, and secretary, Dr. Joseph W. Richards, professor of metallurgy at the Lehigh University, Bethlehem, Pa.

FIFTIETH ANNIVERSARY OF THE WISCONSIN ACADEMY

The celebration of the fiftieth anniversary of the founding of the Wisconsin Academy of Sciences, Arts and Letters will be the occasion of an important gathering at the University of Wisconsin on April 23. Professor T. C. Chamberlin, professor emeritus of geology at the University of Chicago, will give an address on "The founding of the Wisconsin Academy of Sciences, Arts and Letters," at an all-university convocation in the morning. Professor Chamberlin is one of the two or three living members who helped to establish the academy in 1870 for the purpose of preserving the scientific studies of the state. He was then professor of science at Whitewater Normal School. He was president of the University of Wisconsin from 1887–92, when he became professor of geology at the University of Chicago. The regular business meeting of the academy will be held in the morning, April 23, an all-university convocation will be held in the afternoon, and a banquet in the evening.

President E. A. Birge, of the University of Wisconsin, will preside at the afternoon meeting. Professor John M. Coulter, of the University of Chicago, will speak on "The relation of the local academy to the national organization," and Professor C. E. Allen, of the University of Wisconsin, will speak on "The proposed plan of affiliation of the local academies with national organizations."

The Wisconsin Academy was the first important means in the state of gathering scientific material and has preserved it in annual volumes, published at state expense. An anniversary volume of the proceedings, containing the papers of the members, will be published as the twenty-first volume of the *Transactions* of the academy.

A bronze medal commemorating the 50th anniversary of the founding of the academy is to be struck for the anniversary meeting. The medal will bear on its face the portraits of Dr. Increase A. Lapham, pioneer archeologist and antiquarian, Philo R. Hoy, naturalist and antiquarian whose collection of birds is in the Racine Public Library, George W. Peckham, authority on certain groups of spiders whose collection of the Attidæ species is in the Milwaukee Public Museum, Professor R. D. Irving, geologist and at one time head of the U. S. Geological Survey in the northwestern states, and Professor William F. Allen, authority on Roman history and antiquities. All were prominent in the early history of the academy. Under the portraits will appear the words, "Wisconsin Academy of Sciences, Arts and Letters, 1870–1920, Natural Species Ratioque." The obverse will bear the figure of Minerva, holding the lamp of learning, and the words "Naturæ Species Ratioque."

SCIENTIFIC NOTES AND NEWS

Dr. John Alfred Brashear, of Pittsburgh, distinguished as a maker of astronomical and physical instruments and an astronomer, died on April 9, in his eightieth year.

At the recent commemoration day exercises at the Johns Hopkins University, a portrait of Dr. J. Whitridge Williams, dean of the medical school, was presented to the university by Professor William H. Welch, and a portrait of Dr. Florence R. Sabin, professor of histology, by Professor William H. Howell.

The National Institute of Social Sciences, at its annual meeting on April 22, will confer a gold medal on Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research.

Dr. John W. Churchman, professor of surgery at Yale University, who had previously been made officier de l'instruction publique by the French government, has been named officier d'Academie (silver palms). The decorations are in recognition of work done as Medecin-chef of Hôpital militaire 32 bis. during 1916.

Sir Joseph Larmor, of the University of Cambridge, has been elected a corresponding member of the French Academy of Sciences in the section of geometry.

Presidents of sections of the British Association have been appointed as follows: A (Mathematics and Physics), Professor A. S. Eddington; B (Chemistry), Mr. C. T. Heycock; C (Geology), Dr. F. A. Bather; D (Zoology), Professor J. Stanley Gardiner; E (Geography), Mr. J. McFarlane; F (Economics), Dr. J. H. Clapham; G (Engineering), Professor C. F. Jenkin; H (Anthropology), Professor Karl Pearson; I (Physiology), Mr. J. Barcroft; K (Botany), Miss E. R. Saunders; L (Education), Sir Robert Blair; and M (Agriculture), Professor F. W. Keeble. As has already been announced Professor W. A. Herdman will preside over the meeting which opens at Cardiff on August 24.

Dr. C. G. Storm, formerly lieutenant colonel, Ordnance Department, U. S. A., has resigned as assistant director of research with the Trojan Powder Co., Allentown, Pa., to accept the position of professor of chemical engineering in the Ordnance School of Application, Aberdeen Proving Ground, Maryland, and will also be engaged in research work on explosives and other ordnance materials.

Mr. Sherman Leavitt, formerly professor of chemistry and agriculture in Illinois College, Jacksonville, Ill., has become food chemist for the War Department, stationed in the Bureau of Chemistry laboratory at St. Louis.

Dr. Edwin Linton, professor of biology in Washington and Jefferson College, having reached the age of sixty-five years, will retire at the end of the present college year. He expects to devote his time to research work.

Professor Henry Parker Manning, of the department of mathematics of Brown University, has resigned. Professor Manning has been connected with Brown University for twenty-nine consecutive years.

Professor Ora Miner Leland, of the faculty of civil engineering at Cornell University, has resigned his professorship and taken a position with the J. G. White Company of New York.

Mr. H. DeWitt Valentine has resigned from his position as instructor in chemical engineering at the University of Wisconsin, Madison, Wis., and is now retained as chemical engineer and bacteriologist by the Ozone Company of America, Milwaukee, Wis.

Professor Ernest Merritt lectured recently on "Methods used for the detection of submarines" before the Cornell chapter of the Sigma Xi. During the war Professor Merritt conducted investigations that proved of great value in diminishing the danger of submarine attack.

Professor C. F. Hottes gave the address before the Illinois chapter of Sigma Xi, at the meeting of March 17. The subject of the address was "Algæ as rock builders."

Dr. Louis A. Bauer gave the evening lecture at the joint meeting, held in Columbus on April 2, of the Ohio Section of the Mathematical Association of America, the Ohio College Association and the Ohio Society of College Teachers of Education. His topic was "The deflection of light observed during the solar eclipse of May 29, 1919, and its bearing upon the Einstein theory of gravitation," illustrated by lantern slides. He also gave public lectures on "The solar eclipse of May 29, 1919 and the Einstein theory" at Ohio State University, April 3, at Ohio Wesleyan University, April 5, and at the College of Wooster, Wooster, Ohio, April 6.

A course in fractures is being given at the Cornell Medical College, during April by Dr. Joseph A. Blake, Dr. George W. Hawley and Dr. James N. Hitzrot Five. Dr. Alexis Carrel will also give one lecture. Other exercises will be held by Dr. H. H. M. Lyle, Dr. Burton J. Lee and Dr. John C. A. Gerster.

The annual initiation of the Columbia Chapter of Sigma Xi was held on Friday evening, April 9, at Columbia University.

The initiation was followed by a dinner for which the following program was arranged:

Toastmaster: Marston T. Bogert, professor of organic chemistry.

Engineering research: George B. Pegram, dean of the schools of mines, engineering and chemistry.

Research in forest products: Samuel J. Record, professor of forest products, Yale University.

Science in the industries: M. C. Whitaker, vice-president of the U. S. Industrial Alcohol Company.

Applied psychology: E. L. Thorndike, professor of educational psychology.

The new members: Stephen P. Burke.

At the meeting of the Executive Committee of the Massachusetts Society for Mental Hygiene held March 9, 1920, the following resolution was adopted:

The directors of the Massachusetts Society for Mental Hygiene desire to express their deep sorrow and their great sense of loss in the death of Professor Elmer Ernest Southard. To many of them he was a warm personal friend whom they will sorely miss. His great natural abilities, his extraordinary powers of insight and deduction were most valuable to the society in which he took an active and stimulating interest.

The directors feel that they have lost not only a most valuable adviser and colleague but one on whose sympathy and friendship they could always depend.

Dr. George Egbert Fisher, professor of mathematics in the University of Pennsylvania, died on March 28, aged fifty-seven years. The following resolutions have been passed by faculties of the university:

The faculties of the college, the graduate school and the school education have learned with profound sorrow of the death of George Egbert Fisher, professor of mathematics and sometime dean of the college.

Professor Fisher's connection with the faculty dates from 1889, when he was appointed assistant professor of mathematics.

Earnest in purpose, lofty in ideals, a patient and inspiring teacher, he invariably won and held the respect and love of his students.

We of the faculty wish to bear testimony to our appreciation of the profound scholarship of our departed colleague, and to our recognition of his exceptionally deep and abiding love for mathematics. It was always his aim to foster a more general interest in this subject. We would testify also to his ready and sympathetic cooperation in all that was for the best interests of the university.

Sir Anderson Stuart, professor of physiology in the University of Sydney since 1883 and the dean of its medical faculty, died on February 29, aged sixty-four years.

The magnetic survey vessel, *Carnegie*, arrived at St. Helena Island, on March 30. She will sail again early in April, bound for Capetown.

The American Medical Association, as has been already noted, will hold its seventy-first annual session in New Orleans, beginning on April 26. This is the fourth time the association has convened in New Orleans. The twentieth annual session under the presidency of Dr. William Owen Baldwin in 1869 aided in bringing the members of the medical profession in the south into cordial relationship with the national association following the Civil War. In 1885, under the presidency of Dr. Henry F. Campbell, the thirty-sixth annual session was held in New Orleans. In 1903 the association met in the city in its fifty-fourth annual session under the presidency of Dr. Frank Billings. The present meeting will be opened under the presidency of Dr. Alexander Lambert, of New York, and Dr. William C. Braisted, surgeon-general of the U. S. Navy, will be inducted into the office of president.

UNIVERSITY AND EDUCATIONAL NEWS

The legislature of the state of Mississippi has passed a bill appropriating the sum of $350,000 for a new building for the University of Mississippi, to house the department of chemistry and the school of pharmacy.

Dr. Arthur Twining Hadley, since 1899 president of Yale University, has presented his resignation, to take effect in June, 1921, when he will have reached the age of sixty-five years.

Albert W. Smith, dean of Sibley College of Mechanical Engineering, Cornell University, has been selected by the trustees' committee on general administration to be acting president of the university until a permanent successor to Dr. Schurman is appointed.

The professorship of electrical engineering at Lafayette College, made vacant by the resignation of Professor Rood, who left Lafayette to go to the University of Illinois, has been filled by the appointment of Professor Morland King, of Union College, as associate professor of electrical engineering.

Dr. Walter K. Fisher, of the department of zoology at Stanford University, has been promoted to an associate professorship.

Dr. Max Mailhouse has resigned as clinical professor of neurology in the Yale School of Medicine, his resignation to take effect at the close of the present college year.

DISCUSSION AND CORRESPONDENCE

A SUGGESTION AS TO THE FLAGELLATION OF THE ORGANISMS CAUSING LEGUME NODULES

A very interesting note by Hansen on the flagellation of the legume nodule organisms (Rhizobium) appeared recently in this journal.[1] There has been a dispute for some time as to whether these bacteria have one or several flagella. Burrill and Hansen not long ago[2] claimed that they are monotrichic organisms, whereas various other investigators, including the present writers,[3] have observed peritrichic flagella. Hansen now says that he, too, has found peritrichic flagella on cultures obtained from clover, vetch and alfalfa, and calls attention to the fact that his earlier studies had been on organisms from cowpea and soy bean. Hence he suggests that there may be two different groups, one peritrichic and the other monotrichic. It is, indeed, generally recognized that the organisms of cowpea and soy bean differ from the other varieties of *Rhizobium* in certain cultural features, primarily in respect to vigor of growth.

Hansen's suggestion is very interesting, but does not explain all the facts that have been observed. Wilson[4] has found peritrichic flagella on cultures of the soy bean organism. To be sure, as insisted by Hansen, Wilson has not published any photomicrographs; but the statement he makes is definite and no one need question it. We have seen one of Wilson's microscopic preparations (soy bean organism) and also one of Hansen's (cowpea organism); and find four or five flagella on some of the bacteria in Wilson's preparations, but only one each on those in Hansen's.

Upon enquiry we find that Wilson's cultures were sometimes as old as 28 days at the time of staining; while it appears from Burrill and Hansen's paper that their preparations were only a few days old. In this connection it is an interesting fact that a certain organism (belonging to a different group) studied in this laboratory was found to have a single polar flagellum when a few hours old, but two or three polar flagella when a day or more old. This naturally raises the question whether the cowpea and soy bean organisms may not be monotrichic in young cultures and peritrichic when they are older. This suggestion is further borne out by the fact that Hansen found (as shown by statements in his text and by his photomicrographs) the single flagellum to be attached at the corner or even at the side more often than exactly at the pole. This is just what would be expected if it were a matter of chance which one of the peritrichic flagella developed first in a young culture.

Ever since the appearance of Burrill and Hansen's paper we have wanted to investigate the truth of the matter. As we have not had the chance to do so, we take this occasion to put the idea in print that any one else inter-

1 Hansen, Roy, "Note on the flagellation of the nodule organisms of the Leguminosæ," Sci., N. S., 50: 568–569, 1919.

2 Burrill, T. J., and Hansen, R., "Is symbiosis possible between legume bacteria and non-legume plants?" Ill. Agr. Exp. Sta., Bul. 202, 1917.

3 Breed, R. S., Conn, H. J., and Baker, J. C., "Comments on the evolution and classification of bacteria," *Jour. Bact.*, 3, 445–459, 1918.

4 Wilson, J. K., "Physiological studies of *Bacillus radicicola* of soybean (*Soja* Max., Piper) and of factors influencing nodule production," Cornell Agr. Exp. Sta., Bul. 386, 1917.

ested in this rather puzzling question may study it to see whether there is anything in the theory suggested here.

H. J. Conn,
R. S. Breed
Agricultural Experiment Station,
Geneva, N. Y.

PENSIONS FOR GOVERNMENT EMPLOYEES

The American Association for Labor Legislation calls attention to the very serious evils arising from the lack of a pension system in the government bureaus at Washington. They say: "It is now reported that of a total of 878 employees in one federal bureau in Washington, 303 are over 65 years old, 104 over 75, and 29 over 80. The Treasury Department alone has 1,000 aged who average only 25 per cent. efficiency—1,000 drawing full pay for work that could be done by 250."

This is a matter which concerns scientific men. I remember several years ago calling on one of the most eminent zoologists in the National Museum. I found that he was writing all his letters by hand, because the stenographer assigned to him was too old to do the work. He explained that of course he could not, or would not dismiss her; but as a result he was left without the assistance he should have had. I recall a scientific assistant, retained by a bureau long after he had ceased to be able to do anything of value, but required to spend his days at his desk. No one would have thought of turning him away unless he could be adequately provided for. The effect of these conditions on the progress of science is obvious and lamentable.

It appears that there is now a bill before Congress, providing for retirement on part pay at 65, the employee contributing 2½ per cent. of wages, the government the rest. It should certainly be supported.

T. D. A. Cockerell
University of Colorado,
March 1, 1920

THE RECENT AURORAS

The Weather Bureau is compiling observations of the auroras of March 22–23, 23–24, and 24–25, 1920, as seen in the United States, or elsewhere, with a view to publishing a detailed account of this remarkable display in the March, 1920, issue of the *Monthly Weather Review*. It is hoped that those who observed an aurora on any of the dates mentioned will notify the bureau, and if details were noted will send copies of their notes. Information about any display which may be seen on April 18, 27 days after the brilliant night in March, or auroras observed on other dates in 1919 or 1920 will also be appreciated. Communications should be addressed to "Editor, Weather Bureau, Washington, D. C.," and should reach Washington by the end of April.

Charles F. Brooks,
Meteorologist-Editor

QUOTATIONS

CIVIL SERVICE PENSIONS

After years of half-hearted consideration Congress seems about to pass a bill for the retirement and pensioning of employees in the federal service. It will be applicable only to those in the classified service, about 300,000 in all. It is a measure of justice and at the same time a measure of economy, for the government hasn't been heartless enough to turn the superannuated loose. Thousands of them retain their places, but do little or no work.

The government retires employees in the military and kindred services. It ought to set a similar standard for faithful civil employment. The retirement age in the army is sixty-four, and in the navy sixty-two. Taking into consideration the easier conditions of civil employment, the bill which has just passed the Senate fixes seventy as the civil retirement limit. The allowances will vary according to length of service, from thirty years down to eighteen years. Persons disabled through disease or injury in the line of duty may be retired before reaching seventy.

Another distinction is to be made between civil and military beneficiaries. An annuity assessment of 2½ per cent. will be levied annually on the salaries of civil employees until a retirement fund is accumulated. This assessment is expected to pay about half the cost of the system.

There are now about 9,000 superannuated civil servants, most of them in Washington. They will go out in a body. The retired list will eventually reach about 30,000. But with the moderate annuities allowed, the maximum being $720, the government's experiment will cost little. The efficiency of the working force will be increased. More work will be done by a smaller staff.—*New York Tribune.*

THE ECOLOGICAL RELATIONS OF ROOTS[1]

Professor J. E. Weaver has recently put out an extensive study on roots which comprises observations made in the "prairies of eastern Nebraska, chaparral of southeastern Nebraska, prairies of southeastern Washington and adjacent Idaho, plains and sandhills of Colorado, the gravel-slide, the half-gravel-slide, and forest communities of the Rocky Mountains of Colorado." The roots of about 140 species are described. The species include shrubs, grasses and other herbs. With a description of the roots is presented a characterization of the physical environment. Among other features of the latter are given the rainfall and evaporation, the temperature of the air and to a certain extent the temperature of the soil and its moisture content. The work is abundantly illustrated with root maps and reproductions of photographs.

The study by Weaver is a continuation and an extension of his well-known work along similar lines. It is wholly observational and must be considered as constituting a very noteworthy contribution to our knowledge of the habits of roots. It touches elbows with so many features associated with the habits and relations of the plants of the regions studied that it is not practicable to present a summary of the results. However, it may not be amiss to point out certain of the more interesting of the facts presented. For detailed information the reader is referred to the work itself.

[1] Carnegie Institution of Washington, Publication No. 286, 1919.

Without attempting to summarize exactly it can be said that in a general way the root systems of plants in the communities studied are fairly characteristic. Thus in the prairies and the plains also the roots usually extend widely and penetrate deeply, but more deeply in the former than in the latter community. And the tap root is the principal feature. In the sandhills the roots of several species are confined to the surface 2 feet, and practically all show a striking "profusion of long, widely spreading laterals in this surface-soil stratum." In the gravel-slide and forest communities of the Rocky Mountains, adjoining Colorado Springs, the roots are confined to the surface 18–24 inches. In the half-gravel-slide, however, the root penetration is deeper, although the root systems develop widely spreading shallow roots as well. Finally, in the case of species growing in more than one habitat it was found that in most cases the direction and extent of roots developed corresponded very well to the "community root habit."

Roots of different species may be so unlike in the extent and direction of their development, as well as in other morphological features, as to be readily identifiable. They also undoubtedly exhibit quite as distinct physiological characteristics, although such can not be told from inspection. For these reasons a knowledge of the roots of any habitat gives a very good clue to many of the striking features of that habitat, just as the nature of the shoot of a plant reveals much regarding the subaerial conditions under which it has developed. It consequently follows that through the study of roots of native plants, much can be learned in advance of culture of the possibilities of agricultural lands. Such, however, is a possible economic application of this and similar root studies and was suggested, but not developed, by the author.

The most striking root figure by Weaver is that of *Ipomœa leptophylla* of the sandhills about forty miles southeast of Colorado Springs. The soil absorbs all of the rain and there is practically no run-off. Through a rapid drying out of the surface sand a dust mulch is formed which retards effectively further water loss from the soil. At a depth of a few inches the soil is always moist, and, from data given for another locality with similar soil, it would appear that the moisture may be fairly uniform to a depth of six feet. Exact data, however, as regards this feature are wanting. Of 19 sandhill species whose roots were studied, 8 have roots which are entirely or nearly confined to the first two feet of soil, and of the balance all save one have the greatest root development at this depth. The roots of *Ipomœa* were the most extensive of those of any species in the community, or, for that matter, apparently the most extensive of any observed during the course of the study. The block of soil included within their reach was approximately fifty feet in diameter and over ten feet in depth. The roots were fairly well distributed throughout except only in the surface foot from which they were largely wanting. Another feature of the root was the enlarged and tapering tap which was about eight inches in diameter a foot beneath the surface and the enlarged portion of which was about three feet long. The enlarged tap of *Ipomœa* constitutes an important reservoir for food and water storage.

Weaver finds in general that in the communities studied the most striking root characters, at least so far as the gross morphology is concerned, are intimately related to the moisture conditions of the soil. Where, for example, the uppermost soil layers only are moist, there is a marked development of laterals. In the event the soil carries moisture to a considerable depth, as on the prairies, deep root penetration in many species occurs. Apparently he does not find soil temperatures or soil aeration limiting factors in root penetration although that such may be the case in certain instances seems to the reviewer not unlikely. For example, the roots of *Opuntia fragilis* do not appear to attain to a depth greater than fifteen inches, and it is usually considerably less than this. The roots of *Yucca* are also for the most part shallowly placed. And, finally, in the prairies as regards penetration, there is a fairly well-marked stratification of the roots. It may be as suggested in the case of plains species that the "well developed system of shallow, widely spreading laterals is undoubtedly a response to the moisture in the surface soils resulting from frequent light summer showers." However, in the opinion of the reviewer, the possibility that the root-temperature or the root-soil aeration relation may also be of importance is by no means excluded. The various root relations are so closely interwoven that any one can only be evaluated when the rest are so far as possible controlled. And this requires exhaustive experimentation, which was not within the scope of the present study.

The extremes as regards root penetration appears to be met in the case of *Opuntia fragilis*, of the plains, on the one hand, and possibly, *Lygodesmia juncea*, of the Nebraska prairies. In *Opuntia* most of the roots lie within one to three inches of the surface of the ground, with an extreme penetration of eight to fifteen inches. While the roots of *Lygodesmia* have been found to attain a depth exceeding twenty feet seven inches. In the latter instance the soil is loess, with uniform physical properties, and is very favorably for deep root penetration. This well authenticated penetration is sufficiently deep, but it is of interest to note the observation given in Merill[2] that "Aughey has found roots of the buffalo berry (*Shepherdia argophylla*) penetrating the loess soils of Nebraska to a depth of fifty feet."

In a work so well done it seems captious to allude to a feature not by itself of fundamental importance. However that may be, it seems to the reviewer unfortunate that the English and the metric systems of measurement, especially, are both used throughout the study. Consistency in this regard would surely meet more general approval.

W. A. Cannon

Desert Laboratory

[2] "Rocks and Rock Weathering," p. 181.

SPECIAL ARTICLES

THE TERTIARY FORMATIONS OF PORTO RICO[1]

In 1914, the New York Academy of Sciences commenced a scientific survey of Porto Rico and the Virgin Islands. The outcome of this work has been a series of reports, covering geology and other branches of investigation. The important geological contributions which have been published are:

1. "A Geological Reconnoissance of Porto Rico," by C. P. Berkey, *Ann. N. Y. Acad. Sci.*, Vol. XXVI., pp. 1–70, 1915.

2. "Geology of the San Juan District," by D. R. Semmes, N. Y. Acad. Sci., Sci. Surv. of P. R. and the Virgin Islands, Vol. I., pt. 1, pp. 33–110, 1919.

In the summer of 1916, the writer, working under the auspices of the New York Academy of Sciences, made a detailed study of the northwestern portion of the island (Lares District). The results of that survey, together with the conclusions of Berkey, Semmes, and other geologists who have worked in Porto Rico, are outlined in the present paper.

General Outline.—R. T. Hill[2] showed that the central core of Porto Rico is made up of a volcanic complex, with sediments of Cretaceous age, and with coastal belts of a white limestone (Pepino Formation) of Tertiary age. In 1915, Berkey[3] showed that the central mountainous complex (Cretaceous) is overlain unconformably by the Tertiary limestones of the north an south coasts (Arecibo Formation). The Tertiary in turn is overlain disconformably by a limited coastal belt of solidified dune sands and beach deposits (San Juan Formation) of Pleistocene to Recent age. He called the Cretaceous complex the "Older Series"; the Tertiary and Pleistocene formations the "Younger Series," and pointed out that the unconformity separating these two series is a profound one, the chief break in the geologic succession of the island. The work of Berkey, Semmes, and others has added much to our knowledge of the geologic structure of the island, especially of the Older Series rocks. However, the Younger Series is best developed in the northwest corner of the island, and it was not until work here had been completed that a detailed statement of the Tertiary formations could be made.

The Tertiary Formations.—The Tertiary formations are essentially a series of white limestones, part massive or reef-like, part well stratified. The beds are for the most part undisturbed, and dip gently seaward at angles of 4° to 6° on the north coast, and 10° or more on the south coast. Except locally, where slumping or slight warping has occurred, or faulting (on the south coast) these dips represent the initial angles at which the beds were deposited.

The Tertiary formations were laid down upon a slowly subsiding old land surface of considerable relief. The valleys of this old land surface were invaded by the sea during the initial submergence, and in them were deposited gravel, sand, mud, lignitic clay, and marl. Such deposits, with their alternation of fresh water, brackish water, and marine fossil faunas, now form the basal shale member of the Tertiary groups of the north and south coasts. Compared with the overlying limestones, this basal shale is local in distribution, and very variable in thickness.

The maximum thickness of the Tertiary group in the northwest part of the island (Lares District) is nearly 4,000 feet. On the south coast, Berkey[4] estimates the thickness at 3,000 to 4,000 feet. Evidence obtained in the Lares District seems to show that these beds were never deposited vertically to any such thickness, but are somewhat analogous to the fore-set beds of a delta. The limestones represent a series of fringing reefs whose maximum growth was outward rather than upward. It is believed that at the period of maximum submergence in Tertiary time, the central mountain chain of the island was not submerged. During sub-

[1] Presented before the Geological Society of America, Boston meeting, December 29–31, 1919.

[2] Porto Rico, *Nat. Geog. Mag.*, Vol. X., pp. 93–112, 1889.

mergence there was a progressive overlap from west to east. Thus in eastern Porto Rico and Vieques Island, the uppermost formation of the Tertiary group lies directly on the Cretaceous.

Origin.—These Tertiary limestones have been referred to as coral reef limestones. This is misleading, for while corals are abundant in the lowest reef limestone of the group, the overlying limestones are made up chiefly of foraminiferal and molluscan shells.

The so-called "Pepino" or "Haystack" hills (known as "Cock Pits" in Jamaica) are not individual reefs or reef-mounds, as might appear, but are the product of caving or slumping caused by an extensive underground drainage, aided by rapid surface solution. The result is a peculiar type of karst topography, seen on many of the islands of the West Indies, but nowhere so well developed as on the north coast of Porto Rico.

Subdivisions.—As a result of the work in the Lares District, the writer has made the following subdivisions of the Tertiary group of the north coast:

Arecibo Group	Quebradillas	limestone	700– 875 feet
	Los Puertos	limestone	550–1,000 feet
	Cibao	limestone	250–1,000 feet
	Lares	formation	350–1,275 feet
	San Sebastian	shale	max. 700 feet

In this classification, the names introduced by Berkey[5] have been used wherever possible. The term "Arecibo," introduced by Berkey, is used because the earlier name, "Pepino formation," of R. T. Hill is a purely lithological and topographical term, and is therefore undesirable.

On the south coast, no detailed subdivision has been made, but the names "Ponce" limestone and "Juana Diaz" shale (basal member) introduced by Berkey, are sufficient. After a careful study and comparison of a large collection of Tertiary fossils from the north and south coast formations, the following correlation is made, and believed to be essentially correct:

[4] C. P. Berkey, *op. cit.*, p. 14.

[5] C. P. Berkey, *op. cit.*

North Coast	South Coast
Quebradillas limestone Los Puertos limestone	Upper Ponce (including Guanica) limestone
Cibao limestone Lares formation	Lower Ponce limestone
San Sebastian shale	Juana Diaz shale

Age.—T. W. Vaughan,[6] from a study of fossil corals collected by R. T. Hill in the upper San Sebastian shale and lower Lares formation, concluded that the age of the "Pepino formation" is Middle Oligocene (Antiguan). C. J. Maury,[7] from a study of molluscan fossils collected in Porto Rico in 1914 by C. A. Reeds, concluded that the Quebradillas limestone is of Lower Miocene (Bowden) age, and that the "Rio Collazo shale" (= San Sebastian) is Middle Oligocene (Antiguan). The writer, from a study of a large collection of molluscan fossils from the Lares District, agrees with these conclusions, but would place the Quebradillas limestone (= Bowden) in the Upper Oligocene, rather than Lower Miocene. This departure seems to be warranted by the abundance of *Orthaulax* (several species) and *Ostrea antiguensis* throughout the Quebradillas. Furthermore, there is no faunal hiatus or disconformity to be found anywhere within the Tertiary group of the north coast. The entire series is a structural unit, as Berkey pointed out.[8]

The ages assigned to the north coast formations are as follows:

7. San Juan formation.........Pleistocene-Recent
.... Disconformity ....
6. Quebradillas limestone (= Bowden) } Upper Oligocene
5. Los Puertos limestone }
4. Cibao limestone } Middle Oligocene (Antiguan)
3. Lares formation }
2. San Sebastian shale }
....
.... Unconformity ....
1. Older Series ....Upper Cretaceous

BELA HUBBARD

[6] Bull. 103 U. S. Nat. Mus., p. 260, 1919.

[7] *Am. Jour. Sci.*, Vol. XLVIII., p. 212, 1919.

[8] C. P. Berkey, *op. cit.*, p. 15.

THE AMERICAN CHEMICAL SOCIETY. IX

An examination of Wisconsin oil of Monarda Punctata: Nellie Wakeman. (By title.) Following up the work on "A Possible New Terpene in the Volatile Oil of *Monarda Punctata*,"[5] reported upon at the New Orleans meeting of the American Chemical Society in 1915, another examination of the oil has been made. This study confirms in every particular the earlier report. The low boiling terpene fractions contain a hydrocarbon, $C_{10}H_{16}$, which yields a nitroso chloride melting at 89°. This in turn yields a nitrolpiperidide which melts at 198°–199° and a nitrolbenzylamide which melts at 103°. With aniline the nitroso chloride behaves like that of pinene, the regenerated hydrocarbon having a pinene-like odor, quite different from the original oil. The fraction boiling at 165°–168°, which gives the most abundant yield of nitroso chloride, exhibits the following physical constants at 20°. Specific gravity 0.8476; optical rotation + 4.48; index of refraction 1.4698. The low boiling nonphenol fractions also contain isovaleric aldehyde, identified by its p-nitro phenylhydrazone which melts at 108°–109°, also by oxidation to an acid and its determination as silver valerinate. The noncrystallizable phenol portion contains carvacrol, hitherto not known in this oil, identified by its phenyl urethane melting at 137°.

On hemoglobin, 1. Optical constants: Wm. H. Welker and Chas. S. Williamson. The absorption constants of hemoglobin from various species of animals were studied by means of the spectrophotometer. The hemoglobin was prepared by a method, which was more favorable for the removal of associated colloids than the older methods. Hemoglobin from the dog, ox, cat, chicken, guinea-pig, rat, sheep, horse, pig and man were studied. The results obtained would indicate that if there is any difference in the absorption constants of hemoglobin from different species, these differences are not sufficiently large to serve as means of identification of the species.

Analysis of pleural fluid from a case of chylothorax: Wm. H. Welker and Chas. S. Williamson. Quantitative analyses of pleural fluids obtained from cases of chylothorax are extremely rare in medical literature. The analysis of the fluid obtained from this case, follows:

	Per Cent.
Specific gravity	1.0199
Solids (total)	6.64
Ash (ignition at 750° C.)	0.85
Nitrogen (total	0.75
Nitrogen (non-colloidal)	0.02
Nitrogen (colloidal, calculated as protein).	4.56
Lipins (total)	0.79
Lipins (unsaponifiable)	0.75
Chlorin (calculated as NaCl)	0.73

Digestibility of avocado and certain other oils: H. J. Deuel and Arthur D. Holmes. (By title.) The experiments were carried on similarly to the previous ones in which the digestibility of about 50 different oils has been determined. With the exception of the avocado fat, the oils and fats included in this study incorporated in a special cornstarch blancmange or pudding were eaten with a simple basal diet (commercial wheat biscuit, oranges and sugar) which supplied only a very small amount of fat and tea or coffee was used according to personal preference. It was thought best to test the digestibility of avocado fat by serving the fruit as it grows with a simple basal ration very nearly fat-free, the avocado being eaten in such quantities that it supplied an amount of fat comparable with the fat consumed in other fat experiments. Weighings were made of all the food served and refuse remaining, the difference between the two representing amounts eaten. The fat of water-free feces was also recorded. Both food and feces were analyzed in order to determine the amounts of protein, fat and carbohydrate in each. The difference in the amounts of these constituents present in the food and in the feces was taken to represent the amounts of each actually utilized by the body. The estimated digestibility was avocado fat 82.5 per cent., capuassu fat 92.7 per cent., cohune oil 99.0 per cent., hempseed oil 98.5 per cent., palm-kernel oil 98.0 per cent., and poppy-seed oil 96.3 per cent. The digestibility of avocado fat is somewhat lower than that found for most fats and oils. While the intake of avocado fat varied somewhat with the different subjects, the data available is not sufficient to warrant any conclusions as to whether or not a smaller intake of avocado fat would have been more completely assimilated. The average amount of fat eaten daily in each of the experiments was: Avocado 90 grams, capuassu fat 40 grams, cohune oil 52 grams, hempseed oil 53 grams, palm-kernel oil 100 grams and poppy-seed oil 49 grams. The number of experiments re-

[5] Science, Vol. 42, p. 100.

ported in each group was 4 with the exception of hempseed in which three experiments were reported and poppy-seed in which 7 experiments were reported. The subjects reported no laxative effect in any of the experiments with the exception of slight disturbances with the capuassu fat which was similar to the disturbances caused by cocoa butter. The general conclusions are that these fats should prove valuable for food purposes and that cohune, hempseed, poppy-seed and palm-kernel oils are very completely assimilated by the body.

Experiments on the digestibility of entire wheat flour ground by various processes: C. F. Langworthy and H. J. Deuel. (By title.) It seemed advisable to determine what effect different methods of milling had on the digestibility of entire wheat flour so experiments were carried out with entire wheat flour ground in five different commercial processes. The different methods of milling used were: (1) A commercial roller mill, (2) roller mill of the Bureau of Chemistry, (3) burr stone mill, (4) steel burr mill, and (5) attrition mill. The experiments were conducted in the same manner as previous experiments of such a nature have been carried on by this office. The flour was incorporated in a ginger bread and fed with a basal ration of oranges, butter and sugar, and tea or coffee was used according to the individual preference. The general results from these experiments seemed to indicate that the finer the wheat is ground, the more completely the protein is absorbed while the percentage of carbohydrate absorbed remains nearly constant. Even in the most finely-ground flour, the protein was only 79 per cent. absorbed while in the case of highly-milled flour (*i. e.*, flour in which the bran has been removed), it has been found that it is about 88 per cent. digested. In the case of the flour milled on the stone burr and steel burr mills the digestibility of the carbohydrate was found to be 97 per cent. and 95.5 per cent. digested, respectively. The protein in each case was 79 per cent. digested. The digestibility of the flour milled on the attrition mill was 95.5 per cent. for the carbohydrate and 74.5 per cent. for the protein. With the commercial sample of roller-milled flour, 94 per cent. of the carbohydrate was digested and 70 per cent. of the protein, and with the sample prepared in the laboratory roller mill, the carbohydrate was 95 per cent. digested and the protein 71 per cent. Both the samples ground on a roller mill were considerably coarser than those ground on any of the other three mills. It is expected that a bulletin will appear shortly giving a summary of these experiments.

Adsorption of fat by fried batter and doughs and causes of their variations: Minna C. Denton and Edith Wengel. (By title.) The various ingredients of the dough exert varying effects upon fat absorption. The gluten of wheatflour, when acted on by hot fat of suitable temperature, tends to form a crust which prevents or hinders fat penetration; so the stiffer dough absorbs less fat, other things being equal. Sugar increases fat absorption very decidedly. Fat present as an ingredient of the dough, *greatly* increases the fat absorption. Egg, if not above 60 per cent. of the weight of the liquid (as is the case in doughnut recipes) does not lessen the fat absorption, but contrary to current opinion seems even to increase it somewhat. Many details of manipulation exert the most profound effects upon fat absorption. Length of time of frying and relative amount of surface exposed, are two of the most important. Crust formation is of the greatest importance. Any manipulation increasing volume (and consequently surface) increases fat absorption. Turning the cakes repeatedly as they fry increases fat absorption, because it promotes the exposure of a soft crust, to the hot fat. The influence of temperature upon fat-absorption (constant time, temperature 150° C. and 200° C.) is variable and depends entirely upon the consistency and ingredients of the dough. In practical cookery, however the time would be reduced at the higher temperature and this would lessen fat absorption. Temperature is important also because of its influence upon crust formation and upon expansion of the dough.

Charles L. Parsons,
Secretary

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

PLATINUM AND THE METALS OF THE PLATINUM GROUP

WHAT promises to be the most complete and authoritative work on platinum and platinum deposits is about to be published in Geneva, Switzerland. The author, Louis Duparc, is professor of chemistry and petrology in the University of Geneva; the name of Marguerite N. Tikonovitch is announced as that of the associate author.[1]

Professor Duparc has long been known as the writer of many papers on the great platinum deposits of the Ural region in Russia, of which he has made special study. He has also investigated personally the notable platinum deposits in other parts of the world, and he gives in the present work the ripe results of more than twenty years investigation of the sources of this rare metal.

The first chapter will be devoted to the topography and geological aspects of the Ural region. This is followed by a chapter treating of the "mother rocks" of platinum, and by others on the petrography of the primary platiniferous centers, the dunites and peridotites. Then, in turn, are offered considerations on the pyroxenites and koswites, the rocks of the gabbro family and various vein rocks. The view is then extended to cover the metamorphosic rocks accompanying the eruptive platiniferous zone.

Turning then to what more immediately concerns the metal itself, the constituent elements of native platinum are studied, and its state in the different primary deposits, as well as the probable genesis of these deposits. The writer now passes to the analysis and chemical

[1] Louis Duparc and Marguerite N. Tikonovitch, "Platinum and Platinum Deposits," pub. by "Société Anonyme des Editions 'Sonor,'" 46 Rue du Stand, Geneva, Switzerland, 600 pp., 99 text ill., 90 stereotype pls., 11 in black and color, 8 of dredges, etc., atlas of Ural deposits, 4°.

composition of platinum, as investigated by the ordinary methods used and certain new ones that have been applied. The average content of deposits is presented as a test of the eventual results of working them, and the differences in the composition of native platinum from the principal deposits are noted. Secondary deposits and platiniferous alluvial, and the extraction of platinum from alluvial, form the subject of two chapters.

The dunitic deposits of the Urals are very fully and extensively presented by Professor Duparc, who has investigated the occurrences of platinum in this region with especial care and thoroughness. The succeeding chapter is devoted to an equally exhaustive examination of the pyroxenitic platinum deposits of this region. Then comes a chapter on the deposits in other parts of the world; in San Domingo, Honduras, equatorial Colombia, Brazil and French Guiana, as well as in North America, where the deposits of the United States, of Mexico and of British Columbia are studied. To these succeed the deposits of Oceania, of Borneo, of New South Wales, Australia, of New Zealand and of Tasmania. Nor are the African deposits in the Transvaal forgotten, while the alleged deposits on the Island of Madagascar are duly mentioned. Asiatic deposits of the Wilui and the Oldoi rivers, and of the Altai, close this comprehensive description.

The treatment of the ore and the metallurgy of platinum are then gone into very fully, and the extraction and separation from one another of the various metals of the platinum group, such as palladium, iridium, rhodium, osmiridium and ruthenium. The melting and moulding of platinum closes this chapter.

The uses of platinum in the arts and industry are then presented, whether for apparatus employed in sulphuric acid concentration, for colalytic mixtures, in photography, in the manufacture of electrodes, in dentistry, in incandescent lamps, in laboratory apparatus, or for various other minor uses. Its employment in jewelry is also duly noted.

A concluding chapter gives a recapitulation of the main results and statistics of the world's production of the metal. This is followed by a bibliographical list.

The whole will form a quarto volume of 600 pages, with 99 text illustrations, 90 stereotype plates, 11 plates in black and colors, an atlas with 5 geological colored maps of the Ural deposits, and 8 plates giving illustrations of the principal installations of buddles, dredges, etc.

The work is issued by the "Société Anonyme des Editions 'Sonor,'" 46 Rue du Stand, Geneva, Switzerland. The first hundred numbered copies are not in trade; for the 500 numbered copies, running from No. 101 to No. 600, the price to subscribers is 100 francs; if purchased through booksellers, 125 francs will be charged.

An interesting recent publication of Professor Duparc (in collaboration with A. Grossett) is a study of the lately discovered platiniferous deposits of the Sierra de Ronda, Spain, in which he draws attention to the similarity of the conditions there to those observable in certain parts of the Ural region.[2]

The new edition of Professor James Lewis Howe's "Bibliography of the Metals of the Platinum Group," which has just appeared, may confidently be pronounced to be a realization of just what a bibliography ought to be.[3] Professor Howe acknowledges his indebtedness to a supplement of his earlier bibliography, issued in 1897, bringing this down to 1910, which was prepared by Dr. Hendrick Coenraad Holtz, then of Amsterdam; the few references in this supplement to American and English works were completed by Professor Howe, and the amplified record was brought down to the end of 1916.

[2] L. Duparc and A. Grossett, "Étude comparée des gîtes platinifères de la Sierra de Ronda (Espagne) et de l'Oural," *Mém. Soc. phys. et hist. nat. Genève*, Vol. 38, fasc. 5, p. 253, 1916.

[3] "Bibliography of the Metals of the Platinum Group, Platinum, Palladum, Iridium, Rhoduim, Osmium, Ruthenium, 1748–1917," by Jas. Lewis Howe and H. C. Holtz, Washington, D. C., 1919, 558 pp., 8vo; U. S. Geol. Surv. Bulletin 694. The first previous edition of 1897 (under the same title) bears only the name of Jas. Lewis Howe; published by the Smithsonian Institution, Washington, D. C., 1897, 318 pp. 8vo.

Professor Howe notes the value of an earlier bibliography he was able to consult, that of Professor C. Claus, contained in his pamphlet entitled "Fragment einer Monographie des Platins und der Platinmetalle." This was published in 1883 by the St. Petersburg Académie des Sciences, from manuscript sheets found among Claus's papers after his death, which had occurred more than twenty years before. The bibliography extends to the year 1861, but, owing probably to the illegibility of the manuscript, many errors have crept in; nevertheless the unique knowledge of this author in the domain of the platinum metals made it of great value. As only 300 copies were printed, this pamphlet is now very rare.

In Professor Howe's earlier edition (of 1897) there were given 61 titles before 1800; 737 between 1800 and 1849, and 1,642 between 1850 and 1896, making in all 2,440 titles. The following recapitulation shows the notable increase in the second edition:

Titles before 1800	65
1800–1849	749
1850–1899	1,823
1900–1916	1,924
Total	4,561

As will be noted, the literature for the seventeen years 1900–1916, gave a larger number of titles than were offered by the preceding half-century. This well indicates the growing importance of this rare and valuable metal. The titles are disposed chronologically, those of each year being separately numbered. In the indexes both the year and the number are given for each title, not the page of the bibliography. The author index, alphabetically arranged, covers 29 pages and embraces nearly 2,500 names. This is followed by an exceptionally full subject-index of 74 pages; under such subject the literature is given in chronological order, with year, number and author's name. It will be seen that no pains have been spared to facilitate the task of any one who is seeking for sources of information as to platinum or any of the platinum metals.

It is to be hoped that this bibliography will be continued, as Professor Howe is still in the prime of life, having been born August 4, 1859, at Newburyport, Mass. He graduated at Amherst in 1880, and received the degree of Ph.D. from Göttingen, Berlin, and Massachusetts Institute of Technology, successively. Since 1894, he has occupied the chair of chemistry in Washington and Lee University. He has done especially valuable work in the study of ruthenium and other platinum metals. He has published a very attractively written biographical notice of the French chemist, Chabaneau (1754–1842), the first maker of a platinum ingot. This weighed some 23 kilograms (about 50 pounds). The writer gives many details of Chabaneau's skill in using the newly-found metal for ornaments, after he had discovered the secret of making it malleable, by taking platinum sponge at a white heat, at the moment of formation, and hammering it repeatedly while in this state.

The titles dating from before 1800, beginning with the first printed mention of the metal in Don Antonio de Ulloa's "Relación histórica del viage á la América meridonal," Madrid, 1748, show that Sweden shares with France and England in the earliest investigations as to its composition and the best methods of refining it. With the names of Watson, Brownrigg, Lewis, Morin, Macquer and Buffon, must be associated those of Scheffer, Cronstedt and Bergman, nor should we forget the Germans, Marggraf and Count von Sickingen. The earliest records of the various platinum metals naturally attract one's attention. The first notice of palladium is in a communication of R. Chenevix to the "Philosophical Transactions," London, Vol. 93 (180–3), p. 290. Tennant's paper on iridium appeared in the *Transactions* for 1804, Vol. 94, p. 411, but his discovery dates from a year or two previous to this time; in 1804, A. F. Fourcroy and L. N. Vauquelin describe it in the *Annales de Chimie,* Paris, Vol. 49, pp. 188, 219. To W. H. Wollaston in 1804 is due the credit of the discovery and determination of rhodium (*Phil. Trans.,* London, Vol. 94 (1804), p. 419), and in the same year Tennant gives the first description of osmium, in connection with that of iridium. The discovery of the sixth member of the group, ruthenium, came much later, and was made by C. Claus in 1844; it was first announced in Russian, in his essay for the Demidov Prize, published at Kazan in 1844.

Professor Howe states that the compilation of his first platinum bibliography was probably due to a suggestion made by Dr. H. Carrington Bolton, and his special interest in the platinum group of metals was aroused by a chance remark of Dr. F. W. Clarke, who expressed surprise the chemists were not more interested in them.[4] The series of valuable studies in ruthenium, the least known metal of the group, and the indispensable bibliography, are fruits of thirty-five years of devoted application to the study of this series of metals.

The bibliography takes due notice of those indispensable aids to the investigator and student of the platinum metals, the annual reports of "Mineral Resources" by the United States Geological Survey, and those comprised in the year book entitled "Mineral Industry." In the former this subject has been successively treated since 1904, by David T. Day, F. W. Horton, Joseph Struthers, Waldemar Lindgren, and for several years past by Dr. J. W. Hill, who has contributed a particularly able study of the platinum deposits of the world to the *Engineering and Mining Journal* for 1917, Vol. 103, p. 1145. In *Mineral Industry*, from 1892, the reports have been furnished, in succession, by Charles Bullman, Henry Louis, Joseph Struthers, L. Tovey, Frederick W. Horton, F. Lynwood Garrison, and in the years 1916–1919 by the writer of the present notice, who also contributed the platinum data for the Eleventh Census (of 1890) with photographs he took while studying the deposits and has published in the *Bulletin of the Pan-American Union* for November, 1917, a paper entitled "Platinum: with especial reference to Latin America" (23 pp., with many illustrations), as well as another paper, in a later issue of the *Bulletin*, on the palladium deposits of Brazil.

A work of this kind makes a special appeal at the present time, when the manifold uses to which platinum and the platinum metals can be put, are better known than ever before. The intense demand for the metal in the munition factories, because of its superior resistance to the action of acids, brought it to the notice of many who had barely heard of it in times past. Still the fact that before the war some 500,000 ounces of it had already found employment for catalyzing purposes, as much more for electrical apparatus, at least 1,000,000 ounces for dental work, and another 1,000,000 ounces for chemical vessels, retorts, crucibles, etc., shows that its peculiar merits were recognized by many. Of late years it had become a favorite metal for gem-setting, more especially for diamond-setting, because of the refined beauty of its silvery hue, and its great durability. Another, analogous use, was in the finer articles of jewelry, wherein more truly artistic effects could be secured by its employment than by that of gold.

The gradual increase in value due to these circumstances had already been quite marked before the war. In January, 1909, an ounce of platinum was worth $24.10, only a few dollars more than an ounce of gold ($20.67) but by July, 1914, just before the outbreak of the World War its price had risen to $43.50; indeed it had commanded as much as $46.25 for a brief time in 1911. However, as a result of the special war demand, and of the interruption of the supply from Russia, which had produced annually 90 per cent. of the world's platinum, prices began to soar, until by the early part of 1918 the government set an official limit of $105 an ounce, and took at that figure the entire imports of the metal as well as part of the stocks on hand.

The end of the war, and the removal of this price-restriction, coupled with the sale of the stock accumulated by the government, brought about, for a very brief time, a trifling reaction to be soon followed by a resumption of the upward movement, so that at present, in February, 1920, as much as $165 has been paid for an ounce of platinum, making it worth considerably more than eight times as much as gold. Many coin collectors are familiar with the Russian platinum coins issued be-

[4] From a personal communication of Professor Howe's dated February 17, 1920.

tween 1828 and 1845, during which period 1,373,091 three-ruble pieces were minted, besides a few six-ruble and 12-ruble pieces. The three-ruble piece was worth $2.33 and it weighed 10.3 grams, for platinum was then worth but $7 an ounce; with platinum at $165 an ounce, the intrinsic value of such a coin to-day would be more than $54 of our money.

In view of the fact that the platinum output continues to be much smaller than some years ago, while the increasing demand for jewelry purposes offsets the falling off in the demand for munitions processes, it appears likely that the price will continue to go up, at least until the full resumption of platinum mining in Russia serves as a check. The search for the discovery of new sources is being diligently prosecuted, and Colombia seems the most hopeful of all the regions except Russia.

The newspaper notoriety given to platinum, because of the great legitimate demand for it and the consequent astonishing rise in value, before long excited the cupidity of dishonest persons. As a consequence of this there have been numerous thefts of the material. In several cases, valuable specimens of platinum have been purloined from museum collections, and chemical utensils made of platinum have been stolen from a number of chemical laboratories. Indeed, in one instance an entire university laboratory was burned down to hide the theft of platinum.

As to future prospects, an extensive development of the platinum resources in the Republic of Colombia is in active progress. Possibly Canada may contribute somewhat by improved methods of refining the copper-nickel ores, and similar ores mined elsewhere may also furnish considerable platinum. However, the most encouraging sign is the reported determination of Soviet Russia to issue platinum certificates, that is to say, certificates secured by the platinum stock that has been accumulated in Russia and has not fallen into the hands of the Allies, or will be mined now and in the future.

GEORGE F. KUNZ

SEXUALITY IN MUCORS. II

"NEUTRAL" RACES

As regards the intensity of sexual reaction, however, a gradation is clearly shown. A more detailed view of the complete table showing the combinations only where reactions might be expected, can be seen more clearly (Table I.). The higher grades of A and B predominate at the upper left-hand corner while at the opposite corner are only O's with C's and D's between. There is therefore in this species, varying degrees of sexual activity from the strongest down through the weakest to so-called "neutrals" which fail to show any sexual reaction under the conditions of the experiment. The word "neutral" is obviously only a relative term since, if the two races Nos. 811 and 367 had not been used as testers, No. 370 would have been classed as a neutral. It is possible that the 3 so-called neutrals would have taken part in zygospore formation if strong enough testers of the proper sex had been available or if more favorable environmental factors had been present. The fewer the number of tests made and the more unfavorable the environmental conditions, the larger will be the number of races listed as neutral from any collection of races of a given species.

A change in sexual activity tending toward neutrality may be brought about by environmental factors. Thus we have obtained a temporarily neutral condition in both the plus and minus races of *Mucor Mucedo* by growing them for several non-sexual generations at unfavorably high temperatures. The sexual activity can be regained in a few generations by cultivating them at low temperatures. In the same species the spores in a germ sporangium frequently are neutral in reaction but later become sexually active. One of my most active forms (*Mucor* V) has become much reduced in sexual activity since its opposite races were first separated some sixteen years ago. A similar reduction in sexual vigor resulting in neutrality has been reported in a number of species by other investigators. In *Phycomyces* the plus and minus spores in a germ sporan-

TABLE I

"Dark" Absidia

↓ Grade	Grade →	2.55	2.39	2.33	2.06	2.06	1.78	1.61	1.56	1.56	1.50	1.44	1.44	1.39	1.33	1.33	1.33	1.28	1.00	0.11	0.00	0.00	0.00
		Plus (+) Strains																			Neutral Strains		
		369	203	345	359	366	348	202	347	353	716	350	364	201	351	356	357	355	714	370	354	360	368
2.53	Minus (−) Strains 571	B	A	B	C	B	A	C	B	B	C	B	C	B	B	C	C	C	C	O	O	O	O
2.21	713	C	B	A	B	C	B	C	C	C	B	C	C	C	C	C	C	C	C	O	O	O	O
2.16	811	B	B	B	C	B	C	C	C	C	B	D	C	C	C	C	C	C	C	D	O	O	O
2.10	365	A	A	B	B	A	A	C	C	C	C	C	C	D	D	C	D	O	D	O	O	O	O
2.10	711	A	B	C	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	O	O	O	O
2.05	362	B	C	B	C	C	C	C	C	C	C	C	C	B	C	C	C	C	C	O	O	O	O
1.84	349	C	D	B	C	C	C	C	C	C	B	C	C	D	C	C	C	C	D	O	O	O	O
1.84	352	B	C	C	C	C	C	C	C	C	C	C	D	D	C	C	C	C	C	O	O	O	O
1.68	363	B	B	B	D	C	C	C	C	O	C	O	C	C	O	C	C	C	C	O	O	O	O
1.58	572	B	B	C	C	C	C	C	C	C	C	D	D	C	O	D	D	C	O	O	O	O	O
1.58	715	C	C	B	C	C	C	C	D	C	O	C	C	C	C	D	C	D	O	O	O	O	O
1.42	346	B	C	D	A	C	D	C	D	C	O	C	D	D	D	C	D	D	O	O	O	O	O
1.42	367	C	C	C	D	C	D	D	C	D	C	D	D	D	D	D	C	C	D	D	O	O	O
1.42	712	B	C	C	B	C	C	D	D	D	O	D	C	D	C	D	D	D	D	O	O	O	O
1.11	371	C	C	C	D	D	D	C	D	C	D	C	D	D	D	O	O	O	O	O	O	O	O
0.68	358	D	C	D	D	C	O	D	D	D	D	D	D	O	O	O	O	O	O	O	O	O	O
0.53	717	C	C	D	C	C	O	O	O	O	O	O	O	O	D	O	O	O	O	O	O	O	O
0.26	638	D	D	C	D	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
0.00	Neutral Strains 354	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		O	O
0.00	360	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		O
0.00	368	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	

gium may produce mycelia, neutral toward each other, though reacting with the plus and minus parent stocks. Here again the neutrality or self-sterility is only temporary, since after a few spore generations their ability to take part in active zygospore formation *inter se* is completely established.

In nature the number of neutral strains appears to be large and many species have been studied, the races of which have never been induced to react, either *inter se* or with strong testers of other species. There is no evidence that even in these cases, the neutrality is absolute and the races completely devoid of sexual tendencies. Their apparent neutrality may mean merely that we have not yet happened to expose these forms to the peculiar environmental conditions necessary for an expression of the sex which is actually present.

SEXUAL DIMORPHISM

Similar tabulations of the sexual reactions between their races have been made for several species beside the "dark" Absidia and with similar results (Table II). All the races which were able to assist in zygospore formation appear to be sexually dimorphic, consistently either plus or minus. A few investigators have believed they have found evidence in certain species that would militate against sexual dimorphism in the diecious mucors. In a specific instance (8), however, where it was possible to retest the material upon which such conclusions were based, it was found that the dimorphism was in fact present but, for

TABLE II

SUMMARY, DECEMBER 19, 1919

	No. Locations Represented	No. Gross Cultures	No. Races	No. Combinations Possible $\left[c = \frac{n(n-1)}{2}\right]$	No. Testers Used	No. Combinations Made	Plus (+)	Neutral (N)	Minus (−)
Absidia cœrulea	3	12	22	231	22	*231	4	5	13
A. glauca	5	5	10	45	10	*45	4	0	6
A. sp. (whorled)	11	15	34	561	34	*561	14	2	18
A. sp. (dark)	13	26	40	780	40	*780	19	3	18
Phycomyces			15	105	15	*105	11	3	1
Cunninghamella bertholettiae	18	36	92	4,186	14	1,183	13	8	71
C. elegans	1	16	42	861	12	426	25	1	16
C. echinulata	14	25	72	2,556	2	141	9	55	8
Syncephalastrum	18	35	80	3,160	18	1,269	37	4	39
Circinella spinosa	13	28	54	1,431	4	206	36	5	13
Rhizopus			236	27,730	20	1,574	89	85	62
Choanephora cucurbitarum	2	19	33	528	10	275	5	0	28
Total			730	42,174	201	6,796	266	171	293
Mated strains not listed above			34		4	102	16	0	18
Unmated strains			248		4	511	51	108	89
Total additions			282		8	613	67	108	107
Total			1,012		209	7,409	333	279	400
Zygospore Germinations									
Mucor Mucedo			512		514	1,280	46	432	34
Phycomyces			392		394	980	258	16	118
Zyg. Germ. totals			904		908	2,260	304	448	152
Grand totals			1,916		1,117	9,669	637	727	552

* All possible combinations made.

various reasons, has been misinterpreted by the investigator.

Burger, in a recent paper (11) concludes that sexual dimorphism does not exist in the mucor genus *Cunninghamella.* He reports finding certain races, among 25 or 26 of *C. bertholettiæ* studied, which will form zygospores with both plus and minus races. In other words a race A will conjugate with race B, B conjugates with C and C conjugates with A, and the family triangle is complete. In personal conversation, Dr. Burger has told me that he has found a similar condition in *Syncephalastrum.* It is not appropriate at the present time to enter into a discussion of Burger's paper. It will be sufficient to say that we have used some of the same strains that he worked with and, except for infections in an early series of contrasts before we discovered the great danger in *Cunninghamella* of contamination of a culture with spores of the opposite sex, we have never had results at all comparable with his. The negative results obtained by us do not, of course, prove that sex intergrades or hermaphrodites never occur in diecious species. He would be a rash philosopher who would deny to any protoplasm the possibility of reacting in an unexpected manner. They do indicate, we believe, that the occurrence of such sexual conditions must be, at best, a rare phenomenon. In view of the work tabulated in the accompanying table, it seems wisest therefore, to leave out of discussion, for the present, unconfirmed conflicting conclusions which are based on relatively meager material.

In the first 5 species of the table (those marked with a star) all the possible combinations have been made. For the others it would obviously have been too enormous a task to have been profitable. The races from zygospore germinations have been added as being likely to show through segregation sexual abnormalities if such existed. Nearly 10,000 combinations have been made using nearly 2,000 different races of diverse types of mucors and no race of a diecious species has been found which, if it showed any sexuality at all, reacted other than as a plus or a minus.

We have just been discussing *intra*-specific sexual reactions. The next table shows *inter*-specific reactions previously discussed under the term "imperfect hybridization." In testing the reactions between the plus and minus races of two different species, all the four possible interspecific combinations have been made but, since the combinations between races with like signs have never given reactions, they have been omitted from the table. Only a part of the possible combinations have yet been tested, but sufficient to indicate that the same sexual dimorphism exists in all the species investigated.

We feel justified in concluding from our experience, that the forms in the tables are sexually dimorphic. From our experience with the diecious sporophytes of willows and poplars, such a strict dimorphism was hardly to have been expected. It would be a safe wager that one could not examine even a hundred individuals of either of these genera without finding sex intergrades. The apparent sharper differentiation of sex in the diecious mucors in comparison with higher plants is perhaps connected with the fact that in mucors we are dealing with sexually differentiated gametophytes instead of with sporophytes.

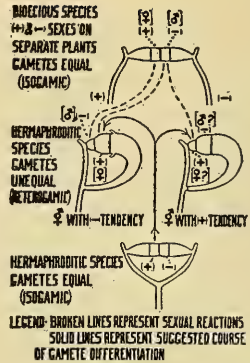

Fig. 4. Diagram illustrating sexual reactions and gamete differentiation.

GAMETE DIFFERENTIATION

I should like to close our discussion by a consideration of gamete differentiation in mucors and other forms. As a general rule, all of the diecious mucors represented at the top of the chart (Fig. 4) have gametes equal in size. Of the hermaphrodites there are two types—those with equal gametes (isogamic), figure below, and those with a constant and marked difference in size (heterogamic), figures at right and left. We can conceive of the hermaphrodites as having been derived from the diecious types or the diecious types from the hermaphrodites. If the latter be the actual course of evolution, we may conceive a differentiation of sex to have taken place in two directions beginning with the isogamic hermaphrodites—first toward a differentiation, chiefly physiological, separating the sexes on separate plus and minus individuals in diecious forms; second toward a differentiation, conspicuously morphological, bringing about a constant difference in the size of the gametes in the heterogamic hermaphrodites. The prevalent biological distinction between males and females is based ultimately upon the relative size of the gametes which they produce. The smaller gamete is considered the male; the larger recognized in the left figure by the outgrowths behind it, is considered the female. The diagram (6) shows the reactions obtained in attempting, by use of this criterion of sex, to homologize the plus and minus signs with the terms male and female or vice versa. The hermaphrodite, which is heterogamic, is grown between the plus and minus races of *Mucor* V. On the right its smaller gamete reacts with the plus race and on the left its larger gamete reacts, though but weakly, with the minus race. The smaller gamete is therefore minus and the larger plus. On the assumption that the smaller gamete is male and the larger female, the minus race must be considered male and the plus race female.

In our previous diagram (Figure 4) we recognize on the left the heterogamic species (*Absidia spinosa*) just discussed, by the outgrowths back of the larger gamete. That heterogamy has actually been derived from isogamy in this species is rendered probable by Lendner's report (12) of finding a race of the same species with equal gametes. The broken lines, connecting the unequal gametes on the left with the plus and minus diecious species above, represent the reactions which have taken place and indicate that the larger gamete is plus and the smaller gamete, minus. The isogamic hermaphroditic species below also reacts with the diecious form above and hence its gametes also may be labelled plus and minus. The plus gamete of the lower isogamic species may be considered, in the process of evolution, to have given rise to the larger gamete of the left-hand figure as indicated by the solid line. This is an orthodox interpretation and consistent with the facts so far discovered for this species. There are some facts, however, which indicate that such is not the necessary course of evolutionary development in all forms.

It has been shown that although the plus race is perhaps usually more vigorous than the minus, this condition is sometimes reversed. Some hermaphrodites have predominatingly plus and some predominatingly minus tendencies. Is there any intrinsic reason why, of two equal gametes, the plus should invariably become the larger in the process of size differentiation? I do not believe that there is. If not, we should expect to find forms like the one figured on the right where the plus gamete is represented as having given rise to the smaller of the heterogamic pair. In *Zygorhynchus heterogamus*, we have perhaps such an example. The evidence is not entirely conclusive since we have obtained reactions as yet only with one of the paired test races and the larger suspensor fails to show outgrowths which might help in distinguishing the unequal gametes when reacting with other forms. However, the appearance of the reactions between the right-hand figure and the minus race resembles that between the left-hand figure and the plus race. The figure on the left has a minus tendency, the same as its smaller gamete while the figure on the right has a plus tendency also the same apparently as its smaller gamete. No one realizes more strongly than the speaker that the specific case under discussion is in need of more thorough investigation. Whether or not my suggested interpretation of the right-hand figure proves to be the correct one, it will serve to call attention to the fact that those who define male and female in terms of size differentiation in the sex cells are making the gratuitous assumption that quantitative differences in the gametes are the fundamental peculiarities of the two sexes. I have used from preference, therefore, the terms plus and minus because I have wished to speak in terms of the physiological differentiation into sexually dimorphic races established in diecious species rather than in terms of male and female which are defined by differentiation in size of gametes and which conceivably may be secondary sex characters.

I trust it will be granted that there is something fundamental, common to all the plus races that causes them to react sexually with minus races in the same or in different species and that this same fundamental something is present also in hermaphroditic forms whether possessed of equal or of unequal gametes. Dr. Gortner and I some years ago started an investigation based upon the assumption that the fundamental differences between the sexes might possibly be bound up with differences in sex proteins. The work was unfortunately interrupted before a definite conclusion could be reached with the delicate blood reactions employed. If we are able to imagine some fundamental biochemical constitution such as a sex protein, common to all the plus protoplasms in the mucors, we may be able to spur our imagination still further to conceive of this same constitution as existing in one of the two sexes in all organic forms. It might then be theoretically possible by proper technique to obtain reactions with our isogamic plus and minus races of the mucors and thus have males and females in different groups of plants and animals compared on a common and fundamental basis. If this highly imaginative proceedure were possible, is there any reason to believe that the so-called males in all groups of plants and animals would invariably be related to the same sex—plus or minus of the mucors? It might transpire that the so-called females of the moths and birds, to take an extreme example, would be found by their reactions with test mucors to bear the same sign—plus or minus—as the males of flies and mammals.

Sex has apparently developed independently many times in different groups of plants and animals. The term male and female are applied to the end products seen in visibly dimorphic gametes. There is no assurance that these terms have laid hold of the fundamental differences between the two sexes. Spines, superficially similar, are developed on the porcupine, jimsonweed and sea urchin, yet these have no close genetic relationship to one another. They are examples of parallel development in unrelated structures—in other words they are to be considered analogous rather than homologous organs. Is it not possible that visible differences in dimorphic gametes are also analogous rather than homologous; that the sperm in one form may be homologous to the egg in another form? It is suggestive in this connection that the males of mammals have this in common with the females of birds—that they produce two kinds of gametes. Moreover, it is the sex glands of the male of mammals and of the female of birds which form hormones influencing profoundly the expression of the secondary sex characters, albeit in a somewhat different manner. I do not suggest that in starting with human terminology, as we generally have done in describing lower organisms, we should call the rooster a female and the hen a male. I wish merely to call attention to inadequately explained sexual phenomena in higher forms in which similarities in the gross morphological differentiation of the so-called male gametes of two forms are not associated with certain physiological peculiarities which are common rather to the opposite sexes.

It seems reasonable to consider in mucors the physiological sexual differentiation into plus and minus races, more expressive of any fundamental peculiarities of sex, if such actually exist, than the size differences and associated phenomena in higher forms. Sperm cells, in addition to being gametes, are organs of locomotion and the egg cells, in addition to being gametes, are storage cells to supply nourishment to the developing zygote. Motility in the sperm and storage in the egg we can conceive of as secondary rather than primary sex characters. It is not alone the gametes of higher forms in which we find differences associated with the diverse functions of bringing the gametes together and nourishing the zygote formed by their union, but also the two sexual organisms themselves may have their sexual differences related directly or indirectly to these same somewhat conflicting functions.

The diecious mucors seem largely free from such secondary sexual characters which may tend to obscure more fundamental sexual differences. Their gametes are normally equal in size and nourishment for the developing zygote is supplied approximately in equal amounts from both sexes. Moreover, in those few forms in which the conjugative filaments seem to exercise attraction toward each other, such attractions seem to be mutual and equal.

It would carry us too far to attempt to meet the objections of cytologists or of others to our hypothesis of gamete differentiation or to attempt to show in what other ways the sexual differentiation in mucors may be of interest to students of higher forms. We will be satisfied, however, if we have shown that the simple bread mold may eventually be of some service in helping to solve the fundamental problems of sex, for we believe that many of these problems are to be solved only with the structurally simpler forms of life like the mucors.

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SCIENTIFIC EVENTS

THE DIVISION OF STATES RELATIONS OF THE NATIONAL RESEARCH COUNCIL

A statement concerning the work of the division has been issued by the council, in which the chairman, Professor John C. Merriam, of the University of California, writes:

The Division of States Relations is organized with special reference to the consideration of research interests related to organization of the states as political and economic units. In our commonwealth the state presents an important form of organization for the development of certain aspects of science. The function of science in such a unit is to direct the conservative use of the state's natural resources, to increase productivity, to improve sanitation, and in other ways to promote prosperity and the public welfare. The purposes of this division may be stated in simplest form as follows:

1. To obtain information as to the most effective types of organization for groups of departments concerned with research within state governments.

2. To become acquainted with the best methods of cooperation among the institutions within the state—educational, commercial and industrial—which are concerned with scientific research.

3. To study the wider outside relations of research in state organizations, including the contracts with activities of other states and with national agencies of the country.

However, much information upon the present situation is needed before steps can be suggested for the closer coordination of state scientific agencies. The division is, therefore, undertaking a study of the present relationships of the various scientific agencies in the government of a number of the states. Several systems for the organization of state scientific departments are in operation, some, presumably, with better effect than others. Relations have been variously developed between these state departments and the scientific groups in state educational institutions. The relation between research work in many state departments and the work of enforcing the regulations based upon scientific investigation has attracted attention from the point of view both of science and of political economy. Moreover, determination of the most satisfactory forms for central bodies which may be used to organize scientific effort within states, and of the auspices under which such bodies should act will require much careful study. The nature of the state organization must be adapted to the particular situation found in the state in which it may seem desirable to organize such a body. It is believed that careful review of present conditions and of means for improving them is warranted by the possible gains in the progress of science and the advance in public welfare which may be expected from the most rational development of these scientific agencies. The division bespeaks the cooperation in this study of all those who are interested in this aspect of the advancement of science.

SUMMER MEETING OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The summer meeting of the institute will be held in Canada. The date has been fixed tentatively as June 21–26. Plans as worked out at present include a meeting of two days, Monday and Tuesday, at Montreal, for the business sessions, reading of papers and possibly one or two excursions to chemical industries in Montreal.

The program of papers to be presented is being prepared and the secretary desires information as to papers being prepared for presentation at this meeting. Members are urged to present to the society as many papers as possible in order to make the meeting profitable and the *Transactions* valuable. Papers on any phase of chemical engineering work would be welcome. A special endeavor is being made to secure papers on electrolytic industries and papers on this subject are especially desired.

Wednesday will be spent at Ottawa visiting the copper and nickel refinery of the British-American Nickel Corporation, also inspection of the government buildings and the laboratories of the Bureau of Mines.

Thursday and Friday will be spent at Shawinigan Falls seeing the power development and the electrolytic industries located in this vicinity.

Saturday will be spent at LaTuque where we have secured permission from the Brown Company for a visit to the very large sulphate pulp mill where the explosion process described by Hugh K. Moore at our Savannah meeting is in operation. From this point a trip is being planned to the very large artificial lake which has been made at La Loutre. This includes a 50 mile boat trip, stopping at a fishing camp on the lake where there will be opportunity for motor boating and fishing. After a stop of a day or two in this very picturesque and wild part of Canada, the return trip will be made to Quebec.

J. C. Olsen,
Secretary

THE AMERICAN PHYSICAL SOCIETY

The one hundred and third regular meeting of the American Physical Society will be held in Washington, at the Bureau of Standards, on Friday and Saturday, April 23 and 24. The first session will begin at 10 o'clock on Friday morning. The program contains the titles of forty-six papers.

The other meetings for the calendar year will be as follows: The Thanksgiving meeting, on November 27, will be held at Case School of Applied Science in Cleveland, instead of in Chicago. The annual meeting, beginning on December 28, will be held in Chicago, this being the occasion of the special Quadrennial Meeting of the American Association for the Advancement of Science and the Affiliated Societies. The October meeting will be omitted for the year 1920.

The Pacific Coast Section will hold a meeting at the University of Washington, in Seattle, at the time of the meeting of the Pacific Division, A. A. A. S., June 17–19, 1920. Correspondence relating to this meeting should be addressed to the Secretary of the Pacific Coast Section, Professor E. P. Lewis, University of California, Berkeley, California.

Dayton C. Miller,
Secretary

Case School of Applied Science

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences will hold its annual meeting at the U. S. National Museum, Washington, D. C., April 26, 27 and 28. The William Ellery Hale Lecture will be given on April 26 by Dr. Harlow Shapley, of the Mount Wilson Solar Observatory, and Dr. Heber D. Curtis, of the Lick Observatory, on "The Scale of the Universe."

The American Philosophical Society is holding its general meeting in Philadelphia on April 22, 23 and 24. On the evening of the twenty-third, Professor R. W. Wood, of the Johns Hopkins University, lectures on "Invisible Light in War and Peace."

DR. JAMES R. ANGELL, professor of psychology in the University of Chicago and dean of the university faculties, this year chairman of the National Research Council, has been elected president of the Carnegie Corporation, New York.

PROFESSOR THEODORE W. RICHARDS and Professor George D. Birkhoff, of Harvard University, have been elected members of the Danish Academy of Sciences.

THE Royal Irish Academy has elected as honorary members Professor George Ellery Hale, Professor A. E. H. Love, Sir Ernest Rutherford and M. Henri Louis le Châtelier.

THE founder's medal of the Royal Geographical Society has been awarded to Mr. H. St. John B. Philby, for his two journeys in south-central Arabia, 1917 and 1918; the Patron's medal to Professor Jovan Cvijic, rector of the University of Belgrade, for studies of the geography of the Balkan Peninsula; the Victoria medal to Lieutenant-Colonel H. S. L. Winterbotham, for his development of scientific methods of artillery survey and the production of maps of inaccessible areas.

OFFICERS of the Malacological Society of London for 1920 were elected at the annual meeting on February 13 as follows: *President:* G. K. Gude; *Vice-Presidents:* H. O. N. Shaw, T. Iredale, J. R. le B. Tomlin, and A. S. Kennard; *Treasurer:* R. Bullen Newton; *Editors:* B. B. Woodward; *Secretary:* A. E. Salisbury.

A CORRESPONDENT writes: "The many friends of Professor Ludwig von Graff, formerly head of the Zoological Institute of the University at Graz, Austria, and well known for his work upon the Plathelminths, will be sorry to hear that he is suffering with arteriosclerosis, and that since the beginning of the war he has not been able to do any mental work. Owing to the great depreciation of Austrian money, he and his family are in straitened circumstances."

WILLIAM T. SEDGWICK, professor of biology at the Massachusetts Institute of Technology, left the United States this week for England, where he will serve as the institute's first exchange professor to the universities of Leeds and Cambridge.

DR. EDWARD P. HYDE, director of the Nela Research Laboratory, Cleveland, sailed for Europe on April 13, in connection with business for the International Commission on Illumination, of which he is the vice-president. He expects to return to this country in July.

DR. J. O. HALVERSON, associate in the department of nutrition of the Ohio Agricultural Experiment Station, the past three years, has been appointed to take charge of similar work in the Agricultural Experiment Station at Raleigh, N. C.

MR. R. A. MCGINTY, associate professor of horticulture in the Colorado Agricultural College and Experiment Station, has resigned to enter the employment of a canning company at Canon City, Colorado.

MR. R. H. BULLARD, instructor in chemistry at Hobart College, has accepted a position in the research department of the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J.

DR. PIER ANDREA SACCARDO, the distinguished mycologist and professor emeritus of the Royal University of Padua, Italy, died on February 12, in the seventy-fourth year of his age. Professor Saccardo was a member of numerous academies and societies both Italian and foreign, and is known to all pathologists and mycologists by his great Sylloge Fungorum.

MR. J. S. MACARTHUR, the English industrial chemist, known for his part in the discovery of the cyanide process for the extraction of gold and other metals, and for the work in chemistry and mining, died on March 16.

THE Dartmouth Scientific Association organized in February, 1870, observed its fiftieth anniversary on the 18th inst. by the presentation of an address on "The Founders" by the only living member of the original seven, Dean-Emeritus Charles F. Emerson. Professor Emerson has been an active member from its organization, as he has been connected with the college as student and teacher for fifty-five years, and has seen the College expand from 176 students to 1738. So far as reports from colleges and universities in America could be secured, this Scientific Association has maintained the longest continued existence without a lapse of meetings, twice a month, except vacations. The association is now in a most prosperous condition with about 70 members.

Northwestern University department of chemistry has received a grant of $3,500 from the Interdepartmental Social Hygiene Fund of the United States Government. This fund is for the purpose of supporting research leading to the development of new metallo-organic compounds which may prove of therapeutic value in the treatment of syphilis of the central nervous system. A plan of cooperation has been worked out between the Universities of Wisconsin, Minnesota, Illinois, and Northwestern whereby all pharmacological work will be done by the first-named institution and the synthesis of new compounds by Minnesota, Illinois and Northwestern in cooperation.

A sum of money has been raised by the olive growers and the canning industry for an intensive study of botulism in California. The investigation will be conducted in the laboratories of the Stanford University Medical School and the George William Hooper Foundation for Medical Research of the University of California and has the cooperation of the U. S. Health Service and the California State Board of Health. The investigation will include a careful study of the distribution of the *Bacillus botulinus* in nature, of the ways in which food materials may become infected and of the steps necessary to destroy the organism when it has infected raw food materials. A staff of specially trained workers has been engaged and it is expected that the work will require at least two years.

Concurrently with the introduction of a bill into the United States Senate by Senator Johnson providing for the establishment and maintenance by the United States Forest Service of a Forest Experiment Station in California in cooperation with the University of California, the Division of Forestry at the State University has expressed the opinion that such an experiment station "would be of great importance to every one interested in California forests." It was stated that the Forest Products Laboratory established about ten years ago at the University of Wisconsin has not only developed into a large and important institution doing work known throughout the country, but that it is now the leading institution of its kind in the world. "There is no reason why the Forest Experiment Station proposed for California to enable scientific investigation of forestry problems should not also become the leader in its field." An initial appropriation of $25,000 is suggested in Senator Johnson's bill, it was stated. The work of the staff of the proposed station would be carried on in cooperation with the faculty of the Division of Forestry of the University of California.

A british Association of Research for the cocoa, chocolate, sugar, confectionery, and jam trades has been formed in accordance with the government scheme for the encouragement of industrial research. The association will establish and maintain laboratories and conduct experiments, and powers are also taken to encourage the technical education of persons engaged or likely to be engaged in the allied trades. The government will contribute, with certain limits, out of the funds of the Imperial Trust for the encouragement of scientific and industrial research a sum equal to that subscribed by the members themselves for five years.

Among recent appropriations made in Cuba there is one providing $225,000 to remodel the Hospital Las Animas of Havana and to erect a monument to Dr. Carlos Finlay at the entrance of the hospital.

The Rockefeller Institute for Medical Research has received a letter from Surgeon-General William C. Braisted, U. S. Navy, testifying to his appreciation of the valuable aid rendered by the institute in connection with the War Demonstration Hospital, New York City. The assistance was not limited to the active period of the war, but continued after the signing of the armistice.

THE eighteenth annual meeting of the North Carolina Academy of Science will be held on April 30 and May 1, at the N. C. State College, West Raleigh. Professors A. H. Patterson, physicist, and R. W. Leiby, entomologist, are president and secretary-treasurer, respectively.

UNIVERSITY AND EDUCATIONAL NEWS

THE family of Henry Phipps have given $500,000 to the Henry Phipps Institute of the University of Pennsylvania for the study of tuberculosis.

MR. JAMES F. BRADY and Mr. Vincent Astor have subscribed $250,000 to the two million dollar endowment fund of the New York Post Graduate Medical School as soon as the first million dollars has been raised.

DR. ALBERT W. SMITH, dean of the college of mechanical engineering of Cornell University, has been appointed acting president of the university during President Schurman's leave of absence. President Schurman will resume office on June 1, retiring on June 23.

MR. ALBERT E. WHITE, formerly head of the metallurgical branch, technical staff of the Ordnance Department, has returned to his former position as professor of chemical engineering at the University of Michigan, Ann Arbor, Mich.

DR. WILLIAM LEONIDAS BURLISON, professor of crop production of the University of Illinois, has been appointed head of the department of agronomy, to fill the vacancy caused by the death of Dr. Cyril G. Hopkins.

DISCUSSION AND CORRESPONDENCE

CEREBELLAR LOCALIZATION BY THE APPLICATION OF STRYCHNINE

THERE exists, at the present time, a considerable diversity of opinion with respect to the localization of functions in the cerebellum. The conception of cerebellar localization is based on the studies of Elliot Smith, Bolk, van Rynberk, André-Thomas and Bárány. Nevertheless, in a recent study of war wounds involving the cerebellum, Gordon Holmes was unable to find definite evidence in support of the localization doctrine.

The present writer is conducting a series of experiments in which an effort is being made to solve the problem by the application of strychnine to the cerebellar cortex. The experiments are being performed on cats anesthetized with chloroform and ether. Tracheotomy is carried out and both carotid arteries are ligated. The left cerebellar hemispere is then exposed. A 1 per cent. solution of strychnine nitrate containing methylene blue is applied to the surface with a small pledget of absorbent cotton. Any excess is carefully wiped off and spreading to the medulla oblongata is precluded by the use of thick vaseline. The area covered by the strychnine solution apparently embraces the "crus secundum" and to some extent the "crus primum" of Bolk. The crus secundum, according to van Rynberk, is concerned with the ipsilateral hind limb, whilst the crus primum is concerned with the ipsilateral forelimb.

After applying the strychnine the animal is laid on its back and the narcosis is allowed to subside slightly. Within about 5 minutes it is found that flexion applied to the ipsilateral (left) hind leg at ankle, knee and hip evokes a succession of regular tremors which may persist for an indefinite period. Mechanical stimulation or faradization of the pads of the foot yields a like result, which is also evokable by induction of the knee-jerk. Frequently the leg is carried by the rhythmical tremors into a condition of sustained extension, which recalls vividly the condition met with in "decerebrate rigidity."

Application of the above-mentioned modes of stimulation to the contralateral (right) hind leg is usually without result but at times phenomena of similar kind are induced. These, however, are weaker and of shorter duration than in the ipsilateral limb. It appears possible that when a minimal quantity of strychnine is employed the reactions described will be found to be confined to the ipsilateral hind leg. Together with the hind limb phenomena just described there is usually to be noted a rigidity affecting both forelimbs, which again strongly recalls the appearances of decerebrate rigidity.

The reactions above depicted do not appear to be due to an action of the strychnine on the spinal cord and bulb, since the symptoms are confined to the hind and forelimbs. Vigorous stimulation of other parts of the body, *i. e.*, the trunk and head elicits not the slightest indication of strychnine convulsions. There is no opisthotonus; the lower jaw is constantly relaxed and the mouth open.

Magnini and Beck and Bikeles had previously applied a solution of strychnine to the cerebellar cortex for the purpose of localization. The effects described by these authors were, however, of an indefinite character and involved widely-separated regions of the body. According to Luciani the reactions were in part due to diffusion of the drug to the medulla oblongata and the observations of the writers cited lend no support to the doctrine of cerebellar localization. In my experiments, on the contrary, precautions were taken to prevent spread of the drug to the medulla oblongata and the symptoms themselves were of a definite and restricted nature. My experiments are being continued on the cat and the method will be extended to the study of the cerebellum of the dog, monkey and other animals.

Frederick R. Miller
Western University Medical School,
London, Canada,
March 22, 1920

A LOGIC TEST

To the Editor of Science: I have lately came upon what I regard as the very best Logic-Puzzle that I have ever met with; that it is good is proved by the fact that the people I have put it to have been somewhat equally divided as to whether they answer yes or no to the question involved. Moreover, it is an actual case—a real advertisement of a clothing store that I had the good luck to find in a recent newspaper. This is it:

> We have all known from our youth up that to err is human. If this is so, it must be that all of our competitors are thoroughly human.

The implication is, of course, that "our competitors" are people who make (in their cutting and fitting) plenty of errors, and the inference drawn is that this proves them to be human. Now this is either good reasoning or bad; which is it?

I should be extremely glad to receive answers to this question, and especially if they are accompanied with the grounds for the answer—yes or no.

Christine Ladd-Franklin
Columbia University,
March 2, 1920

THE SITUATION OF SCIENTIFIC MEN IN RUSSIA

A recent letter to Science (March 26, 1920, p. 322) having brought up the question of "the situation of scientific men in Russia," with particular reference to Professor Pavlov, it seems fitting to publish the following letter from Professor Boris Babkin, who was for many years assistant to Professor Pavlov. We are all interested in the welfare of our scientific colleagues in Russia as well as in other countries, and this direct statement may throw some light on the situation.

H. Gideon Wells
The Otho A. Sprague Memorial Institute,
Chicago, Ill.,
April 5, 1920

Dec. 17, 1919.
Physiological Laboratory,
University of Odessa.

Dear Professor Wells,

I take advantage of my old acquaintance with you in E. Fischer's laboratory and beg you to assist me in the following matter.

The bolshevik revolution has brought Russia into such a state that not only has scientific work come to a standstill, but even our lives are in danger. Many professors have been put to death, many are in prison. I consider it necessary to continue my scientific activity. I therefore beg you to help me to find a post in some physiological laboratory in the U. S. I do not know English well enough to give lectures just at present but in one to one and one half years I would be able to do so. But now I think I could be of use in some research institution.

I have a similar request to make to you on behalf of my friend Privat Docent A. A. Kronforsky, lecturer on pathology and bacteriology at the University of Kieff, whom I can recommend most warmly. He would emigrate to America for the purpose of continuing his scientific work.

Please be so kind to direct your reply (if it is possible cable me) to British Consulat General in Odessa for Professor B. P. Babkin, Physiological Laboratory, University of Odessa.

With kind regards,

Yours sincerely,
B. Babkin

QUOTATIONS

RESEARCH AND THE UNIVERSITIES

"Imitation research" is the latest object of attack by the Carnegie Foundation for the Advancement of Teaching. "Much," declares the report "of that which has gone on in American universities under the name of research is in truth only an imitation." This is a strong statement. Most persons familiar with the facts, it is safe to say, will feel that it should be modified by striking out "much" and substituting "some." A favorite game with critics of university work has long been the quotation of subjects of doctoral theses. Even those who should know better are unable to resist the temptation of provoking a laugh at the expense of the scholar who labored to give to the world the boon of several hundred pages on "The Middle English Ideal of Personal Beauty," or "A Study of the Cogmonina of Soldiers in the Roman Legion," or "Plane Nets with Equal Invariants." The Carnegie report does not descend to this level, but it gives aid and comfort to such criticism by coupling its extreme statement about "imitation research" with advice to the universities "to take stock of themselves before appealing to the public for funds on an enormous scale."

That stock taking has already been done, and by an agency as pitiless as this world knows. The direction of our war effort was committed in large measure to the college-trained man. He was, in many important positions, a person cursed with a Ph.D., the stigma that told of seminars and laboratories and—well, research. He came from everywhere, from the fresh-water institution of limited facilities as well as from the university of unrivalled resources. That he "made good" from the beginning is one of the commonplaces of the history of our war. He took hold of a situation as unacademic as the most skeptical of his critics could have imagined, and proceeded as if the war were nothing more baffling than a particularly unruly set of sophomores.

There was not a little running around in circles at Washington during the months following April, 1917, but the specialist, product of the American research methods, did not indulge in it.

The colleges are far from perfect. Many worthless law schools are doing a large business, as Dr. Pritchett's report observes, and it it to be hoped that the Foundation may be as successful in wiping them off the map as it has been with the same brand of medical school. But the public has never appreciated research work at its true value, and the rather sensational language of the report is likely to do more harm than good. We need more research work and not less—more of the kind actually prevailing in the mass of our universities.—*The New York Evening Post.*

SCIENTIFIC BOOKS

Inbreeding and Outbreeding, Their Genetic and Sociological Significance. By Edward M. East and Donald F. Jones. Philadelphia and London, J. B. Lippincott Co., 1919. Pp. 285. 46 illustrations.

No better example than this book affords is likely to be found of the successful carrying out of the purpose of the series of "Monographs on Experimental Biology," which is stated by the general editors in these words: "Biology which not long ago was purely descriptive and speculative, has begun to adopt the methods of the exact sciences, recognizing that for permanent progress not only experiments are required but that the experiments should be of a quantitative character. It will be the purpose of this series of monographs to emphasize and further as much as possible this development of Biology." Until quite recently discussions of inbreeding, whether by biologists or others, have savored of anything but the "methods of the exact sciences." It is safe to say that no phase of biology has been enveloped in such a fog of superstition, old wives tales, and other sorts of misapprehension as has inbreeding. The investigations of East during the past decade and more have been a potent and pioneer influence in dissipating this fog. It is particularly appropriate that he and his former student Jones should prepare a critical general review of the really scientific work which has been done in this field. It is a service which puts all biologists considerably in their debt.

After an introductory chapter, which defines the problem of inbreeding and shows its relation to practical questions of sociology and agriculture, as well as biology, three chapters are devoted to the statement of some elementary biological facts and principles which are essential to any rational discussion of a problem which involves and arises out of the phenomena of reproduction on the one hand, and of heredity on the other hand. These chapters, as would be expected by any one acquainted with the authors' other writings, are models of clear and condensed exposition. Chapter V. deals with "Mathematical Considerations of Inbreeding" in which is reviewed recent work on the measurement of the degree of inbreeding existent in complex pedigrees, and on the gametic consequences which must follow the continued inbreeding of a Mendelian population. The analysis of the latter point shows that the amount or degree of heterozygosity decreases with continued inbreeding. The authors state the expectations in the following words:

Assuming, then, that the loss of the stimulation accompanying heterozygosity is correlated with the reduction in the number of heterozygous factors, we should expect to find the decrease of heterosis greatest in the first generations, rapidly becoming less until no further loss is noticeable in any number of subsequent generations of self-fertilization, and that on the average the decrease will become negligible from the seventh to the twelfth generation and from then on no further marked change will take place. Segregation of characters and appearance of new types and reduction in variability will also follow the same course. Some cases are to be expected in which stability is reached earlier, and some cases in which it is reached later; or, theoretically it may never be reached.

The next chapter reviews the actual results of long continued inbreeding. The classic data here are afforded, on the animal side, by Miss King's brilliant experiments with the white rat, and on the plant side by the no less outstanding work of East and Jones on maize, corroborated by the concordant but less extensive researches of Shull on the same form. These two great experimental investigations may fairly be regarded as a real triumph of American biology. Operating in a field on which a mass of inconclusive experimentation and uncritical speculation had been carried out these researches of East, Shull and Miss King have essentially *solved* for all time the important features of the problem of inbreeding. We now understand where formerly we speculated. The main aspects of the problem are now matters of exposition not debate. The net result must be stated in the authors' words:

In tracing the evolution of ideas concerning the effects of inbreeding and outbreeding we must give great credit to Darwin for calling attention to the importance of the phenomena in relation to evolution and for being the first to see that heredity differences, rather than the mere act of crossing, was the real point involved; but with all due credit to Darwin, it was not until Mendelism became known, appreciated, and applied that the first real attack upon the problem was made possible. When linked with Mendelian phenomena it was clearly recognized for the first time that one and the same principle was involved in the effects of inbreeding and the directly opposite effects of outbreeding. Inbreeding was not a process of continual degeneration. Injurious effects, if present, were due to the segregation of characters. In addition to this segregation of characters the fact was established that an increased growth accompanied the heterozygous condition. All the essential facts were accounted for. A decade later the great extension of knowledge in the field of heredity has made possible a still closer linking of the facts of imbreeding and outbreeding with Mendelism. The hypothesis of the complementary action of dominant factors is the logical outgrowth of former views and makes the increased growth of hybrids somewhat more understandable. The fact of a stimulation accompanying heterozygosity is supplemented by a reason why such an effect is obtained. The former view of a physiological stimulation and the more recent conception of the combined action of dominant factors are not then two unrelated hypotheses to be held up for the choosing of the one from the other. The outstanding feature of the latter view is that there is no longer any question as to whether or not inbreeding as a process in itself is injurious. Homozygosity, when obtained with the combination of all the most favorable characters, is the most effective condition for the purpose of growth and reproduction.

A chapter on the value of inbreeding and outbreeding in plant and animal improvement gives a very sane and well-balanced discussion of the practical application in agriculture of the principles set forth in the earlier portion of the work. So far as thoroughly scientific exposition may hope to do so the bogey of the necessary and inevitable harmfulness of inbreeding is laid to rest. It is pointed out that, so far as may be judged from the past, inbreeding has been the greatest single instrument in the breeder's hands for securing uniformity and the concentration of desirable qualities. It has the further advantage of bringing clearly to light undesirable qualities which may then be easily eliminated by selection or otherwise.

The last two chapters of the book are of a more speculative character, but surely no one will deny to those who have made such solid experimental deposits in the bank of knowledge the right to speculate a bit. The first of these chapters deals with effects upon the individual and the second with effects upon the race. Both chapters may fairly be regarded as among the sanest and most cogent arguments for the integral incorporation of eugenic ideas and ideals into the conduct of the social and political affairs of life which have yet been put forth. The known facts are examined critically, though briefly, and there is a refreshing absence of blind and blatant propaganda. To take a single simple example it is shown with great clearness that the ridding of a racial germ-plasm of defective characters is very far from being the simple process that enthusiastic devotees of sterilization legislation would have us believe. To prevent the multiplication of individuals visibly bearing the defects is, in theory at least, not particularly difficult. But to do this alone will not even approximately solve the problem. The residual and vastly more difficult question concerns the somatically normal transmitters of defective qualities.

Altogether this is a notable book, in which American science may well take pride. It should form a part of the required reading of every student of biology, because nowhere else is there brought together in such clear and well-digested form the results of a mass of experimental work which has successfully lighted a dark corner of biological science.

Raymond Pearl

SPECIAL ARTICLES

CORRESPONDENCE BETWEEN CHROMOSOME NUMBER AND LINKAGE GROUPS IN DROSOPHILA VIRILIS

A study of twenty-seven mutant characters[1] in *Drosophila virilis* Sturtevant, reveals the presence of at least five groups of linked genes in this species—in contrast to the four groups in *Drosophila melanogaster* (*ampelophila*). This difference in number of linkage groups agrees in a significant manner with the difference in number of chromosomes in the two species. *D. melanogaster*, as is well known, has four pairs of chromosomes—three large and one very small—and correspondingly has three large groups and one small group of linked genes. *D. virilis*, on the other hand, has six pairs of chromosomes—five large and one

[1] Descriptions of some of these have appeared in two earlier papers: Metz, C. W., *Genetics*, 1: 591–607, November, 1916, and Metz, C. W., *ibid.*, 3: 107–134, March, 1918.

very small[2]—and should, therefore, according to the chromosome theory, have six linkage groups, one of which might be expected to contain relatively few genes. From present evidence it seems probable that the five linkage groups, thus far detected, represent the five large pairs of chromosomes. Detection of the sixth group, representing the very small pair, would hardly be expected until a larger number of mutants had been obtained.

The data upon which these conclusions are based will be published in detail elsewhere, but may be summarized as follows:

Fourteen of the 27 characters are sex-linked, forming Group I. The remaining (non-sex-linked) characters fall into four groups—Group II. with three characters, Group III. with four characters, Group IV. with three characters and Group V. with three characters.

Maps of the five groups, based on crossover values, as determined thus far, are respectively about 90, 40, 60, 0 and 20 units long. These lengths are based, respectively, on data involving 12, 2, 4, 3, and 2 "loci," and hence will probably be extended considerably when more characters are studied. Although the values are only approximations, because of the small number of genes involved, they show that a relatively large amount of crossing over occurs in some of the groups. In the fourth group the three genes appear to be completely linked, but since there is no other evidence to indicate that they are allelomorphs they are assumed, tentatively, to represent three different loci.

Owing to the fact that in *D. virilis*, as in *D. melanogaster*, there is no indication of crossing over in the male, it has been possible to secure clear-cut evidence of the distinctness of the linkage groups, because back-crosses of heterozygous males always give complete linkage, if the genes belong to the same group, or free segregation if they do not. Thus representatives of each group (exclusive of the sex-linked group) have been tested with representatives of every other group and found to give free segregation, whereas with members of their own groups they gave complete linkage. The crossover values were, of course, obtained by back-crossing females instead of males.

It should be noted that in the case of the fourth group no crossing over has yet been detected in either sex, but only three characters have been studied in this group, and there can be little doubt that the sexual difference, as regards crossing over, will prove to be the same here as in the other groups.

[2] See Metz, C. W., *Amer. Nat.*, Vol. L., pp. 587–599, October, 1916.

CHAS. W. METZ
STATION FOR EXPERIMENTAL EVOLUTION,
CARNEGIE INSTITUTION OF WASHINGTON

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION H—ANTHROPOLOGY AND PSYCHOLOGY

AT the St. Louis meeting of the American Association for the Advancement of Science, Section H presented a two-day program. The Monday morning program was given over to papers of especial anthropological interest. Unfortunately due to conflict in the announcements few were present and the session was postponed, resulting in only a few papers being given. On Tuesday morning the Section united with Section L—Education—in a joint program. The address of the retiring chairman of the Section, Dr. Aleš Hrdlička, was entitled "The relations of anthropology and psychology."

Due to action of the Council of the Association the old Section H—Anthropology and Psychology—has been divided up into new sections. The new Section H will be restricted to anthropology and the new Section I to psychology. Officers for both Sections were elected on Tuesday afternoon.

The officers for Section H—Anthropology—are: *Vice-president of the Association and chairman of the Section*, Dr. G. B. Gordon, University Museum, Philadelphia, Pa.; *Secretary*, Dr. E. Hooton, Peabody Museum, Cambridge, Mass.; *Members of Sectional Council*, Dr. F. W. Hodge, Museum of the American Indian, 1 year; Professor R. J. Terry, Washington University, 2 years; Dr. B. Laufer, Field Museum of Natural History, Chicago, 3 years; and Dr. Aleš Hrdlička, United States National Museum, 4 years.

The officers for Section I—Psychology—are: *Vice-president of the Association and chairman*, Professor Edward K. Strong, Jr., Carnegie Institute of Technology; *Secretary*, Professor F. N. Freeman, University of Chicago (for 4 years);

Members of Sectional Council, Professor W. D. Scott, Northwestern University, 1 year; Professor W. S. Hunter, University of Kansas, 2 years; Dr. J. E. W. Wallin, Psycho-Educational Clinic, St. Louis, 3 years; Dr. Helen T. Woolley, Vocational Bureau, Cincinnati Public Schools, 4 years.

A resolution was received from Felix Neumann, secretary of the Anthropological Society of Washington, in reference to an open letter, entitled, "Scientists as spies," written by Dr. Franz Boas, and which was published in *The Nation* of December 20, 1919.

After the article in question was read and discussed at some length, it was regularly moved and carried that "Section H indorses the resolution of the Anthropological Society of Washington." It was further voted that a committee composed of Dr. R. M. Yerkes, Dr. Aleš Hrdlička and Dr. J. E. W. Wallin, take such action concerning the resolution as they deem appropriate.

The following papers were presented:

Notes on the variation between the right and left limbs of man as observed in a small series in the dissecting laboratory: H. C. Danforth. (By title.)

Utilization of dissecting room material for the study of physical anthropology: R. T. Ferry. (By title.)

On certain variations in the form of the human scapula: W. W. Graves. A large collection of scapulas, both of man and of animals, were shown by specimens and on the screen. Variations of many sorts were pointed out.

The occipital (supra-inionic) forsa, and its true significance: A. Hrdlička. (By title.)

Theories of sternal origin: F. B. Hanson. By title.)

The St. Louis group of mounds: H. M. Whelpley. St. Louis became known as the "Mound City," early in the nineteenth century. This was due to a group of twenty-seven mounds on the Mississippi River bank, near what is now the business center of the city. As early as 1819, Major Stephen H. Long made what was probably the first map of the mound group. The twenty-six smaller mounds were destroyed before 1850. The remaining "Big Mound," which was one hundred and fifty feet long and about thirty feet high, was removed in March and April, 1869. Professor Spencer Smith had recently read a paper before the Academy of Science of St. Louis in which he gave seemingly convincing evidence that the mound was a natural formation. This prevented the local universities and scientific organizations from taking an interest in the demolition of the mound. A local artist, A. J. Conant, a photographer, Thomas M. Easterly, and the editor of the Missouri *Democrat,* seem to have been the only ones who followed the destruction of the mound with scientific interest. Conant was present daily. The Missouri *Democrat* describes the excitement caused when the workmen found at the base of the mound a sepulcher over seventy-four feet long, twelve feet wide and several feet high. It contained many human skeletons and a large quantity of shell beads. The editor said: "This stunned the zealous advocates of the natural formation theory." The paper was illustrated with a series of slides made from daguerreotypes, taken by Mr. Easterly, showing successive stages of the work of demolition of the mound.

Notched flint hoes of St. Louis and vicinity: H. M. Whelpley. The flint agricultural implements of the pre-Columbian Indians are designated as "spades and hoes." The spades are so called because they somewhat resemble in shape the blade of a modern iron spade. There is no evidence, whatever, that these blades of flint were ever hafted like our spades of to-day or employed as we use spades. The word "spade" is a misnomer. All flint agricultural implements should be termed "hoes." The hoes are divided into notched and unnotched. The notched hoes form but a small per cent. of the total number of flint hoes. They are distributed over a much more restricted area than the unnotched form of hoes. Flint hoes in general are found over a small section of the Mississippi Valley. The author proposes fourteen terms to designate the various parts of a notched hoe. Six points were considered under "Standard of Perfection." The term "flint" is used in the popular sense. Nearly all of the notched hoes are made from Union county, Illinois, chert. A few are of novaculite, quarried by the Indians in the same county. Occasionally, specimens were made from "Alton flint," from bluish flint balls, and perhaps from St. Louis county flint. The usual type of notched hoe is oval but some are triangular and a few rectangular. The influence of material on type was discussed and the evolution of the notched from the unnotched shown by a long series of successive stages of evolution. Attention was given the probable methods of manufacture. The author has for forty years studied the quarries and work-shops. The finest implements are found in St. Clair and Madison counties, Ill., far from the quarries. Few hoes occur west of the Mississippi River. The gradation of notched hoes into axes, hammers and other artifacts was demonstrated. This paper was based on the study of several hundred specimens in the collection of the author.

Notes on the sitting height in man: R. B. Bean. (By title.)

Clinical study as a type of experimental education: F. N. Freeman. Psychological research in the field of learning has in recent years consisted largely of mass studies or studies of groups of individuals. For example, a common method is to compare the effectiveness of two methods of learning by comparing the average score made by a group which pursues one method with the average score obtained by the other method. These averages often conceal important variations from the rule in the case of individuals. It is necessary to make analysis of the factors involved in such cases if the laws of learning are to be completely understood. The clinical study of a child afflicted with congenital word-blindness illustrates such an analysis. The case was diagnosed as hopeless by a well-known oculist. Difficulty with reading was reported in the case of two near relatives. The Binet test and several specialized tests revealed no defect other than the inability to read. Photographs of the eye movements in reading showed serious lack of coordination. In spite of four years of schooling the child had less than median first-grade reading ability. Forty minutes training a day, in which phonics were abandoned and direct practise in comprehension together with the prevention of attention wandering and eye wandering were emphasized, resulted at the end of ten weeks in better than third-grade reading ability and in much better coordinated eye movements.

The concept of feeble-minded, especially the moron: J. E. W. Wallin. Feeble-mindedness is not primarily a medical or psychological concept, but a socio-legal concept, referring to a condition of social and industrial dependency due to intelligence defectiveness dating from birth or from early life, and should only be used in this sense. The practise has been very widely followed of considering that the highest grade of feeble-minded persons develops to an intelligence level of twelve years. The writer's conclusion, based on the individual examination of thousands of subjects, is in complete agreement with the finding of the division of psychology in the army that the highest grades of mental defectives, the so-called morons, do not develop beyond an intelligence level of nine years, and that some persons who stagnate at the ninth-year level can not be considered feeble-minded. On the basis of the 70 I.Q. standard of feeble-mindedness, and the average intelligence age of the selective service men, the highest intelligence level reached by the feeble-minded would be 9.2 years. These findings necessitate the complete rejection of the concept of the "middle" and "high-grade morons," and a considerable lowering of the borderland region. The borderland region probably must be placed between the upper limit of age seven and the upper limit of age nine or at most ten (by the Stanford scale), instead of between ages ten and twelve. In other words, persons who reach an intelligence level of ten years should be classified as borderland, backward or dull. The gradual appreciation of the above facts has recently led to the proposal that the concept of feeble-mindedness be extended beyond its traditional connotation of intelligence deficiency, so as to include individuals who are emotionally, temperamentally or volitionally defective or unstable, even though they may be normal in intelligence. This extension is unacceptable. Such individuals can not be considered feeble-minded unless they are sufficiently intellectually deficient to be so regarded, but must be classified otherwise. The term defective delinquents is suggested for emotionally or temperamentally unstable delinquents who are in need of restraint or special care and who are of borderline, backward or normal intelligence—and thus not feeble-minded—and who can not be placed in a definite, clear-cut classification, such as psychotic, psychopathic, neurotic, hysterical, choreic or epileptic.

(*To be concluded*)

Edward K. Strong,
Secretary

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CONTENTS

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INVENTIONS AND PATENTS

The status of the inventor within the government service, of his invention and the administration and utilization of the same, presents a problem that has been growing increasingly acute during the last decade.

The pressing need for some one government agency to undertake, under a unified, comprehensive system, the administration and industrial development of patentable inventions and patents originating in the government bureaus was formulated by Dr. F. G. Cottrell, of the Bureau of Mines, in a paper, entitled "Government Owned Patents," presented to the American Mining Congress, in November, 1916.

Dr. Cottrell was brought to the full realization of the highly unsatisfactory situation of the government inventor through his experience with some patents of his own. It was his desire to make the public the sole beneficiary of these, but for reasons which will appear below, there was no practicable way of accomplishing this. Donation to the government was not feasible because there was no government official or agency authorized by law to accept assignment of patents; so he finally conceived and brought into existence a non-dividend paying corporation,[1] and to this assigned his patents for administration and license. A fundamental stipulation in its certificate of incorporation was that the profits, over and above actual running expenses, should be used for the advancement of research, and thus a public double benefit was effected.

This new departure in economics has been in successful operation for several years and the achievement has pointed the way for and has justified the attempt to try out an experiment along similar lines in the government service; and this has culminated in a bill

[1] Research Corporation, New York.

which has been introduced in Congress and which provides as follows:

S. 3223 & H. R. 9932.

A BILL authorizing the Federal Trade Commission to accept and administer for the benefit of the public and the encouragement of industry, inventions, patents, and patent rights, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Federal Trade Commission be, and hereby is, authorized and empowered to accept assignment of, or license or other rights or powers under, to develop, to issue or refuse to issue licenses under, to encourage the industrial use and application of, and otherwise to administer, on behalf of the United States, under such regulations and in such manner as the President shall prescribe, inventions, patents, and patent rights which said commission deems it to the advantage of the public to be so accepted, as these may from time to time be tendered it by employees of the various departments or other establishments of the government, or by other individuals or agencies; and to cooperate, as necessity may arise, with scientific or other agencies of the government in the discharge of the duties herein set out.

Sec. 2. That the Federal Trade Commission be, and is hereby, authorized and empowered to collect fees and royalties for licensing said inventions, patents, and patent rights in such amounts and in such manner as the President shall direct, and shall deposit the same with the Treasurer of the United States; and of the total amount of such fees and royalties so deposited a certain per centum, to be determined by the President, shall be reserved, set aside, and appropriated as a special fund to be disbursed as directed by the President to remunerate inventors for such of their inventions, patents, and patent rights contemplated by this Act as may prove meritorious and of public benefit.

Sec. 3. That the Commissioner of Patents is hereby directed to grant all patents and record all assignments and licenses contemplated by this Act without the payment of any fee.

As is well known, the government has for years been fostering and developing scientific research among its workers, and this phase of its activities has reached a very advanced state of efficiency and productiveness, as examplified, for instance, by progressive improvements in the machines and methods of husbandry resulting from the labors of the Department of Agriculture; by the safety appliances and highly developed technical devices used in our mines; by the advancement in the methods and processes of metallurgy, and by the ever-increasing volume of chemical and other exact scientific discoveries issuing from the government laboratories.

But many valuable contributions to knowledge and a whole mass of scientific facts and principles developed in the course of the numerous and varied investigations carried on by the government have failed to reach and benefit the general public, because of a lack of the means of translating them into actual, practical service. There has always been an obstruction in the way of making them adequately and fully available to industry, because there has heretofore been no administrative machinery for exercising this function.

Various views have been held by government officials concerning the legal status of patents and patentable inventions developed by government employees in the course or as a result of their regular duties. In the process of litigation in patent cases certain doctrines of law have been laid down in court decisions with regard to shop right, implied license, etc., but these have not been uniformly understood or applied in the government service. It is a fact, however, that the law in regard to the ownership of patents by government employees (excepting employees of the Patent Office) is exactly the same as it is for the employees of private individuals or corporations.

A wide range of policy and point of view has existed among the departments and even among the different bureaus of the government as to whether the inventor in government service should be compelled to donate his invention to the government, with or without first patenting it, or whether he should donate it at all; whether in the first event he should receive any compensation therefor, or not, and whether he has the right to develop his patent himself, or to sell it to another; and questions of ethics in this connection have frequently arisen. Such considerations as these have been dealt with piecemeal, arbitrarily, and often very incidentally and with some specific and immediate need in mind.

Thus, in certain bureaus of the service employees are required to dedicate their inventions or patents to the government outright, even in the absence of legal authority for the procedure; in others they are prohibited from taking out patents at all; in others, if they take them out, they must dedicate them to the public; in others, again, the employee may retain title to the patent and make what profit he can with it in the open market, but the government reserves the right of free license thereunder. In some cases this free license is restricted only to the bureau in which the invention originated, the patentee being at liberty to profit individually from the use of his invention by other branches of the service.

Then, again, in the same division, or bureau, the requirements on the individual will vary according to the nature of the service for which he was specifically employed and the character of the invention, *i. e.*, whether the invention was evolved in the course or as a result of his regular duties, or not. These illustrations represent merely a few of the many questions arising with regard to the existing relation between the government and its employees in the matter of inventions and patents.

If the employee dedicates his invention to the government it can not fully benefit the public, because, as has been stated, there is no existing instrumentality for translating inventions protected under government-owned patents into practical, industrial service, and they become practically a waste product.

If a patent be dedicated to the public unconditionally, the public is generally the loser, as has been indicated above, because protection to the capital required to exploit the patent is lacking, and because a patent so dedicated, though possibly pioneer and fundamental may be in such a form that a subsequent patent taken out by another, less generous inventor on an improvement practically essential to its effective application may operate to exclude its free public use. Also, in this contingency, its successful use by the government, itself, is prevented, unless the government assents to whatever conditions the owner of the improvement may impose. If for any reason this should be deemed inadvisable, the government can, of course, use the improved invention without express license, just as it can use any other patented invention, as provided by Special Act of Congress, June 25, 1910, Stat. 851. But the situation thereby created is unsatisfactory, because such action entails litigation before the Court of Claims to determine a reasonable compensation to the patentee, in addition to which the approval of Congress by special enactment must be had before the compensation can be awarded. This is a formidable, costly and tedious business, both for the government and the plaintiff, and besides, works particular hardship and loss to the latter. Indeed, unless the compensation involved should be large it would probably be consumed in the process of securing it.

The tendency of the generally unsatisfactory situation here outlined has been to discourage inventiveness among government workers, and the considerations enumerated call loudly for some settled, definite and equitable disposition of this involved matter, particularly in view of the enormously increased activities and needs of the government and the business world brought about by the demands of the present war, and the unprecedented need for inventions which has ensued. It must be realized that the development and administration of inventions and patents involve business problems which should be handled in an intelligent businesslike way. The present haphazard, futile manner of treating them makes for lost motion and waste of effort.

The Bill here under consideration grants the authority to try out essentially an experiment in constructive economics which, if successful, can not fail to lead to results of fundamental importance, and which, if un-
reasonable compensation to the patentee, in
successful, will, by reason of the measure's purely permissive character, be self-elimina-

ting. It will be an inexpensive experiment, since its operation is aimed to be self-supporting.

The whole system of administration comprehended under its provisions will have to be constructed with the most sedulous care by men specializing in the work, keeping prominently in mind the cardinal fact that this is a matter of research and development. The value of the experiment, indeed the span of its operation, depends upon the wisdom and circumspection with which it is handled. Being something absolutely novel in patent legislation, there are no standards and no information for guidance, and these must be acquired as this administration proceeds, by experiment, just as in any other form of research work.

This Bill provides for centralizing the administration here planned. If this were left to each bureau of the government to work out as it saw fit, the authority thus scattered would result in endless confusion, duplication of effort, increase of expense and, through lack of proper equipment, failure to provide the means for constructive economic work on any adequate or feasible scale. This is practically the present situation and is what this Bill is aimed to correct. It is infinitely better to focus administration in one agency, providing service common to all, in and outside the government employ, such agency having the ability through enlarged opportunity, to specialize in this work and thereby to develop into a power for really great accomplishment.

Assisted and supported by the cooperation of all in interest and, through the larger perspective acquired by the study and correlation of the problems of all, this system insures the working out of administrative details in the most comprehensive way, making possible that sort of team work in the realm of invention that proved so necessary to success in this field during the world struggle just ended.

In this connection, Professor Millikan has already pointed out in Science,[2] that one of the important facts demonstrated by the war was that inventive genius working without direction and correlation proved comparatively futile. Not one invention in the military field out of ten thousand offered the government by isolated inventors proved of any value whatever. It was only when the best scientific brains of the country were mobilized, through the Council of National Defense, into definite groups, each group specializing in some particular field, all being in cooperation and in close touch with similar groups of the Entente, that the weight of American inventive genius as a most important factor in winning the war began to be felt. From that moment, the submarine, the real problem of the war, was doomed. This grouping and coordinating of the country's scientists developed a vast amount of inventive material, the major part of which has a direct peace bearing of immense value, but which is in serious danger of being lost through the want of such an agency as herein contemplated to conserve, develop and administer it and to translate it into industrial application and use.

There are several special phases of the patent situation affecting the government and its workers as well as the public, which the economic administration here provided will fundamentally improve. For instance, there is at present no disinterested organization extensively studying the economic aspect of patents after they have left the patent office. The information available in this field has been derived solely from members of the patent bar, from manufacturers and from inventors. But each of these classes represents a special interest with a particular and partisan viewpoint and need. This bill, however, creates an agency which is peculiarly well equipped to study the subject in the broad light of patent administration on behalf of the public.

Again, it sometimes occurs in the government service that an invention is developed that the government would like to make use of, or to introduce for the benefit of the public, but which has an application not

[2] Science, September 25, 1919, p. 285, et seq.

broad enough to interest manufacturers. An instance of this is the Gibbs breathing apparatus which has proven so efficacious in mine rescue work. Heretofore, there has been no satisfactory way of accomplishing the production of such a device, there being no agency authorized to negotiate the business. Under this bill this agency would be provided.

There is another, allied type of invention which is of great importance to scientists, and so indirectly to the public, and which will secure development under this administration. This concerns improvements in scientific instruments and apparatus. The sphere of employment of these things being comparatively restricted, their manufacture does not ordinarily attract capital, and certainly yields no great profit to the inventors.

A situation in the patent field unsatisfactory to the government is encountered in certain cases where investigations are conducted jointly by experts of the government and those of outside agencies, such as universities, technical schools, state institutions, and industrial concerns. More and more of such cooperative work is being done, to the great benefit of both the government and industry. During the course of it, inventions are sometimes evolved through the mutual efforts of the cooperators, and patents are granted therefor.

Now, it is highly important, if not absolutely imperative, that such a patent, or group of patents, be administered and developed as a unit, but the problem is at once presented as to how this shall be accomplished, to the end that the maximum benefit to industry shall be secured, the patent shall be guarded against falling into adverse hands, the control of the government over the production of its experts shall be maintained, and, at the same time, the equitable interests of the inventors shall be conserved. It is conceived that the solution will be found in the administration here provided.

Perhaps no discoveries in history exceed in importance those made in the last century concerning the nature of diseases, their prevention and cure, yet the people who have made these discoveries have frequently gone unrewarded. The salaries of pathological professors are, as a rule, barely more than pittances, although their work is of transcendent importance to the human race. Increased practise through possible gain of prestige, by accomplishment, does not make up to these men the reward which should be theirs, and even the money thus acquired is no real reward, but remuneration earned by additional labor. Indeed, pathological work often tends to detract from the earning power of physicians as people are only too prone to regard research workers in the field of medicine as faddists and charlatans. The discovery of vaccination, by Jenner, almost ruined him. This situation influenced the British government to provide him with a pension.[3]

This leads to a further phase of the patent situation that has bearing here. It is contrary to the ethics of the medical profession for its members to patent new devices and curative agents. The consequent absence of patent protection eliminates control of these things, though control in many instances is vitally necessary. Great harm has been worked by the manufacture of medicines getting into adverse hands, and it has been necessary in some cases to have special legislation passed to relieve the situation.

Under the measure here proposed such inventions, fraught with great possibilities for good or ill, may be wisely administered for the welfare and protection of the public. To quote from an editorial written upon this Bill in the *Journal of the American Medical Association*, December 20, 1919 page 1887:

> It has been regarded as against the principles of medical ethics to patent instruments or medicaments for personal gain. However, as was pointed out recently in *The Journal*, this does not mean that patenting per se is wrong; in fact, it is at times desirable to patent new discoveries, especially drugs, in order to insure reliability. The problem has been how to make available the patented product in the interest both of the public and of medical science. It would seem that the proposed bill

[3] Science, November 14, 1919, p. 461.

suggests a means, acceptable to the medical profession, for the control of patents in the fields of medicine and surgery; the success will depend on the wisdom exercised by the Federal Trade Commission in the method of granting licenses. Judging from the recent activities of this body in the licensing of former enemy owned patents (such as barbital, procain and arsphenamin), a wise policy will probably be followed. The bill, as proposed, gives opportunity for the medical research worker to obtain recognition, and possible emoluments, for distinctive contributions, without making him subject to criticism. It contains many constructive possibilities and should receive the endorsement of those interested in the altruistic success of science.

Along allied lines in veterinary medicine, processes for producing serums for prevention of diseases among farm animals have been worked out from time to time in the Department of Agriculture. It is very necessary to control these by patents properly administered in the public interest to prevent exploitation of, and loss to, the public.

In the interest of, and in justice to the inventors in the government service, let it be pointed out that save in rare and exceptional instances, they have derived little or no material return from their inventions. It is a general custom among industrial employers to reward their employees directly for valuable inventions which they evolve in the regular course of their duties, either by sums of money, as bonuses, or by increase of salary, or by gift of stock or some other tangible form of interest in the business, as a recognition of merit and a stimulation to further effort. This has proved a sound business policy. Nothing analogous thereto has existed in government employment, except that general excellence of service has always been a determining factor in routine promotions. Furthermore, inventors in the government service have had to pay out of their own slender means all charges incident to the granting of patents assigned by them to the government. This has been in the past a means of preventing applications for patent protection to worthy inventions.

Scientific workers, of which inventors form a class, are notoriously deficient in commercial instinct and experience. Even under the most favorable circumstances they are rarely ever able to properly develop and commercialize their inventions. How hopeless, therefore, is the chance of government inventors getting any benefit for themselves and for the public out of their inventions under the condition of uncertainty of status and lack of development and administrative control now prevailing in the government bureaus.

In the matter of licensing, as provided by this Bill, it it not the purpose here to give unduly a monoply to any one. Indeed, this whole thing will be so directly open to public examination and check that it is not at all likely such a thing would develop. The main idea in this respect is to do two things. To supply the public with a commodity or a device at a reasonable price, and, at the same time, to aid in building up American industry; providing protection to those best qualified for production, but allowing enough licensing to induce competition and thus to stimulate healthy advancement.

An analogy here might be found in the banking laws of Massachusetts, Wisconsin and of some other states, which provide for just enough banking facilities to insure proper and adequate administration in this field, it being recognized that an excess in the number of banks means the carrying of too much overhead for the business done, which is a bad business policy liable to lead to disaster. Under these provisions, before a new bank can be established it is necesary for its organizers to prove to the banking commissioners that there is a real need for it in the region where it wishes to operate.

Again, the patents comprehended under this legislation may be regarded as much the same sort of monopoly as a public franchise; for instance, the charter for a street car line. Only as many car lines are permitted in a city as there is a real need for.

It is believed that the provisions of this Bill form a basis for a plan broad enough to work out the solution of the sort of problems referred to above, no attempt being made to obtrude mandatory regulations in any present system for coping with them. Under it the relation between the inventor in the government service to the government itself is clearly established, and the inventor will be encouraged by the knowledge that he will not be deprived of credit for the work of his genius, and, in the event of his invention proving of actual public service, he will receive some material return therefrom. No question of ethics can arise to embarrass him and he will be relieved of all care and expense in the administration and disposal of his patents.

The government derives its advantage under this measure in the stimulation of inventive productiveness among its workers, in the control it obtains thereof, and in the valuable experience it gains in this field of practical economics, which will very probably be reflected in improvements in patent law.

The public reaps its benefit by having cleared away the obstacle heretofore existing between the inventor's genius and the full and proper industrial application thereof, thus liberating and giving impetus to invention, with consequent increase of productiveness, tending toward improvement of working conditions and general prosperity.

Andrew Stewart

Bureau of Mines

THE USE AND ABUSE OF THE GENUS

I should hesitate to burden the readers of Science with another technical discussion on nomenclature but the question which I wish to bring to the consideration of systematists is not a technical one and has nothing to do with Codes nor with priority.

We are all painfully familiar with the changes that are continually taking place in generic names, both of animals and plants. Such changes fall, roughly speaking, into two categories:

(1) Cases where an older name for the same group is discovered in some overlooked work and is substituted for the one in general use.

(2) Cases where a generic group is subdivided, the old name being restricted to one of the subdivisions and new names given to all the others.

The first sort of change is necessary and is governed by a definite code of rules which is rapidly effecting international uniformity, so far as such cases are concerned. The second set of changes, however, is entirely dependent upon personal opinion, with no hope of uniformity or finality. Generic groups are separated from one another by all degrees of difference and there is no standard by which the amount of difference may be consistently measured. Consequently no two systematists will be in agreement as to how many groups may be recognized in any given family.

Ever since the time of Linnæus generic groups have been undergoing disintegration until in some families the ultimate condition has been reached of a generic group for every species. When this stage has been attained we have lost all trace, in the scientific names of any relationship whatever between the species. The binomial name in other words has become useless and we might just as well have a mononomial. The very object for which the generic name was proposed has been lost.

To illustrate the point further, suppose that we subdivide an old genus into three, and use three generic names where previously we used but one, we emphasize, it is true, that there are differences between these three groups, but by the very same act we obliterate the fact, formerly indicated by the single generic name, that there are resemblances which join these three groups together as compared with other groups in the same family. One of these facts would seem to be of quite as much importance as the other and by the creation of the new genera we lose quite as much as we gain. We should carefully guard against allowing our enthusiasm for the discovery of differences, to blind us to the fact that the real object of systematic research is the discovery of true relationship.

Now the whole trouble in this matter—and a vital flaw, to my mind, in our system of nomenclature—is that we try to make a double use of our system with the result that it is gradually breaking down from the impossible burden.

A generic name as we use it to-day is made to serve two purposes. It is, (1) a term by which we indicate to others what we are talking or writing about, and (2) a term by which the systematist indicates what he regards as a recognizable phylogenetic group.

It is suicidal for any system of nomenclature that names for "things" should be constantly changed to fit our ever changing ideas of their relationships. Surely there should be some way of indicating the progress of our studies in the relationships of birds, for instance, without rendering unintelligible to all save a few specialists, the very names by which we refer to those birds.

We are already striving to find a solution of this problem, as is evidenced in the growing tendency to abandon the technical name entirely in semi-scientific publications in favor of the English name, and restricting the constantly increasing generic terms to systematic or phylogenetic discussions. It seems to me, however, that there is another way open. If we could be content to use the broader generic terms of a few years ago for *nomenclatural* purposes and use another term, call it subgenus or what you will, for further systematic refinements, without incorporating it in the name itself, we should accomplish our aim.

We make no effort to incorporate in the scientific name of an animal or plant its family relationship, and we arrange animals and plants according to geographical relationships without insisting upon modifying the name to indicate such relationship. Why then should we insist upon imparing our system of nomenclature by constantly changing the generic names every time we change our minds as to how many minutely different subdivisions we are going to recognize in the group?

It is very easy to ridicule my proposal to use broader generic terms for nomenclatural purposes by saying that we do not wish to return to the ideas of Linnæus, and place for example the Swallow, the Swift and the Pratincole in the same genus, or to have only one generic name for the sparrows and one for the warblers. This is very true and it is perfectly obvious that we must adopt some position midway between the two extremes, while at the same time we must frankly admit that such a position can only be reached by a purely arbitrary decision as to how many genera we are going to recognize. In any Check-list or monograph, however, we settle this matter by arbitrary decision anyway, as we have no criterion as to what constitutes a distinct genus. Therefore why not adopt an arbitrary set of genera *de convenience* so far as nomenclature is concerned and use subgeneric terms when we desire to call attention to more refined phylogenetic groups. At the present time we constantly make use of "group" names in discussing the relationships of different sets of species in a large genus without in any way interfering with the nomenclature and the practise could just as well be extended.

I do not propose any radical action in the way of lumping present-day genera. In birds, with which I am most concerned, the genera of the A. O. U. and B. O. U. Check-lists could be taken as a point of departure and with some slight alterations and adjustments be adopted. The main point would be to check the excessive generic subdivision which is to-day rampant in certain quarters. If some such reform be not inaugurated technical nomenclature will soon be—if it is not already—useless to anyone but a narrow specialist.

For example the botanist has long known of the differences between the so-called flowering dogwoods and those without involucral leaves, but what profit does he gain by changing the generic name of the former to *Conoxylon* compared to the loss that he inflicts upon the ornithologist, the entomologist, or the student of general scientific interests, who knew them under the name *Cornus* and who, unless they be Greek scholars—a rapidly expiring race by the way—have no conception of what sort of herb, shrub or tree a *Cynoxylon* may be. So too the unfortunate botanist who may have learned to know certain sparrows as species of *Ammodramus* fails utterly to recognize his old friends under the names *Thryospiza, Ammospiza* and *Passerherbulus*.

Is it small wonder that the majority of us are turning to the use of English names except in some group with which we happen to be familiar.

I am perfectly aware that the systematist who concerns himself only with questions of the number of species and genera and the names for the same, in a single branch of science in which he specializes, will regard my remarks as pure rubbish. We must all admit, however, that specialization makes us blind to the views of outsiders and to some of the broader aspects of our specialty. Things that seem to us from long association as necessary, may be found upon unbiased consideration, susceptible of very important modifications and the present problem seems to be one of these.

In presenting these ideas I do not wish to be misunderstood. I do not wish to be placed in the same category as the carping critic of all nomenclatural changes who, by the use of clever sarcasm, appeals to the multitude who know as little about the facts as he does himself. I am a staunch supporter of the International Code of Nomenclature and all of the changes which its enforcement requires. They are necessary for ultimate stability and are happily permanent. I would encourage the study of geographic variation in the species and the establishment of subspecies since no matter how many of the latter we may have, their relationship to specific groups is always clearly indicated by the accompanying specific name.

I would encourage, to the fullest, research into the relationship of species, with however as much consideration for their resemblances as for their differences, and I would endorse the establishment of as many groups as may be desired under subgeneric headings—or any other term that may be preferred—but let us not insist upon introducing our conclusions on this matter into the technical name with the result of seriously imparing the principal use of that name.

Let us be conservative in the number of generic names that we recognize, and let general utility have a voice in the matter, of equal weight with that of the splitter and the lumper, just as to-day in another field of discussion the public is becoming recognized as a third party on an equal footing with labor and capital.

Witmer Stone

Academy of Natural Sciences,
Philadelphia

OSCAR A. RANDOLPH

Dr. Oscar A. Randolph, associate professor of physics in the University of Colorado, lost his life in a snow storm on April 11, during a trip to the Arapohoe Peaks on the Continental Divide. He made the trip with one companion Mr. Ellett, also of the department of physics, for the purpose of photographing winter storm scenes. They ascended to an altitude of about 12,500 feet and then descended into what is known as the Hell Hole. On the trip Dr. Randolph became ill and was unable to overcome the handicap of a sudden heavy fall of snow accompanied by bitter cold. Mr. Ellett had assisted him on the return trip till they were both exhausted. Mr. Ellett then protected Dr. Randolph with all the means at his command and started for help at the cabin of two trappers who were living some five miles away. In his weakened and confused condition he wandered for several hours without making much progress in the deep snow. One of the trappers finally found him and learned of Dr. Randolph's condition. Dr. Randolph died however before the trapper could reach him. Owing to the fact that both men were experienced mountaineers and had often made trips to the peak their friends at the university did not become alarmed till noon on April 12, when a rescue party started for the scene. Mr. Ellett, though terribly exhausted and somewhat frozen, will recover.

O. C. Lester

ALFRED J. MOSES, 1859–1920

By the death, on February 27, of Alfred J. Moses, professor of mineralogy at Columbia University, the science of mineralogy has lost one of its most eminent and valued exponents. Professor Moses's work as a teacher, as a writer and as a scientific investigator can hardly be too highly esteemed and his loss to all branches of his profession is most keenly felt. His text-book on "Mineralogy, Crystallography and Blowpipe Analysis" will for many years remain the standard in a large majority of the universities in which courses in these subjects are given. His work on "The Characters of Crystals," published in 1899, is the first treatise published in America upon physical crystallography, a branch of crystallography which was early recognized by him as of primary importance to chemists, geologists and mineralogists and which has within very recent years assumed a scope, and developed practical applications which have more than justified his early visions of its future.

The research work of Professor Moses was marked by a conservative distaste for announcing a result until he had thoroughly verified it. This admirable tendency was also evidenced in the terseness and finished quality of his statements of fact, whether written or spoken. He was seldom under the necessity of erasing a word from his lecture notes or modifying a statement made to any one consulting him, whether student or scientist.

His personal dealings were marked by a large sympathy coupled with a modesty which was almost shrinking in its avoidance of the prominence which was by reason of his attainments thrust upon him. Yet his vision and enthusiasm for his science was such as to inspire those who worked in close touch with him, and who will long treasure his memory as a master in science, as a man of large ideas and high attainments and as a sympathetic and valued friend.

H. P. W.

SCIENTIFIC EVENTS

INVESTIGATIONS IN POLYNESIA

Two problems of outstanding importance in the study of native races are the Origin and Migration of the American Indian, and the Origin and Migration of the Polynesian race. A study of the first problem has been made possible by the gifts of Morris K. Jessup to the American Museum of Natural History, as a result of which ethnologists, botanists and zoologists are tracing the American tribes back through British Columbia and Alaska to Siberia and the regions beyond.

The Polynesian problem is in some respects more difficult than the Indian problem because it involves the collection of scattered data from hundreds of islands, some of them no longer inhabited, and the separation of racial traits and interlocked customs and languages of Polynesian, Melanesian, and Micronesian peoples. It probably can be solved by carefully organized investigation in widely separated areas over a period of years.

It is an undertaking which if adequately supported involves the expenditure of about $50,000 a year for a period of four or five years. But the problem of a vanishing race is so urgent that even a one-year study is likely to yield large return.

It is generally recognized that the institution best suited to carry on the Polynesian work is the Bishop Museum of Honolulu, founded and endowed for studies in Polynesian, ethnology and natural history. With this in mind, funds sufficient for one year's work, contributed to Yale University by Bayard Dominick, of New York City, have been placed at the disposal of the trustees of the museum. Investigations resulting from the use of these funds will be credited to the "Bayard Dominick Expedition." In the hope that further funds will be contributed for this work, the director has formulated a program for two years' study which in outline is as follows:

A. 1920–21: Parties consisting of an ethnologist, an archeologist, a botanist, with necessary interpreters and assistants to be stationed at what might be termed strategic points to make studies essential in establishing standards of physical form, material culture, traditions and language of the Polynesians. This is essential as a basis for the determination of the significance of changes brought about by the overlapping with other races. For this work the existing means of transportation combined with the use of local small boats is fairly satisfactory. The areas selected are Marquesas Islands, Austral Islands, Tongan Islands, Hawaiian Islands.

B. 1921–22: A boat with a crew and staff of scientists to make careful observations, in selected localities along the route Honolulu, Wake, Marshall, Eastern Carolinas, Gilbert, Ellice Islands, Samoa, Tonga, Friendly, Cook, and Society Islands, returning to Honolulu via Tongareva, Malden, Christmas and Fanning Islands. In connection with the previous year's work this cruise should aid in determining through what place or places in the "Polynesian Sieve" the ancient migrations came.

THE PAN-PACIFIC SCIENTIFIC CONGRESS

As the result of informal conferences and much correspondence, a scientific congress has been organized to meet at Honolulu, August 2 to 20, 1920.

The purpose of the congress is to outline scientific problems of the Pacific Ocean region and to suggest methods for their solution; to make a critical inventory of existing knowledge, and to devise plans for future studies. It is anticipated that this congress will formulate for publication a program of research which will serve as a guide for cooperative work for individuals, institutions and governmental agencies.

Representative scientists from the countries whose interests in whole or in part center in the Pacific will be present, and a number of men whose researches demand a knowledge of the natural history of the Pacific islands and shore lands have expressed their intention to attend.

The program of the conference is in the hands of the Committee on Pacific Exploration of the National Research Council, which consists of the following members:

John C. Merriam, University of California, chairman; Wm. Bowie, U. S. Coast and Geodetic Survey; R. A. Daly, Harvard University; William M. Davis, Harvard University; Barton W. Evermann, California Academy of Science; Herbert E. Gregory, Yale University; E. B. Mathews, National Research Council; George F. McEwen, Scripps Institute; Alfred G. Mayor, Carnegie Institution; William E. Ritter, Scripps Institute.

The meetings will be arranged to place emphasis on the following topics:

1. Research desirable to inaugurate; projects described in considerable detail with reference to their significance, and their bearing on other fields of study. Investigations designed to lay the foundation for a higher utilization of the economic resources of the Pacific may be included.

3. Methods of cooperation with a view to eliminating unnecessary duplication of money and energy.

4. The best use of the funds now available and the source of further endowments.

In addition to those maintained by the Federal and Territorial governments, the active scientific organizations of Hawaii include the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History, the College of Hawaii, the Sugar Planters' Experiment Station, The Marine Aquarium and the Volcano Observatory.

Between Honolulu and San Francisco regular sailings are maintained by four steamship companies, and established routes bring Hawaii into connection with Canada, New Zealand, Australia, the Philippines, China and Japan. In order to procure desirable accommodations, reservations for both outward and return passage should be made at an early date.

Further information if desired may be obtained from members of the Committee on Pacific Exploration or from the undersigned.

Herbert E. Gregory,
Chairman, Pan-Pacific Scientific Congress
Bernice Pauahi Bishop Musem,
Honolulu, Hawaii,
March 20, 1920

APPROPRIATIONS FOR THE NEW YORK STATE COLLEGE OF AGRICULTURE

The Governor of New York State has signed the annual appropriation bill, providing for the maintenance and future development of the State College of Agriculture at Cornell University. The college thus becomes assured of a total appropriation of $1,787,-888.80, of which $517,000 is for the erection of new buildings and $14,530 for the State Game Farm,

Although the new law makes only a little more than half a million dollars available at once for new construction, it directs the state architect to prepare plans for the further extension of the college; and it authorizes the board of trustees, following the architect's plans, to enter into contracts for additional construction to the amount of $3,000,000.

The remaining $1,256,358.80 is for the salaries of the staff and expenses of operation during the fiscal year from July 1, 1920, to June 30, 1921. This appropriation is larger than last year's by $282,855, of which about two thirds will go for increased salaries.

The law also provides for some new officers of administration, principally a vice-dean of resident instruction and a vice-director of the Experiment Station. There is already a vice-director in charge of the extension service. The filling of the new positions will therefore complete the administrative organization in the three chief phases of work which the law requires of the college.

SELENIUM AND TELLURIUM

At the recent meeting of the American Chemical Society in St. Louis a report of progress of the sub-committee of the National Research Council on The Uses of Selenium and Tellurium was presented by Victor Lenher, of the University of Wisconsin, at the request of the Engineering Division of the National Research Council. This sub-committee is working in close contact with all of the producers of selenium and tellurium in the country, and is carrying out one of the ideals of the National Research Council, which is to promote and coordinate research work in every direction.

The source of selenium and tellurium is in the anode mud from the electrolytic refining of copper. Copper refineries can annually produce under present conditions approximately 300,000 pounds of selenium and about 125,000 pounds of tellurium. A few hundred pounds of these elements would amply supply the market to-day. The large amounts of these elements available and for which there is no practical use, has caused the National Research Council to create a committee whose duty it is to find possible methods for their utilization. This committee consists of Arthur E. Hall, chairman, H. G. Greenwood, Victor Lenher, O. C. Ralston, E. W. Rouse, S. Skowronski and A. W. Smith, and it has been working in close contact with the producers of selenium and tellurium. Arrangements have been made whereby large quantities of these elements can be procured for experimental purposes at cost price from the Raritan Copper Works, Perth Amboy, N. J., the United States Metals Refining Co., Chrome, N. J., the American Smelting and Refining Co., Omaha, Nebraska, and the Baltimore Copper Smelting and Rolling Co., Baltimore, Md.

Mr. E. W. Rouse, of the Baltimore Copper Smelting and Rolling Co., Baltimore, Md., will ship at any time reasonable quantities of selenium gratis to investigators upon the recommendation of the Committee of the National Research Council on the Uses of Selenium and Tellurium. Mr. Arthur E. Hall, of the Omaha plant of the American Smelting and Refining Company, will forward reasonable quantities of tellurium gratis under the same conditions.

PHYSICAL AND CHEMICAL CONSTANTS

The American Chemical Society at its St. Louis meeting passed the following resolution:

Whereas, every industry, for its successful operation, depends upon an accurate knowledge of the properties of the materials it uses and produces and the numerical values of these properties which are known as their constant, and

Whereas, during the war, it became evident that much of the published data on these constants was found to be extremely inaccurate, entailing considerable loss in time and money and it was found in many cases that data very much desired was not to be found in published records, and

Whereas, up to now publication of such constants in tabular form has been mostly in some foreign language and consequently of limited availability, and

Whereas, under allotment by the Inter-Allied Council and the International Research Council, the National Research Council of the United States (an organization duly created by the President of the United States) has decided that this deficiency could best be met by the compilation and publication in English of tables of constants which have been critically reviewed as to their accuracy and has decided that this could best be done by the appointment of a committee to act as trustees in charge of such compilation and as far as is necessary to have charge of the determination of such constants as have not already been published or determined, and

WHEREAS, the trustees so appointed were selected as representing the American Chemical Society, the American Physical Society and the American Institute of Chemical Engineers, the representatives being, respectively, Julius Steiglitz, Edwin P. Hyde and Hugh K. Moore, therefore be it

Resolved, that the American Chemical Society in convention assembled heartily endorses this project and promises to the trustees its support in every way within its power.

SCIENTIFIC NOTES AND NEWS

THE American Philosophical Society on April 24 elected members as follows: Wilder D. Bancroft, Washington; Gary N. Calkins, New York; Edward Capps, Princeton; Heber D. Curtis, Mt. Hamilton, Calif.; Leonard E. Dickson, Chicago; William Duane, Boston; Moses Gomberg, Ann Arbor; Frank J. Goodnow, Baltimore; John F. Jameson, Washington; Douglas W. Johnson, New York; Vernon L. Kellogg, Stanford University, Calif.; George F. Moore, Cambridge; Paul Shorey, Chicago; William C. Sproul, Chester, Pa., and Pope Yeatman, Philadelphia.

THE Academy of Natural Sciences of Philadelphia has conferred the Hayden Memorial Medal for 1920 on Professor Thomas Chrowder Chamberlin, professor emeritus of the University of Chicago, in recognition of his distinguished services to geologic science. This medal is presented every three years for distinguished accomplishments in geology or paleontology. It represents a memorial established by an endowment fund by Mrs. Emma W. Hayden in honor of her husband, Dr. Ferdinand V. Hayden, who was for many years director of the Geological and Geographical Survey of the Territories. The medal was first presented to James Hall, formerly state geologist of New York, in 1890, and has since been presented to various distinguished geologists both in America and in Europe. In the opinion of the Committee on the Award, Professor Chamberlin's numerous and remarkable contributions to geologic science place him in a rank high among the others who have received the Hayden Memorial Medal.

DR. VICTOR C. VAUGHAN, of the University of Michigan, has been elected a member of the Institute of Medicine of Chicago.

PROFESSOR A. FOWLER, F.R.S., has been elected a corresponding member of the Paris Academy in the section of astronomy.

ON the occasion of the dedication of its new Agricultural Engineering Hall at University Farm on April 14, the University of Nebraska conferred the honorary degree of doctor of agriculture upon Roscoe W. Thatcher, dean of the department of agriculture and director of the agricultural experiment stations of the University of Minnesota, and the honorary degree of doctor of engineering upon Charles Rus Richards, dean of the college of engineering and director of the engineering experiment station of the University of Illinois. Dean Richards delivered the dedicatory address.

THE intimate international relationships with English and Continental laboratories held by the members of the nutrition laboratory of the Carnegie Institution of Washington, in Boston, Mass., which were interrupted by the war, are again to be resumed. Professor Walter R. Miles, of the department of physiological psychology of the Nutrition Laboratory, has recently left for an extended tour in European countries and for attendance at the International Congress of Physiology to be held in Paris in July.

DR. J. WALKER FEWKES, chief of the Bureau of American Ethnology, will return to the University of Texas in June to continue the work of archeological research begun last year. During Dr. Fewkes' former visit to Texas investigations were made of the Red Burnt Mounds extending from east of Austin westward beyond the New Mexico boundary.

Dr. John L. Todd, of McGill University, and Dr. Simeon B. Wolbach, of Harvard Medical School, have gone to Poland to study typhus fever. They are working under the Red Cross.

Dr. Don M. Griswold has been appointed state epidemiologist of Iowa to succeed the late Dr. E. G. Birge. Dr. Griswold will also act as head of the division of hygiene, preventive medicine and epidemiology of the department of pathology and bacteriology of the University of Iowa.

Dr. E. G. Titus, technologist in sugar-plant investigations, U. S. Department of Agriculture, who has been in charge of seed-breeding and other sugar-beet investigations in the intermountain region, has accepted a position with the Utah-Idaho Sugar Company, Salt Lake City, as director of their new department of agricultural research.

Professor O. M. Leland, of Cornell University, has accepted a position with the J. G. White Engineering Corporation and has taken up his work at their offices in New York City. He has been a member of the faculty of civil engineering at Cornell for seventeen years. During the war, Professor Leland was in active service as Lieutenant Colonel of Engineers, in the 78th Division, and, after the Armistice, in the 89th Division.

Dr. James Brown, formerly research chemist for Zinsser and Co., Hastings-on-Hudson, N. Y., has accepted a position as research chemist with the Calco-Chemical Company, of Bound Brook, N. J.

Professor R. A. Sampson, F.R.S., astronomer royal for Scotland, has been appointed Halley lecturer in the University of Oxford.

The courses and conferences arranged for the physicists and mathematicians who will be assembled at the University of Chicago during the summer quarter, beginning on June 21 and ending about September 1, include the subject of the General Theory of Relativity, by Dr. A. C. Lunn; the Theories of Quanta and Theories of Atomic Structure, by Dr. R. A. Millikan; New Developments in Optics, by Dr. H. G. Gale; Thermionic Phenomena and their Applications, by Dr. A. J. Van der Bijl, of the Research Laboratory of the Western Electric Company; the Theory of Sound, by Dr. Lunn; and Electro-Magnetic Theory, by Dr. A. J. Dempster. The facilities of the Ryerson Laboratory for research and conference purposes are extended to professors holding the doctor's degree from other institutions. A considerable number of physicists of this type are to be in attendance.

Sir Richard Glazebrook, late director of the National Physical Laboratory at Teddington, England, was presented on March 17 by the staff with his portrait in oils, painted by his cousin, Mr. Hugh de T. Glazebrook. Accompanying the gift was an album, containing an illuminated address, followed by the signatures of past and present members of the staff and a photograph of the laboratory taken from an aeroplane. Mr. F. E. Smith, F.R.S., who presided, and Dr. T. E. Stanton, who made the presentation, reviewed the rise and progress of the laboratory under Sir Richard, and referred to the harmony that had always existed between him and the staff. Sir Richard Glazebrook thanked the staff for their gift, and, speaking of the future of the laboratory, said he was sure Mr. Balfour and the members of the council had its interests very seriously at heart, and would do all they could in the future to promote its prosperity. There was an intention on the part of the Ministry to carry on the study of aeronautics, which had been an important feature in the work of the laboratory in the past, and he hoped that place would be made one of the centers where research work would be continued.

At the meeting of the Institute of Medicine of Chicago on April 16, Professor R. A. Millikan, professor of physics at the University of Chicago, presented a paper on "Twentieth century contributions to our knowledge of the atom."

Professor Vernon Kellogg recently addressed the New York Alumni Society of Phi Beta Kappa, and also the Washington Academy of Sciences, on "Europe's food in war and armistice."

DR. WILLIAM CURTIS FARABEE gave an address on "Ethnography at the Peace Conference" before the University of Pennsylvania chapter of Phi Beta Kappa at its twentieth anniversary meeting on April 15. At the same meeting Dr. Farabee was elected to honorary membership in the society.

DR. FRED HEYL, of the Upjohn Company, Kalamazoo, Michigan, recently lectured before the chemical department of Yale University on "The application of organic chemistry in the pharmaceutical industry." The next speaker in this course of industrial lectures being given this year in the Graduate School will be Mr. Walter S. Landis, of the American Cyanamide Company, who will give three lectures dealing with the "Fixation of nitrogen."

THE Lady Priestley Memorial Lecture of the National Health Society was given by Sir George Newman, K.C.B., M.D., F.R.C.P., on Thursday, April 22, at the house of the Royal Society of Medicine. The title of the lecture is "Preventive medicine: the importance of an educated public opinion."

PLANS have been made for an expenditure of about $10,000,000 for the establishment of "a medical center" at Walter Reed General Hospital, Washington, D. C. The hospital is to be gradually developed into one of the main hospitals of the Army, by the building of two additions to the main hospital building for various uses such as medical and surgical wards, dental department, laboratory, eye, ear and throat department and dispensary. Most of these activities now are housed in temporary buildings. The Mayo Brothers, of Rochester, Minn., will assist in the approved project for increasing its usefulness on modern lines.

THE Migratory Bird Act of 1918, designed to carry out provisions of a treaty between the United States and Great Britain for the protection of migratory birds, has been held constitutional by the Supreme Court. The statute was attacked by Missouri authorities, who alleged that it interfered with the sovereignty of the state and with the property right of the people of that state.

EDUCATIONAL NOTES AND NEWS

THE General Education Board has contributed $350,000 to the Endowment Fund of New York University, to endow the work in engineering and collegiate work. It is conditional on the raising of a total fund for these purposes of $1,200,000 and the clearing off of the floating indebtedness of the university, now amounting to approximately $400,000.

ANNOUNCEMENT is made of the establishment in the Yale Graduate School for the year 1920–1921 of a research fellowship in organic chemistry by the National Aniline and Chemical Company of New York. This fellowship is supported by a gift of $750, and the recipient must be a candidate for the degree of Doctor of Philosophy.

THE total civil service estimates of the year in Great Britain are put at £557,474,899. One of the largest increases is for the Board of Education. The following are typical increases:

	Estimat d for 1920–21 £	Granted for 1919–20 £
Board of Education ..	45,755,567	32,853.111
British Museum	294,233	219,714
Scientific investigation, etc.	208,416	113,974
Scientific and Industrial Research	518,298	242,815
Public Education in Scotland	6,877,220	4,677,220

A ROYAL Commission has been appointed to inquire into the financial resources and working of the University of Dublin and Trinity College, Dublin. The commission is to consider the application for state financial help which has been made by the university. It will consist of five members with three as a quorum. The names of those appointed are: Sir Archibald Giekie, O.M., K.C.B., F.R.S.,; Sir John Ross, Bt., Judge of the Chancery Division of the High Court of Justice in Ireland; Dr. A. E. Shipley, D.Sc., F.R.S., Master of Christ's College, Cambridge; Professor J. S. E. Townsend, F.R.S., Wykeham professor of physics and fellow of New College, Oxford; and Profesor John Joly, F.R.S., professor of geology and mineralogy in the University of Dublin. Professor Gilbert Waterhouse, LL.D., professor of German in Dublin University, is to be the secretary to the commisson. The commission will investigate the administration of the existing financial resources, and also the constitution both of the university and of Trinity College, and may make interim reports if it wishes to do so.

Dr. L. D. Coffman, head of the department of education at the University of Minnesota, has been elected president of the university to succeed Dr. Marion L. Burton, who is president-elect of the University of Michigan.

The trustees of the Peking Union Medical College, Peking, China, announce the resignation of Dr. Franklin C. McLean as director of the college, and the appointment of Dr. Henry S. Houghton, formerly dean of the Harvard Medical School of China, at Shanghai, as acting director. Dr. McLean retires from the directorship in order to devote himself to the professional work of the department of medicine of the Peking College of which he is professor and head.

Dr. Lawson G. Lowery, for three years chief medical officer of the Boston Psychopathic Hospital, has been appointed assistant professor in the psychopathic hospital of the University of Iowa.

Dr. J. B. Cleland has been appointed to the newly created chair of pathology in the Adelaide University, South Australia.

DISCUSSION AND CORRESPONDENCE

UNIFICATION OF SYMBOLS AND DIAGRAMS

The recent attempts to unify the mathematical symbols used in physics and chemistry are probably approved, in principle, by practically every one. They have stimulated and guided a large amount of voluntary effort and cooperation. Their complete recognition and adoption has been hindered by the difficulty of getting any one system to satisfy the very varied requirements and personal preferences involved.

These two facts suggest, first, a further field for the applying of unifying methods, and second, an advantageous way of making the application. The field is the great number of special or minor subjects; such as electron tubes, radio work, gas theory, calorimetry. The notations used in most of these would be better if more nearly unified; and this could much more easily be brought about if each subject is treated as deserving a notation of its own, founded on the general scheme, but having also a special development. Such a treatment of the special topics would probably help solve the conflicts which impede the general scheme also.

A possible advantageous method of getting the work done is for the committees in charge to act more or less as referees, allowing the authors of new papers to do a good deal of the work and even to furnish much of the initiative. Most scientific workers seem to be strongly of the opinion that unification in these numerous subjects is desirable, but among those who would most naturally be expected to take the lead there is a lively appreciation of the work and difficulties involved. These obstacles should be diminished by the plan here suggested. It really puts the committee in a position just opposite to that which similar committees have usually held. Instead of canvassing the whole field and submitting a complete system to be judged by others, the committee would have the final judgment, and the constructive part would be done mainly by active workers specially interested in each different subject, and specially familiar with it. It might be that each decision of the committee, like the decision of a court, would apply to a single case submitted to it, that is, to a single paper. Frequently, then, a brief might be submitted by the author, giving reasons for the desired selection of symbols, and some review of those used by previous writers in the same subject and in those allied to it. The method would thus be flexible and the results capable of modification, though as a rule after one important paper had been passed upon there would be very little more work for the committee in that particular subject.

Whether any such general plan as that just suggested is ever followed or not, it is at least fairly clear that the use of symbols in the various special and restricted subjects can be regulated with far less perplexity and conflict than attends the attempt to provide a single system to fit the whole of a very complex science. Another important conclusion is that voluntary effort and cooperation can accomplish much, even without any formal committee. For instance, most of the existing diversities in symbols are due to inadvertence or negligence, not to real difference in opinion or taste. Most of them would have been avoided if writers had simply made it a rule to notice the symbols of their predecessors, and not make changes without any reason. There is little doubt that the majority of writers are willing to follow this rule as soon as their attention is directed to it. Where previous usage differs, or where some writer wishes to make changes for a reason, the individual writer's judgment may not be wise. In such cases cooperation, through correspondence or otherwise, between different writers is advantageous. Such cooperating writers, however, will usually desire the cooperation of a formal committee. Indeed, my own reason for venturing to present these suggestions to the public is that I happen to belong to a small group who are willing to make mutual concessions and so secure a uniform set of symbols in a new minor subject, and who wish to have their work in this direction given the improvement and greater promise of permanence that would come by having it passed upon by a recognized committee.

The symbols used in diagrams, and in many cases the forms of the diagrams themselves, can also gain by standardization. Certain familiar conventions have long been used in electrical diagrams, but in general the field is so divided and varied that here, even more than with the symbols used in equations, piecemeal and detailed standardizations seem at once easiest and most useful. Sweeping and absolute rules are almost sure to prove detrimental in some cases, and have aroused opposition. Even in striving for uniformity the greatest uniformity is not necessarily always the greatest benefit. Moreover, a set of general rules, formulated once for all, does very little to unify the special and minor details, which are, if anything, the most important, since they are the most numerous, and hardest for the reader to remember. The value of general rules for symbols and diagrams will hardly be denied, but a large measure of attention to separate subjects seems likely at once to be of value in itself and to avoid much of the difficulty and conflict which have hitherto impeded progress in standardization of symbols by more wholesale methods.

Walter P. White
Carnegie Geophysical Laboratory

CARBON MONOXIDE

To the Editor of Science: One of the characteristic by-products of our industrialism is carbon monoxide and the mild hysteria which one finds in certain parts concerning the possible accumulation of this compound in our atmosphere is interesting as an example of a little learning. The report of the press that a high percentage of this gas was discovered in some of our camps where automobiles, aero-engines and gas engines in general were operating has given color to the fears expressed by some of our scientists who should know better. There is probably more carbon monoxide produced during a severe lightning storm in a given locality than is emitted by our coke burners, gas engines and other sources in industry during much longer periods. The silent discharge which proceeds during storms in mountainous areas produces much of the gas. Now while carbon monoxide is inert chemically and scarcely absorbable by ordinary laboratory methods, under natural conditions there are sources of disposal which guarantee that the gas does not accumulate rapidly, at least, in our atmosphere. Chlorophyll "fixes" carbon monoxide in a stable way, so that much chlorophyll is lost to plants in regions where there is an unusually high concentration of the gas, being rendered impotent in photosynthesis by the attachment of CO. In like manner, hemoglobin fixes carbon monoxide and in all probability a relatively large part of aerial CO is disposed of in this way. The hemoglobin binding CO is destroyed in the liver, the CO probably remaining attached to the protein end of the globin, and not to the biliary and urinary pigment which result from the decomposition of hemoglobin. The globin is excreted as urea, ammonia, etc., while some may be retained as amino-acid, but doubtless the CO globin is treated as foreign material and excreted. Another method of disposal of aerial carbon monoxide is the union in sunlight, with the halogens, bromine, iodine, etc., of our atmosphere and with the fluorine freed in the mountainous districts during storms involving lightning. In such cases, the carbon monoxide is converted to a carbonyl halide or to CO_2, in either case being capable of utilization by bacteria, plants with chlorophyll, etc.

The above communication was written previously to the publication of Lamb, Bray and Frazer's contribution from The Chemical Warfare Service entitled "The removal of carbon monoxide from the air" in the J. Ind. and Engineering Chemistry, March 1920, Vol. 12, p. 213.

W. M.

THE ATTAINMENT OF HIGH LEVELS IN THE ATMOSPHERE

To the Editor of Science: In the April 9, 1920, issue of Science, Dr. J. G. Coffin, on behalf of the Curtiss Aeronautical and Motor Corporation, questions the record of Major Schroeder, namely 36,020 feet, given in my brief review of high level records, in Science, March 19, 1920.

So far as I can now ascertain, Dr. Coffin is justified in questioning this particular record. The director of the Bureau of Standards informs me that the bureau has not yet determined the true altitude and that when determined it will be for the Air Service to make proper announcement. With such imperfect data, as I can now obtain, the approximate values are: Rohlfs, 9880.5 meters (32,418 feet); Schroeder, 9505.0 meters (31,184 feet). These are the elevations corrected for mean air column temperature, vapor pressure, gravity, altitude and latitude. The main reduction factor is of course the temperature. These results, however, must not be accepted as final. Until final and authentic data are forthcoming, the justice of Dr. Coffin's criticism must be admitted. The words "The record now stands—Schroeder, February 27, 1920, 10,979 meters" in Science, No. 1316, p. 288, should be accepted with reservation.

Let us hope, however, that before the end of summer both of these plucky aviators will have attained a true height of 10,000 meters.

Alexander McAdie

Blue Hill Observatory,
April 22

SCIENTIFIC BOOKS

Introduction to General Chemistry. By Herbert N. McCoy and Ethel M. Terry. Chicago, Ill., 1919. Pp. viii + 605.

The subject matter covered in the course in chemistry given to the freshmen class at the University of Chicago is the basis for this text-book. It does not aim to include all the material usually considered in a course in descriptive inorganic chemistry; the facts of the science are used primarily to illustrate fundamental principles and laws. A brief statement of the order in which the material is treated will bring out the point of view of the authors. The first chapter deals with the measurement of gases. In the next four chapters the fundamental concepts of the science are developed; these include indestructibility of matter, a pure substance, an element, analysis of substances, law of definite composition derivation of formulæ. Acids, bases, and salts, water and solutions, the kinetic theory and the atomic hypothesis are next considered. A chapter on chlorine and its compounds with hydrogen and metals is followed by a consideration of chemical equilibrium, oxidation and reduction, heat and energy. Three chapters are devoted to the ionic hypothesis and one to electro-chemistry. Nitrogen, phosphorus, sulphur and carbon and their simple compounds are then described. A rather long chapter on organic chemistry in which structural formulæ are freely used follows. Attention is next turned to the theory of dilute solutions, disperse systems, some additional elements, the periodic classification, and radio-activity.

In the discussion of the topics noted many chemical facts are brought before the student but stress is laid on principles and little space devoted to facts of general interest unless they serve as examples of these principles. For example, the only reference to the preparation of iron from its ores is a paragraph on carbon as a reducing agent, in which the statement is made that metallic iron is made from the mineral hematite by reduction with coke at white heat.

The book is clearly written. It will be of interest to teachers to see how rather difficult subjects can be handled effectively in a simple manner. It will be looked upon with favor as a text for beginners by those who desire to teach facts only through the use of laws and theories and do not think it advisable to unduly emphasize the applications of the science.

James F. Norris

NOTES ON METEOROLOGY AND CLIMATOLOGY

RAINFALL INTERCEPTION BY TREES AND CROPS

For several years Mr. Robert E. Horton, consulting hydraulic engineer, Voorheesville, N. Y., has carried on investigations of the various aspects of rainfall in relation to runoff.[1] In such studies what the hydraulic engineer needs to know first is how much rainfall reaches the ground, over a watershed. Is it the amount of precipitation that as shown by well-exposed gages?[2] No. Much rain and snow is intercepted by trees, and evaporated. Thus the hydraulic engineer, unlike the meteorologist, needs to study the catches of rain-gages under trees as well as in the open. [Some cooperative observers seem to have anticipated this need.] Mr. Horton has made a careful study of the amount of precipitation which falls through different kinds of trees and of that portion of the intercepted rainfall which runs down the trunks. Also, in order to enable him to form an estimate of the water which reaches the ground over a varied watershed he has determined the amount of rainfall intercepted by different growing crops in various stages. The results of his investigations have been published in the *Monthly Weather Review*.[3]

Mr. Horton concludes that

> Rainfall interception represents a loss of precipitation which would otherwise be available to the soil. The loss takes place through evaporative processes, but may, for convenience be subdivided into (*a*) interception storage, and (*b*) evaporation during rain.
>
> The amount of interception loss is primarily a function of the storage capacity of the plant surface, the duration of precipitation, and the evaporation rate during precipitation. Since there is generally a fairly close correlation between shower duration and amount of precipitation, estimates of interception loss can, for practical purposes, be expressed in terms of precipitation amount per shower.
>
> The interception storage loss for trees varies from 0.02 to 0.07 inch per shower, and approaches these values for well-developed crops. . . . The . . . loss is greater in light than in heavy showers, ranging from nearly 100 per cent. where the total rainfall does not exceed the interception storage capacity to about 25 per cent. as an average constant rate for most trees in heavy rains of long duration. [Of this] the amount of water reaching the ground by running down the trunks of trees . . . is . . . commonly 1 to 5 per cent. of the total precipitation. The percentage increases from zero in light showers to a maximum constant percentage in heavy showers of long duration. Light showers are much more frequent than heavy ones, and the interception loss for a given precipitation in a month or season varies largely according to the rainfall distribution.

[1] See "Additional Meteorological Data Needed by Engineers," by R. E. Horton, *Engineering News Record*, March 27, 1919, pp. 614–616; reprinted in *Monthly Weather Review*, May, 1919, Vol. 47, pp. 305–307.

[2] See "The Measurement of Rainfall and Snow," by R. E. Horton, *Jour. New England Water Works Assoc.*, 1919, Vol. 33, pp. 14–71, 21 figs., 12 tables; reviewed in *Monthly Weather Rev.*, May, 1919, Vol. 47, pp. 294–296.

[3] September, 1919, Vol. 47, pp. 603–623, 17 figs.

Expressing the interception loss in terms of depth on the horizontal projected area shadowed by the vegetation, the loss per shower of a given amount is very nearly the same for various broad-leaved trees during the summer season. . . . The interception loss from needle-leaved trees, such as pines and hemlocks, is greater both as regards interception storage and evaporation during rain than from broad-leaved trees.

Data are insufficient for a final determination of the relative losses from trees in winter and in summer. Apparently the winter and summer losses for a given monthly precipitation for needle-leaved trees the winter interception loss appears to be about 50 per cent. as great when the trees are defoliated as during the growing season. The average interception loss from 11 trees . . . during the summer of 1918 was 40 per cent. of the precipitation.

ATMOSPHERIC MOISTURE IN THE UNITED STATES

Three years ago, Mr. P. C. Day, chief of the climatological division of the Weather Bureau, published a monograph on "Relative humidities and vapor pressures over the United States, including a discussion of data from recording hair hygrometers,"[4] and to which recently Mr. W. J. Bennett, of Tampa, Florida, has added an interesting discussion of tables prepared along similar lines for Tampa.[5] The diurnal changes in *relative humidity* (which is the water vapor present in the air divided by the maximum which would be possible at the temperature) are practically the opposite of the temperature changes, there being a change generally of 3 to 4 per cent. for each change of 1° C. in temperature.

Vapor pressure (the pressure exerted by the water vapor locally in the air) is a direct index of the *absolute humidity* (water vapor per unit volume of space). In summer in dry climates, such as at Boise, Idaho, the vapor pressure rises during the few hours immediately after sunrise as the moisture from the surface (*e. g.*, dew) is evaporated. Then after about 10 A.M. the vapor pressure decreases as convectional currents reach higher and higher and mix the lower air with the drier air above until the principal minimum is reached at about 6 P.M. After this, evaporation, even though small is able to raise the vapor pressure in the absence of convection. In a moderately humid climate, such as that of Columbus, Ohio, the maximum in summer comes at about 10, as in the drier region, but the minimum is not reached until sunrise, when cooling has condensed a maximum of the water vapor. In a marine climate, using San Francisco as typical, the vapor pressure depends almost entirely on the temperature, and so the maximum comes at about 2 P.M. and the minimum around sunrise.

In the annual period the relative humidity is usually highest with the lowest temperature; but the vapor pressure varies directly with the annual temperature changes. The vapor pressure is 2 to 4 times as great in summer as in winter in most of the United States. The distribution of relative humidity depends, (1) on the temperature of the air, (2) on the proximity of the main source of moisture, (3) on the prevailing wind direction, and (4) on the topography to windward. East of the Rockies, April is generally the month of lowest relative humidity; while west, the mid-summer months are driest. In most of the United States, the highest relative humidity comes in the colder months, except in the southeast where it may occur in late summer or early fall. The lowest relative humidities occur in the far southwest, and in the lee of high mountains elsewhere, while the highest occur near the oceans, similarly, on the lee shores of the Great Lakes, and on the windward sides of mountains. On Pikes Peak and Mount Washington the humidities are generally high and show little variation. In the western half of the country the record minima range from 2 to 10 per cent., while in the eastern half, the lowest are 10 to 20 per cent.

Since absolute humidity is controlled by temperature more than by any other factor for most of the country, the lowest vapor pressure comes in winter, and is experienced

[4] *Monthly Weather Review*, Suppl. No. 6, 1917, 61 pp. (mostly tables), 34 charts. *Cf.* review in *Geogr. Rev.*, February, 1918, Vol. 5, pp. 155–156.

[5] *Monthly Weather Review*, July and October, 1919, Vol. 47, pp. 466–468, 710, 2 figs.

in the coldest part of the United States. In summer, the lowest is in the lee of the Sierra Nevadas. It is rather surprising to learn that the July vapor pressures about Yuma-Arizona, in almost the hottest and driest part of the Arizona desert are as high as those about the cool Great Lakes. Nothing could emphasize more strongly the fact that we feel in terms of relative humidity rather than in terms of absolute humidity.

In all the humidity tables and maps of Mr. Day's contribution we see a complex weather element which depends on the two variables, temperature and moisture. Humidity maps are in this respect on a par with snowfall maps; but they are less complex than those of evaporation, in which wind enters as another factor.

Charles F. Brooks

SPECIAL ARTICLES

LIMITS OF THE GENERA VANDELLIA AND URINOPHILUS

My monograph on the Pygidiidæ was published September, 1918. I was not able to state the limits of the genus *Vandellia* nor to indicate the type of the genus *Urinophilus*. These minute fishes are found in the tropical lowlands of South America. They attach themselves to other animals and drink the blood. Some of them are said to enter the urethra of bathers, and being provided with erectile, retrorse spines on the opercles can not be withdrawn. If not excised they finally enter the bladder and cause death.

It was found during the preparation of the monograph that some of the species contain teeth on the mandibles, others not. It was not known whether the type specimen of the genus *Vandellia* contained mandibulary teeth or not. The specimens are in the Jardin des Plantes, Paris, and were not accessible during the war. Dr. J. Pellegrin has recently examined these specimens and reports that the types of *Vandellia cirrhosa* Cuv. & Val. and of *V. Wieneri* do not have mandibulary teeth and the name *Vandellia* may, therefore, be restricted to those species without mandibulary teeth, *cirrhosa, plazai, wieneri* and *hasemani*, The name *Urinophilus* becomes, thereby, restricted to the only known species with teeth on the tips of the mandibular rami, *Urinophilus sanguineus* (E.). The species *Urinophilus sanguineus* is known from one specimen, 62 mm. collected by Mr. Haseman at San Antonio de Rio Madeiro, Brazil. Its alimentary canal was gorged with blood.

The genera *Vandellia* and *Urinophilus* are members of the Pygidiidæ, a family of the Nematognathi, the cat-fish-like fishes. In most of these the maxillary is reduced to a rudiment forming the base of the chief barbel of the catfish. In *Urinophilus* and *Vandellia* the maxillary bone carries peculiar claw-like teeth. In the monograph mentioned above the tooth-bearing maxillary was labelled "premaxillary" in the explanation of Figs. 35 *A* and *B*, and in Fig. 37.

C. H. Eigenmann

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION H—ANTHROPOLOGY AND PSYCHOLOGY. II

Racial differences in mental fatigue: T. R. Garth. An experiment was given to school children of three races—white, Indian and negro, involving a simple task which all could perform. The problem was to ascertain which race showed least falling away in a task of continuous performance. The young group worked for twenty-eight minutes and the older group for forty-two minutes. The Indians, as a group, excel the whites in endurance but not in total performance.

Supernormal memory: P. F. Swindle. Ordinarily, the term *hysteria* is a name applied to certain spectacular forms of behavior which arise quite suddenly and which consist of strong and very permanently associated responses. Such a form of behavior may be called a somnambulism, a fugue, a hysterical fit, or a special personality; and it is manifested only by those persons in whom associations are easily and at the same time quite permanently formed. If, in this sense, a person possesses an exceptionally good memory, a single unusual occurrence will probably suffice to establish in him a series of strong responses which will be manifested later as a somnambulism. It is profitable to speak of "big" somnambulisms and "little" somnambulisms, or spectacular somnambulisms and ordinary somnambulisms. Hysteria is entirely a relative term. The terms *amnesia* and *dissociation of the personality*, which are so frequently used in speaking of hystericals, are misleading. Each of them should mean that if a person is occupied in one way, he is ordinarily not doing other things or thinking in other ways at that time. For example, only a few minutes ago I was occupied in thinking about a certain demonstration that a katydid can exert a force of at least thirty pounds with its ovipositor. While occupied in this way, I had complete amnesia for a dog I once owned; and at the time that I was thinking about my dog, I had complete amnesia for the experiment with the insect. My dog and the insect established in me two "little" somnambulisms; and I am never active in both ways at the same time. Likewise, a typical hysterical remembers his somnambulism only under the condition that he manifests it again; and when he the cases of typical hysteria which have come under my observation, many of the somnambulisms manifests it he has amnesia for other things. In or personalities were remarkably well associated. This circumstance makes it easy to produce artificially any of the existing states; and it is also responsible for the remarkable periodicity in the manifestations, by certain patients, of their established somnambulisms.

Definitions of mind offered by college students: C. R. Griffith. The purpose of this investigation was (*a*) to obtain a definite expression of the nature of the beliefs and prejudices about "mind" which are held by common-sense, and (*b*), to point out some of the antecedents of these notions. Definitions of "mind" obtained in a naïve manner from students at the University of Illinois are suggestive of the beliefs of popular opinion at large, and indicate, as well, the degree in which the laymen lags behind the trend of scientific thought. A tabulation of the definitions under appropriate categories discloses the fact that popular opinion engages in little or no critical reflection upon the matter. Conceptions of mind as a power, force, energy, guide or faculty are frequent, as are also conceptions confusing mind with the brain, the nervous system, or some internal organ. Less frequent notions make use of such terms as "soul," "spirit," "personality" or "storehouse." Most of the definitions are, in fact, plainly reminiscent of the days of magic and of worn-out philosophies and discarded theories. Moreover, they represent in an undisguised way the wishes and desires of the men who value them. Over the whole is a thin surfacing of modern science. The opinions, thus formed, are garbled in the telling, and betray, for the most part, a notable want in critical ability as well as a lack of substantial knowledge.

Organization of course of study in the elementary school: Helen T. Woolley.

Contributions of experimental psychology to the psychology of the elementary school branches: C. T. Gray.

Safety-first education in school: M. J. Mayo. The loss of life and property in the United States through avoidable accident has become well nigh a national reproach. There is a growing public sentiment against the continuance of this evil. Largely through the influence of the National Safety Council, industrial accidents have been materially reduced. This has been effected through two means: (1) the appliance of safety devices to machinery wherever possible; and (2) a campaign of safety education among workmen. What are known as public accidents, however, show no decline. In the home and on the streets and highways an increasing number of serious and fatal accidents occur. The toll among the school population is large. The teaching of accident prevention is now admittedly a school problem. No other kind of education can more completely justify itself. Public safety can be promoted through two means: (1) the elimination of all avoidable sources of danger; and (2) adequate safety education. Safety education consists of (1) a thorough knowledge of all common danger situations, (2) correct habits of behavior in their presence, and (3) high ideals and right attitudes in regard to safety. We must teach definitely under what circumstances explosives and poisons are dangerous, just how it is that accidental burns and falls occur, just what our habits of behavior on the streets should be. We must act consistently and habitually in accord with this knowledge. This behavior can be secured only through high ideals of the value of human life and limb and a positive attitude towards safety. Our ideals must be dynamic in character. Only, for instance, when we have created an active ideal among the boys—a sort of public sentiment—that condemns riding on the rear end of street cars as a piece of recklessness and stupidity, can this source of fatal accident be eliminated.

The distribution of grades in large lecture rooms: C. R. Griffith. The distribution according to seating arrangement of the grades of students registered in large lecture classes discloses a variation that can not be attributed to differences in mental ability or in physical well-being. For example, the grades of students who sit at the periphery of a group are appreciably lower than those of students who sit in the center. Again, grades at the rear of a room show greater variation than do those at the front. In general, the grades obtained by a given student are dependent partially upon such factors as his mental ability and physical condition, but partially also upon his position with reference to the rest of the group to which he belongs. The disadvantages arising from an unfavorable position in the group can not be wholly attributed to the size of the lecture-rooms, or to idiosyncrasies of the speaker. It is overcome, in part, during the course of the semester, and it may also be offset by the addition of frequent small sectional meetings; it is increased by such factors as intervening aisles and by unoccupied seats. The disadvantage has been found incidentally to rest upon variations in certain perceptual and attentional factors and upon differences in the type of self-instruction under which the individual works; but essentially to rest upon the varying degrees of social integration which are always present among the members of an assembled group.

Speech and brain patterns: L. W. COLE. Association experiments with nonsense syllables indicate that verbal recalls are due to the presence of brain patterns in which each syllable is under the influence of one branch of the pattern. The interweaving of these patterns accounts for the continued suggestion by similarity of one idea by another, or, in other words, it gives a neural basis for association by similarity. It also gives a reason for verbal lapses of memory in which there is recall of part of one word with part of another when the word sought for is partially forgotten. The theory is merely an extension of Sherrington's conception of reflex patterns and it would replace with a definite meaning such vague terms as "mode" of impression, retention and recall, which are used by many writers for the lack of a more definite term. Finally the experiments with nonsense syllables show that rhythm is the most persistent and permanent element of a verbal impression.

A learning curve starting at approximately zero: E. K. STRONG, JR. A boy of 5 years has been given two minutes drill on addition combinations a day for 150 days. At the start he knew nothing of additions except that one and one made two and that one and two made three and that he could count orally to twenty-five. The learning curve obtained in this case does not follow the usual course but runs nearly parallel to the base line for many days and then rises with a positive acceleration. At the end of 158 days it had not suggested a change from positive to negative acceleration.

Methods of error elimination in a mental maze: T. PETERSON. The mental maze method attempts to study maze learning devoid of all the disturbing spatial factors characterizing the usual mazes. The experimenter has before him a picture of a circular maze, with the various parts lettered in a random order. Sitting behind a screen, he calls out to the subject pairs of letters representing bifurcations in the maze and the subject chooses without seeing the maze. Whether the correct letter is called first or last is a matter that is determined by chance. The subject is instructed to get to the goal with as few errors as possible, and is told the number of errors each time on reaching the goal, but he must find out for himself where the errors are. Subject is also timed. Results show backward elimination of errors of entrance to blinds, and relatively early elimination of return "runs," thus substantiating results obtained by the author on rats in different forms of mazes. The tendency to return to the starting place in the maze at first greatly exceeds that expected on the law of probability, but this tendency rapidly yields to that of keeping the forward direction. "Coefficients of learning" for the runs past the several blinds are worked out statistically, each coefficient representing the ratio of probable runs past to probable runs into the blind. These coefficients are found to increase toward the goal end of the maze, thus accounting for the backward elimination of errors; and the advantage for learning at the goal-end of the maze over the entrance-end is shown to be greater than in mazes with many than in those with few blinds. Moreover, this advantage is greater in the first trial than in subsequent trials by any subject; it decreases with successive trials, thus favoring more rapid learning in early trials. Statistical calculations as to the number of errors in each part of the maze on the expectations of chance laws, lead to the conclusion that, independently of the backward elimination tendency, learning progresses more rapidly, in proportion to exercise, in the first and in the last part of the maze than between the extremes.

The development and functioning of a concept in problem-solving: J. C. PETERSON. An objective study is made of the reactions of adults to a number of series of closely related novel problems. In the solution of successive problems of a series the essential common elements are gradually abstracted and associated with an appropriate symbol of some sort. There thus develops a general concept which functions increasingly in succeeding problems in directing observation and controlling re-formulation of hypotheses, until finally new problems are solved at sight or a general formula is given for all problems of the series. In the solution of successive *series* of problems further functioning and development of the concept occur, enabling the subject finally to generalize correctly in advance for new series of problems of the same type. The order of abstraction of essential situation-elements was found to follow closely the order of frequency of the subject's reactions to them. This is also the order of their temporal nearness to the goal or end of the trial. The recombination of essential elements in connection with appropriate symbols, and their association with effective responses, follow the same order though somewhat less closely. There was usually a high degree of transfer of the effects of learning from problem to problem and from series to series of problems. The median percentage of transfer from the first to the second series was almost invariably surpassed by subjects who required more than the median number of trials for the mastery of the first series. This high degree of transfer in the work of slow learners appears to have arisen from the greater strength of mechanical associations rather than from a deeper insight into the causal relations involved. However, the basic concept mentioned above appears to have been the principal medium of transfer. Yet it should not be forgotten that this concept functioned through specific associations which had become mechanized to a high degree largely through repetition.

EDWARD K. STRONG, JR.,
Secretary

GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE 59th meeting of the American Chemical Society was held at St. Louis, Mo., April 12 to Friday, April 16, 1920. The council meeting was held on the 12th, a general meeting on April 13th, both in the morning and in the afternoon, divisional meetings all day Wednesday and Thursday morning, and excursions, Thursday afternoon and Friday. Full details of the meeting and program will be found in the May issue of the *Journal of Industrial and Engineering Chemistry.* The registration was slightly over one thousand, eight hundred and twenty-five enjoying the smoker.

General public addresses were given by Paul W. Brown, editor and publisher of "America at Work," on "The Physical Basis for the Economical Development of the Mississippi Valley," by Chas. H. Herty on "Victory and its Responsibilities." The chief public address was given in the assembly room at the Central High School on "Chemical Warfare" by Col. Amos A. Fries, director of the Chemical Warfare Service.

The following Divisions and Sections met: Agricultural and Food, Biological, Industrial Chemists and Chemical Engineers, Organic, Pharmaceutical, Physical and Inorganic, rubber, and water, Sewage and Sanitation Divisions and the Dye, Leather, and Sugar Sections. Further details of their meetings will be found in the May issue of the *Journal of Industrial and Engineering Chemistry.*

The banquet, held on Thursday evening, April 15, filled the large banquet hall of the Hotel Statler.

A general business meeting was held on Tuesday morning, at which resolutions published in the Council Proceedings, this issue, on the death of Professor Alfred Werner were read by Dr. Chas. H. Herty. Also, Ernest Solvay was unanimously elected an honorary member of the American Chemical Society.

CHAS. L. PARSONS,
Secretary

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

MULTIPLEX TELEPHONY AND TELEGRAPHY OVER OPEN-CIRCUIT BARE WIRES LAID IN THE EARTH OR SEA[1]

INTRODUCTION

THE "key problem" in the procurement of essential Signal Corps supplies in the United States during the World War, curiously enough turned out to be the production of the necessary braiding machines for finishing insulated wire. The bare wire itself could be obtained, the rubber insulation could be obtained, even the cotton thread with which the braiding was made could be obtained, but the necessary machinery for braiding the thread, which finally led us into the intricacies of the procurement of steel, was never anything like adequate for the enormous demands required in the field.

The braiding capacity of the entire United States, as of September 1, 1918, was about 8,000 miles of twisted pair insulated wire per month, while the requirements for the American forces alone at that date were about 40,000 miles a month. On October 1, 1918, the Allied Council reached the decision that beginning March 1, 1919, it would be necessary for the United States to furnish all of this type of wire used by the Allied armies in the field, and the estimated minimum requirements for this purpose were equivalent to four times around the earth a month. To supply this amount of insulated wire would have required cargo space for overseas

[1] Abstract of paper presented to the National Academy of Sciences at the session held at the National Museum, April 27, 1920.

shipment in the amount of 14,000 ship tons a month, but had it been possible to use single conductor bare wire in place of the twisted pair insulated wire, the space required would have been reduced to 2,500 ship tons a month, thus releasing the balance for transportation of food, and other vitally necessary supplies.

It is therefore of paramount importance to diagnose, as far as possible, the technical problems of equipment in the light of past experience and of the present trend of development.

The above facts show the necessity of developing, if possible, new methods by which a reduction may be effected in the enormous quantities of expensive and bulky insulated wire, which was so difficult to procure, and which must now be buried in the earth to a depth of 8 or 10 feet throughout the advance sectors of the front line of a modern army.

THREE MEDIA FOR ELECTRIC WAVE PROPAGATION

The following reasoning led to the carrying out of the experiments to be described:

1. Since we can already communicate by radio means between one submarine and another submarine, both completely submerged, it was considered that connecting two such stations by a submerged copper wire could have no other effect than to facilitate the propagation of the electric waves between the stations.

2. It was considered possible that the behavior of earth or water under the action of high frequency currents might exhibit greatly different properties from those with which we are familiar at direct or low frequency currents.

3. It was realized that whatever high frequency energy losses might occur in the case of bare wires laid in earth or water, yet the over-all efficiency would be higher than in the case of radio space transmission where the plant efficiency is so very low.

4. It was noted by the writer in September, 1910, and discussed by him in April, 1912,[2] that the three-electrode audion could be used as a potentially operated device on open circuits. This arrangement was considered suitable for the reception of the signals over bare wires in earth or water.

PRELIMINARY EXPERIMENTS

The first experiment was an extremely simple one as follows: A bare No. 18 phosphor bronze wire, such as is used for the Signal Corps field antenna, was laid across the Washington Channel of the Potomac River from the War College to the opposite shore in Potomac Park. It was paid out from a small boat with sufficient slack to lay on the bottom of the river. A standard Signal Corps radio telephone and telegraph set, SCR 76, was directly connected to each end of the wire, one set serving as a transmitter and the other as a receiver. At the receiving end of the line the bare wire was directly connected to the grid of the receiving set and the usual ground connection left open. A frequency of about 600,000 cycles a second was used and the line tuned at each end by the usual methods. Excellent telegraphy and telephony were obtained. Care was taken to make this preliminary experiment as simple and basic as possible and precaution taken to insure that the wire itself should be bright and clean entirely free from any grease or other insulating material.

[2] *Journal of The Franklin Institute*, April 1, 1912, "Some Experiments in 'Wired Wireless' Telegraphy for Field Lines of Information for Military Purposes," by Major George O. Squier, Signal Corps, U. S. Army.

The success of this simple experiment immediately led to more thorough consideration of the entire subject.

One of the questions to be investigated was the general efficiency of the electron tube when used as a potentially operated instrument. The following experiment was made:

A strip of wire netting was buried in the snow outside the office of the Chief Signal Officer in Washington and a wire attached thereto leading to the second story of the building. The upper end of this wire was connected directly to the grid of an electron tube. The reason for connecting the grid to the upper end of the antenna is of course obvious if we are to use the tube as a potentially operated device. It was necessary for maximum sensitiveness to connect it to the point of maximum potential of the antenna which in the case of a linear oscillator occurs at the open end. By this arrangement, messages were readily received from distant points in the United States.

These two simple experiments, above described, demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water and the use of an electron tube as a potentially operated device for the reception of signals. The technical data will be published later.

SUMMARY

For military reasons, if for no other, as stated in the introduction of this paper, the Signal Corps has recently undertaken certain investigations in the phenomena connected with the transmission of high frequency electromagnetic waves over bare wires in earth and in water.

In carrying out these investigations and in attacking the problems from various angles, the research staff of the Signal Corps laboratory at Camp Alfred Vail, Little Silver, New Jersey, was directed to carry out experiments on bare wires laid on the surface of moist ground and also buried in earth. The staff at the Signal Corps research laboratory at the Bureau of Standards was directed to investigate fundamentally the transmission of electromagnetic waves over bare wires in fresh water. In addition to this, the engineering staff of the Office of the Chief Signal Officer has carried out from time to time certain experiments of a more or less crucial character which have come up for solution in the prosecution of this work at the other laboratories.

Certain data from each of these groups of engineers have been presented above. The phenomena associated with the transmission of high frequency waves over bare wires in earth or water are obscure and complex, and the writer has formulated no definite theory at the present time.

RESULTS OBTAINED

1. Telephone and telegraph communication has been established between Fort Washington, Maryland, and Fort Hunt, Virginia, across the Potomac River, below the city of Washington, over a distance of about three quarters of a mile, by the use of a bare No. 12 phosphor bronze wire laid in the water to connect the stations. The transmitter consisted of an electron tube oscillator which delivered a current of about 270 milliamperes to the line at a frequency of about 600,000 cycles a second. At the receiving end of the line an electron tube and a 6-stage amplifier were used without any ground connection. With this arrangement good tuning was obtained at both ends of the line, and telegraphic and telephonic transmission secured over the bare wires immersed in fresh water.

2. A resonance wave coil has been devel-

oped. The coil is in the form of a long helix wound with a large number of turns on which stationary waves are produced by the incoming radio signals. An electron tube is used as the detector, the grid being connected to the point of maximum potential on the coil. The wave coil may be used either as a part of the usual antenna system or a part of a line wire, or it may act itself as the antenna for picking up the energy of the signals. In the latter case the coil may be either free at both ends or grounded at one end. Good results have been obtained in either case. It has been also found that the open coil has directional properties and can be used as a goniometer not only for horizontal measurements but for vertical measurements as well. This form of radio goniometer has the great advantage that it permits not only of determining the plane where the signals are strongest but also the direction from which such signals proceed.

Telegraph and telephone communication has been also established between two stations at the Signal Corps Research Laboratories at Camp Alfred Vail, Little Silver, New Jersey, using a bare No. 16 copper wire buried in the earth to a depth of about eight inches to connect the stations. The distance between the two stations was three quarters of a mile. Frequencies as high as one million cycles a second were used. Similar communication has been carried on over a bare wire one and three quarter miles long laid on the surface of moist earth. The current at the transmitting station in these installations was about 100 milliamperes. It has been shown that a bare wire buried in moist earth with the distant end open can be tuned both at the transmitting end and at the receiving end.

SUGGESTIONS

1. In the older art of ocean telegraphy, the elaborateness of line construction has already reached a practical limit. The best Atlantic cable of the present day is limited in operation to electric waves of frequency of the order of magnitude of 10 per second. The electrical construction is such as to limit the voltage employed on any long cable to from 50 to 80. The relative values of the line constants in any ocean cable preclude the possibility of ocean telephony.

The most promising hope of improving the line construction for ocean cables is believed to be, to abandon the present method of design and construction and to start with the simple case of bare wires in water using high frequency currents and study the necessary changes to produce optimum transmission.

The use of a high frequency "carrier" has the inherent advantage that the distortion phenomena accompanying present methods of long distance transmission are eliminated, and we are principally concerned with the problem of reducing attenuation. The most suitable voltage may be employed and present multiplex methods may be utilized. The electron tube is available for both the generation and the reception of the waves.

2. During the last few years an intensive study has been made of the surface conditions of wires necessary to produce the emission of electrons, and to this intensive study, both by universities and industrial research laboratories, is due the high state of efficiency of the present electron tube. Nothing short of a similar study of the surface conditions of wires for preventing the emission of electrons instead of producing them, will finally give us the wire conductor of the future.

3. The development of types of reson-

ance wave coils, both open at one end and at both ends, for general radio work offers an interesting field for investigation. This involves the study of the electron tube as a potentially operated device. The application of such coils properly designed for specific purposes may lead to the practical solution of a number of radio problems such as directional effects, and wave coils antennæ of very small dimensions.

4. The account of the experiments thus far conducted and the reasons which have led to the undertaking of these experiments on the part of the Signal Corps, are presented to the National Academy of Sciences at this time in conformity with the new spirit of organization for national and international research so admirably typified by the National Research Council which is under the general direction of this official body.

George O. Squier

Office of the Chief Signal Officer,
War Department,
Washington, D. C.

RÉSUMÉ OF RESEARCH IN THE PSYCHOLOGY OF AVIATION DURING THE YEAR 1919

The writer has been in charge of the department of psychology of the Air Service Medical Research Laboratory since January 15, 1919. Members of the department engaged in research during that year included Drs. F. C. Dockeray, D. C. Rogers, H. C. McComas and J. E. Coover, as captains; Dr. English Bagby and Mr. Schachne Isaacs, as lieutenants; and Dr. F. C. Paschal, Miss Barbara V. Deyo and Mrs. Cressie Campbell Merriman, as assistants. Certain members of the group were present for but a short time; and others were present for several months. Dr. E. N. Henderson and Mr. L. J. O'Rourke, as captain and lieutenant, resepctively, were connected with the department for some time, but the exigencies of the service did not permit of their employment in research. Since October last the staff has consisted of Lieutenant Isaacs and the writer, with Miss Deyo and Mrs. Merriman as research assistants.

During the year the department prosecuted research along two distinct and independent lines: (1) an effort to gain a somewhat more intimate acquaintance with the effects of low oxygen on the integrity of response; and (2) an effort to develop more sensitive tests for the detection of (*a*) general aptitude for aviation work and (*b*) of its deterioration in the earlier stages of staleness. The reports of this work will probably appear in due time in the various American psychological journals, under the names of the authors who are individually or jointly responsible. Meanwhile, a résumé of the year's activities of the department as an organization may not be out of place here.

An extensive and detailed statistical study of the records of over 6,000 classification-tests for resistance to deprivation of oxygen, has been made under the direction of Captain Coover. He was assisted by Lieutenant Isaacs, Dr. Paschal, Miss Deyo, Mrs. Merriman and the writer. The results indicate the extent to which the subject's performance may be affected by atmospheric pressure, temperature and humidity; by the absolute quantity of oxygen supplied the subject in the air to be rebreathed; by the duration of the test; by the time of day at which the test is taken; by the judgmental eccentricities of the psychological and clinical observers; and by a lowered morale, such as that which immediately followed the armistice. With these data available it is now possible, by controlling or correcting for the influence of these variables, to approximate much more closely to uniformity and constancy of the standards of classification than has been possible hitherto.

An attempt was made by the writer, in collaboration with Dr. Paschal, to demonstrate the progress of impairment of behavior by the use of an objective record of the speed and accuracy which the subject can maintain in carrying on work of uniform difficulty as the supply of oxygen is being diminished.

(The subject was required to encipher a number of sets of nonsense-material into specially prepared codes, both the material and the ciphers being selected for uniformity in the distribution of difficulties.) Some interesting records were obtained, which, however, do not give the quantitative measure of impairment which the appearance of the graphs suggests. One reason for this fact is that many subjects tend to compensate for impairment of response by an increase of "voluntary" effort. The fact can be noted by the observer, and such clinical notes are necessary to correct interpretation of the "quantitative" data.

Some tests on the fluctuations of visual acuity over extended periods of observation were made by the writer, using in general the method described by Cobb;[1] the test-field, however being a real image of the pattern of the Ives-Cobb visual acuity test-object, slightly magnified on one half and slightly reduced on the other, projected into the plane of an opening in a screen 60 cm. from the eye. Some results thus obtained were not fully expected; *e. g.*, (1) it appeared that fixation and accommodation upon a stationary object can be maintained until the last stages of asphyxiation have been reached; (2) that disturbance of the visual function is not exhibited by this type of test until the more highly coordinated processes have actually begun to fail; and (3) that in the last stages of asphyxiation, visual impressions may become intermittent and the entire field become darkened, without the outlines of objects appearing blurred, and without diplopia developing under the conditions of this particular test. It should be remarked, however, that these conditions are much less trying than those which compel coordinated eye-movements to be executed within a limited time; and that the latter conditions often elicit and exhibit marked disturbances. This work will probably be carried farther.

Dr. Rogers perfected an attachment for the Henderson rebreather by means of which the rate of diminution of oxygen can be controlled, within reasonable limits, through the replacement of a known proportion of the oxygen consumed within a given time. The apparatus is considered superior in some respects to one previously used in another department, and its employment assures that different subjects can be made to experience comparable degrees of oxygen-hunger for comparable times.

An investigation was made by Dr. McComas on the influence of diminished air-pressure, simulating an altitude of 20,000 feet, on the time required for selective reaction to a number of combinations of signals visually perceived. The experiment being exploratory in character, and the time of the experimenter being limited, it was not feasible to introduce certain controls which otherwise would have been desirable. However, the data as obtained indicate that the time required for selective response is greatly lengthened and its variability increased, by the abnormal conditions of the experiment, until the subject by continued practise has rendered his responses almost purely mechanical. The results obtained in the later stages of training are open to more than one interpretation, and it is planned to resume experimentation as soon as may be practicable.

Dr. Bagby made a systematic contribution in the form of a study entitled "A psychological point of view in psychiatry, with special reference to pathological behavior under deprivation of oxygen." This report calls attention to manifestations of emotional instability which sometimes occur during the rebreathing test in the absence of adequate external stimuli. The display under such conditions of anger, fear, destructiveness, excessive nonchalance, silliness and euphoria, is compared with symptoms of alcoholic intoxication, and with characteristic symptoms of certain types of insanity. The opportunity incidentally afforded by the test, of observing evidences of lack of poise which are not necessarily prominent in the normal state, is emphasized.

A study of associative responses was begun

[1] Cobb, P. W., "The Influence of Pupillary Diameter on Visual Acuity," *Am. Jour. Physiol.*, 1915, Vol. XXXVI., pp. 335–346.

during the summer by Dr. Bagby, for the purpose of exhibiting the extent to which pathological reactive tendencies, existing normally in a state of repression, tend to be released under diminished barometric pressures corresponding to fairly high altitudes. The author was separated from the service before the work was completed, but not until after an excellent collection of test-material had been compiled and tested. Arrangements have been made to have the work completed by Lieutenant Isaacs, as soon as the low pressure chamber has been installed in its new location.

The results of the tests of aptitude for flying, administered by Drs. McComas and Bagby at Taylor and Souther fields under the direction of Major Stratton in 1918, were worked up in the department under the direction of Dr. Coover, with the assistance of several members of the staff. The data indicate that the tests taken as a group have some diagnostic value and that certain of the individual tests if further refined may have considerable practical value. An important fact exhibited by the data is that flying grades do not adequately differentiate aviational ability. About 85 per cent. of the cadets tested at one field was rated within a range of five points on a scale of 100. This means, practically, that a certain grade was taken as expressing the rating "Fairly good," for example; and that practically all the men so regarded received the same grade, no means being provided for ranking them *within* the class within which they fall. This makes a comparison of flying grade with other scores, quite difficult of interpretation.

The results of a number of tests of aviational ability used by Captain Dockeray and Lieutenant Isaacs in the A. E. F. were worked up by those authors here. The data show that the scores of the subjects in two of the tests are highly correlated with the estimate of aviational ability as made by the training department, the coefficients in both cases being approximately 0.73. It is safe to say that if six to eight tests as satisfactory as these were developed, they would afford a better basis of prediction of flying-school performance than is afforded by the cadets' records in civil life, or by their performance in ground school, etc. It is planned to continue the effort to develop such tests.

Preliminary work in the department suggested that two forms of test, if sufficiently refined, might prove to be quite valuable in diagnosis of aviational ability and in exhibiting its impairment. These tests are (1) of the ability to control the coordinated activity of certain systems of voluntary muscles; and (2) of the *relative* time required for selective reaction to one of three signals presented successively and in irregular sequence (*a*) under a standard condition of observation and (*b*) under a condition of observation so difficult as to be trying. This work is still in the early stages, due largely to the delay in making the annual appropriation available, and to the general disorganization and turmoil incidental to the closing of Hazelhurst Field and moving the laboratory hither.

In addition to the research activities recapitulated above, some considerable energy of the department was devoted to supervision of the psychological features of the routine tests run at branch laboratories; to the administration of classification-tests at the local fields; and to cooperation with other departments in the administration of tests in which the department of psychology was not directly interested.

Courses in psychology were given to three classes of military physicians in training for the work of flight surgeons. These courses covered: fundamental presuppositions of the science of psychology as defined by the more prominent contemporary authors; the rudiments of psychophysical methods and technique; an introduction to elementary statistics, including measures of central tendencies, variability and correlation; the psychological features of the classification-tests used in the Air Service; and an introduction to the concept of the wish as a unit in behavior. While most of these students made quite a creditable showing it has since been deemed advisable to discontinue the work in statistics and to substitute for it work bearing directly on the "personality study" which these physicians are required to make of their wards.

Harry M. Johnson,
Sanitary Corps.

Mitchel Field, L. I., N. Y.

GENERAL BIOLOGY AND THE JUNIOR COLLEGE

Biologists are much indebted to Professor Nichols for his excellent summary of sentiment in respect to the so-called "General Biology" course. His survey would appear to indicate that possibly a majority of biologists believe that a year's work, consisting of a half year each of introductory botany and zoology, is general biology or is at least a preferable substitute for it. In a recent article Professor Henderson expresses his dissent from this view and raises the question of the relation of this course to general culture and the junior college. He says:

> I take it as axiomatic that there is a certain minimum of information regarding matters biological which every educated man ought to have . . .

and

> It seems—at least some of us hope—that to-day we are about to see a displacement of the academic course in favor of the junior college, which would give such general subjects as the languages, American history, elementary chemistry and physics, and the one or two other things which every one should have; . . .

The Junior College.—That there is already a strong current of sentiment toward the junior college is a fact of which one can scarcely remain unaware. For this there appear to be several reasons. In the first place many of the larger universities are fairly swamped with students of immature age in respect to the nature and content of the courses offered them. A second and possibly more important reason is that such junior colleges can be established and maintained in most larger towns and cities. This results in a desirable saving in expense to the student. Its chief advantage to the university lies in the fact that it frees it from overcrowding and acts as a desirable preliminary period during which there is likely to occur a sorting out of the students better qualified by ability and interest to pursue the professional courses of the university.

In the third place our universities are showing stronger and stronger tendencies away from "general culture" courses. To the small college is left, in large measure, the task of imparting general culture. Modern education consists, then, either in a series of years devoted wholly to general culture, or in an equal period of specialized, more or less technical study, the determining factor being whether the student happened to attend a small college or one of the larger universities. The exigencies of modern life forbid, in the case of many individuals, and render of doubtful value for others, the spending of four years in acquiring general culture. On the other hand, a curriculum devoted wholly to specialized training is thought by many intelligent persons not to afford a liberal education, at least in the best sense of that term. The junior college offers a feasible, if not an ideal, solution of the difficulty by allowing (or perhaps requiring) two years of general culture on which may be superposed two or more of specialized training.

An important feature of the junior college which commends it to many is the limited election which its organization permits. The immature student may well be compelled to form acquaintance in an elementary way with the subject matter of the chief lines of human endeavor, and, what is more important, with the point of view and habits of thought of workers along these lines. Too free a range of election in the earlier years hinders this attainment of broad outlook by tempting the student to follow along familiar pathways. With distressing frequency is the spectacle presented of students clinging to certain groups of courses because they feel reasonably sure of success therein, whereas their own best educational interests demand that they venture into strange fields and feed on untried pabulum.

Whether the first two college years are given on the university campus or in a separate junior college it seems highly desirable to reconsider the nature and content of their courses. As matters now stand in the larger institutions there are likely to be from twenty to thirty separate departments of instruction, each of which offers an elementary course introductory to its particular field of investigation. Under these circumstances the student finds it difficult or impossible to acquire a *general knowledge* of the fields of human endeavor. It is true, of course, that most departments aim so to construct their introductory courses as to make them suitable foundations for further and more specialized work and at the same time afford as much general information and training as possible. The truth, in the opinion of many, is that this double object is very difficult, or perhaps impossible, of satisfactory achievement. It is the old, old problem of serving two masters and usually with "General Culture" cast for the rôle of Mammon. The general result is that there are numerous excellent courses in every university, considered from the point of view of introductions to their respective subjects, but very few general culture courses worthy the name. But even granting that some do achieve this two-fold object and that all might do so, it still remains true that the student must take too many courses to secure what he desires and must learn many specialized facts and acquire special technique which he neither ardently desires nor particularly needs.

If, now, the case against the growing extreme specialization in the first two college years has been fairly put, we are faced with the problem of attempting a resynthesis of the subject matter of elementary courses which will at once reduce the number of courses and broaden their outlook. The chief aim should be to remove them from the field of specialization to that of general culture; to make them fit into the general educational scheme of the genuinely well-educated man. However, sight must not be lost wholly of the fact that these junior college courses will constitute, also, the collegiate introduction, in some cases, to the specialized lines of study to be pursued later. To be specific, the general biology course must not only present a broad view of the field of biology to the general culture student but should also make clear to the future physician, agriculturist, or scientific investigator the relation of his special field of effort to that larger domain of which it is but a specialized part.

Before considering the specific application of these general ideas to the question of elementary instruction in biology it seems desirable to raise and discuss two preliminary inquiries: (1) What is wrong with the "General Biology" courses of the past? (2) Why are the usual consecutive courses in botany and zoology regarded as unsatisfactory?

The Case against "General Biology."—Careful reading of Professor Nichols's paper shows that the objections to general biology are directed, for the most part, against the "standard" course, based originally on the text-book of Huxley and Martin; but with an undercurrent of opinion that no course can avoid certain pitfalls, among which are: the difficulty of finding men of sufficient breadth of view to give general biology adequate presentation; the equally serious difficulty of finding zoologists and botanists who can cooperate harmoniously in giving a course jointly; the danger that abstract principles may be stressed unduly, to the exclusion of concrete facts; and finally, the alleged unsuitability of general biology as an introduction to further study of zoology or botany. Disregarding, as we should, those objections that are based on interdepartmental or interprofessional jealousies, and assuming, as we may, that zoologists and botanists will cooperate willingly, if the need for such cooperation becomes clear, the problem boils down to the question whether a "General Biology" course properly designed to afford a maximum of general culture would also be a useful and desirable introduction to his field for the future botanist, zoologist, or physician.

Objections to Consecutive Courses in Botany and Zoology.—Consecutive courses usually are not, and generally are not intended to be, adequate presentations of general biology. On the contrary these courses are commonly admirable introductions to the sort of botany or zoology taught in their respective institutions. They are open to criticism from two directions. In the first place they contain much that is of little interest or importance to the general culture student and they usually involve an excessive amount of detailed laboratory work for this type of student. We do not mean to assert that a thorough training in the laboratory is not good for any sort of student but merely to point out the absurdity of compelling him to acquire a different one for each field of study if he is to become a really well educated man. Not unnaturally the majority of students, under a system of relative freedom of election, decline to attempt to secure a general education at this exorbitant price.

On the other hand these courses are seriously deficient, from this point of view, in what they omit. This is more serious than the inclusions, for one may reasonably be willing to pay an excessive price for a worthwhile article but he can hardly be expected to be satisfied to pay for what he ardently wishes and really needs and then not get it, even after being overcharged.

Furthermore this criticism comes not alone from the general culture student but also from one of the largest groups of biologists, namely, the medical students. The tandem arrangement has never been satisfactory to them, and now, with the increasing pressure upon their time for technical zoological courses, such as comparative anatomy, becomes virtually impossible. The present situation is that the prospective medical student takes no botany at all, or does so only at the sacrifice of valuable and important non-scientific study, of which he obtains at best far too little. And furthermore, whether he studies botany or not, he goes through his course without having had formal opportunity to acquire a broad conception of life itself and the interrelations of living things with one another and with the inorganic world.

What is General Biology.—To the writers it seems clear that it does not consist in some zoology and some botany, whether administered in the old-fashioned mixture, improperly called general biology, or in the more modern separate dose method of consecutive courses. To us it seems axiomatic that it must have a much broader outlook and that it must in a general way include somewhat the following topics: (1) The structures and functions common to all living things; (2) The distinguishing characteristics of plants as such and their function in the world; (3) The essential characters of animals; (4) The interrelations of plants and animals with one another and with inorganic nature, with special reference to competition, survival, injury, death, disease, and decomposition; (5) The processes of nature whereby matter and energy are so conserved and transformed as to permit the ceaseless and indefinitely continuous round of life. To be more specific this means a study of: (*a*) Protoplasm—its structure and functions, cells, cell division, colonial and multicellular organisms, growth and differentiation; (*b*) the rôle of green plants in the transformation of the free energy of sunlight and simple inorganic compounds into complex energy-containing organic compounds to be used as foods—*i. e.*, as sources of energy and building materials—by animals and non-green plant cells; (*c*) how these foods are used by animals in growth and work and how they produce wastes, eventually to be used again by plants; (*d*) the sensitivity of protoplasm and its rôle in relating the plant and animal to their environment; (*e*) growth and reproduction; (*f*) heredity and evolution; (*g*) disease and death; (*h*) decomposition, putrefaction, and fermentation and other processes in the soil that render organic materials again usable by green plants; (*i*) the transformations and conservation of matter and energy as exemplified in the carbon, nitrogen, and other organic cycles.

Administrative Difficulties.—It seems probable that much of the prejudice against the "General Biology" course has actually had its origin in the inter-departmental friction of administering a large joint undertaking. We have no doubt that this can be overcome, with patience and good will, even with the present organization of our chief universities. But, on the other hand, these difficulties are greatly minimized under a junior college organization. Presumably in most institutions the first two years work would be placed directly under the control of a dean or other similar administrative officer with little or no departmental bias. He would be empowered and obligated to organize such general courses —General Biology and others—without interference from departments or technical schools, though he would doubtless wisely seek such advice as he needed.

Under a junior college organization, general biology is but one of the urgent needs. A presentation of the general concepts of physics and chemistry is certainly just as much needed and doubtless equally feasible. Certainly the educated man should know something of the earth on which he lives and the planetary system to which it belongs—interesting subject matter for a general course. It is possibly venturing afield for biologists to suggest that a general course could also be devised that would inform the student concerning the human environment in which he lives. What a fascinating course could be made by a serious attempt to set before the student the rôle of the state, the church, labor, capital, eugenics, and euthenics!

In conclusion the writers, a botanist and a physiologist, respectively, would beg to record their conviction not only that a course in general biology, and other similar courses, can be organized and that they are highly desirable but also that the advance of the junior college will shortly force us to attempt it whether we like it or not.

LEONAS L. BURLINGAME,
ERNEST G. MARTIN
STANFORD UNIVERSITY

FRANCIS C. PHILLIPS

DR. FRANCIS CLIFFORD PHILLIPS died at his residence, 144 Ridge Avenue, Ben Avon, Pa., on Monday, February 16, of influenza-pneumonia, passing away in the same peaceful manner which characterized his life.

He was born in Philadelphia, April 2, 1850, the son of William S. and Fredericka Ingersoll Phillips. He received his early education at home from an unusually capable and devoted mother. In 1864 Dr. Phillips studied at the Academy of the Protestant Episcopal Church in Philadelphia and in 1866 entered the University of Pennsylvania, where he obtained his A.B. From 1871–1873 he studied under Regimus Fresenius at Wiesbaden, Germany. During the latter year he was private assistant to Professor Fresenius. He then spent a year at the Polytechnic School at Aachen (Aix-la-Chapelle). Here he was associated with Professor Landolt. Professor Phillips was unable to complete his studies abroad because of the poor health of his father. He returned to America and during the following year became instructor in chemistry at Delaware College. In 1875 he was appointed to the teaching staff of the University of Pittsburgh, then the Western University of Pennsyvania, where he taught for forty years, retiring as head of the Department of Chemistry in 1915. For many years he taught chemistry, geology and mineralogy. Even in the writer's student days (1898–1902) Professor Phillips still taught all branches of chemistry and mineralogy. In 1878–1879 he also lectured to the students in the Pittsburgh College of Pharmacy, where he succeeded the late Professor John W. Langley, a brother of the late Samuel P. Langley, then at the Allegheny Observatory and afterwards secretary of the Smithsonian Institution. In 1879 he received the degree of A.M. from the University of Pennsylvania, and in 1893 the Ph.D.

He was married in 1881 to Sarah Ormsby Phillips daughter of Ormsby Phillips, a former mayor of Allegheny.

In 1915 Dr. Phillips retired from active service in the University of Pittsburgh under the pension system of the Carnegie Foundation. Since that time he had been engaged continuously in research and writing in a laboratory provided by the Mellon Institute. During the recent war he conducted researches on gases in coöperation with the Gas Warfare Service.

In June, 1919, Dr. Phillips received the honorary degree of Doctor of Science from the University of Pittsburgh.

Dr. Phillips was an authority on natural gas in which field he held international recognition. In 1904 he published the "Methods of Analysis of Ores, Pig Iron and Steel used by the Chemists in the Pittsburgh Region," and in 1913 a text-book of "Chemical German," of which a second edition appeared in 1916. At the time of his death Dr. Phillips had two other books well under way, one on the "Life and Work of Joseph Priestley," the other on "Qualitative Gas Reactions."

Dr. Phillips was a member of the following societies:

Phi Kappa Sigma Fraternity since 1867.
Engineers' Society of Western Pennsylvania since 1880.
American Association for Advancement of Science since 1887.
American Institute of Mining Engineers since 1892.
American Chemical Society since 1894.
American Philosophical Society since 1894.
Phi Lambda Upsilon Fraternity since 1919.

Dr. Phillips was a member of the Chemists' Club of New York City and the University Club of Pittsburgh.

He has been a member of the council of the American Chemical Society since the organization of the Pittsburgh Section in 1903.

Beside his widow, Mrs. Sarah Ormsby Phillips, Dr. Phillips leaves two sons, Clifford S. and Frederick I. Phillips.

Alexander Silverman
School of Chemistry,
University of Pittsburgh

SCIENTIFIC EVENTS

BIRD BANDING WORK BEING TAKEN OVER BY THE BIOLOGICAL SURVEY

The Bureau of Biological Survey at Washington, D. C., has taken over the work formerly carried on under the auspices of the Linnaean Society of New York by the American Bird Banding Association. In taking over this work the bureau feels that it should express the debt that students of ornithology in this country owe to Mr. Howard H. Cleaves for the devotion and success with which he has conducted its investigation up to a point where it has outgrown the possibilities of his personal supervision.

Under plans now being formulated this work will give a great amount of invaluable information concerning the migration and distribution of North American birds which will be of direct service in the administration of the Migratory Bird Treaty Act, as well as of much general scientific interest.

It is desired to develop this work along two principal lines: first, the trapping and banding of waterfowl, especially ducks and geese, on both their breeding and winter grounds; and secondly, the systematic trapping of land birds as initiated by Mr. S. Prentiss Baldwin, the early results of which have been published by him in the *Proceedings* of the Linnæan Society of New York, No. 13, 1919, pp. 23–55. It is planned to enlist the interest and services of volunteer workers, who will undertake to operate and maintain trapping stations throughout the year, banding new birds and recording the data from those previously banded. The results from a series of stations thus operated will undoubtedly give new insight into migration routes; speed of travel during migration; longevity of species; affinity for the same nesting-site year after year; and, in addition, furnish a wealth of information relative to the behavior of the individual, heretofore impossible because of the difficulty of keeping one particular bird under observation.

The details of operation are now receiving close attention, and as soon as possible the issue of bands will be announced, with full information regarding the methods to be followed and the results expected. In the meantime, the Biological Survey will be glad to receive communications from those sufficiently interested and satisfactorily located to engage in this work during their leisure time, for it is obvious that a considerable part must be done by volunteer operators. It is hoped that a sufficient number will take this up to insure the complete success of the project.

E. W. Nelson,
Chief of Bureau

THE PACIFIC COAST DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The fourth annual convention of the Pacific Coast Division of the American Association for the Advancement of Science will meet at the University of Washington, Seattle, on June 17, to continue three days. Delegates from California, Oregon, Washington, Idaho, Montana, Nevada and British Columbia, will be present. It is expected that more than 250 scientists will take part in the proceedings.

Delegates from California, Stanford, Oregon, Idaho, Washington and Southern California universities, California Institute of Technology, Scripps Institute, Oregon Agricultural College, Reed College and Washington State College have been asked to attend the research conferences, which are under the direction of the National Research Council.

Morning sessions the first two days, Thursday and Friday, June 17 and 18, will be devoted to meetings of the affiliated societies, the Western Society of Naturalists, Pacific Fisheries Society, American Physical Society, Astronomical Society of the Pacific, Cordilleran Section of the Geological Society of America, Pacific Coast branch of the Paleontological Society, American Phytopathological Society, San Francisco section of the American Mathematical Society, Seismological Society, American Chemical Society, Cooper Ornithological Club, Ecological Society of America, Society of American Foresters and Research Society.

The program includes registration, programs of the affiliated societies, a symposium on fisheries, Seattle automobile drives and welcoming addresses by President Henry Suzzallo and John C. Merriam, dean of faculties of the University of California, president of the Pacific Coast division of the American Association for the Advancement of Science and chairman of the states relations committee of the National Research Council. A Sigma Xi-Phi Beta Kappa lecture will be arranged for on Friday evening. Provision will be made for excursions to Rainier National Park and the Biological and Astronomical stations, Snoqualmie Falls and other points of interest, and a reception at the University of Washington last evening.

THE RESIGNATION OF THE DIRECTOR OF THE BUREAU OF MINES

Dr. Van H. Manning, director of the Bureau of Mines, Department of the Interior, has tendered his resignation, effective on June 1, to President Wilson. Dr. Manning is leaving the government service to accept the position of director of research with the recently organized American Petroleum Institute, the most important body of petroleum men of the country.

In his letter to the President, Dr. Manning says:

I hereby tender you my resignation, to take effect June 1, 1920, as director of the Bureau of Mines.

It will be with reluctance and deep regret that I shall sever my connection with the Department of the Interior after thirty-four years of active service therein, and it is the opportunity of being able to continue in another capacity the work for the advancement of purposes fostered by the department that has been the chief factor in determining my decision to resign.

I take this opportunity to express my sincere appreciation of the confidence that you have reposed in me as a public official and of the cordial cooperation of the departmental executives whom I have been able to serve. Especially I appreciate your constant help in my efforts to develop an organization that has at heart the welfare of the public, the advancement of the mineral industry, and the safety of the two million workers who contribute to the success of that industry.

In leaving the government service there comes to me, as it has over and over again, the thought that although this government spends each year many millions of dollars in useful scientific work for the benefit of the whole people, the monetary recognition of its scientific and technical servants is not sufficient to enable them to continue in the service for the people. This has been especially true within the last few years when it has been impossible for many men to remain in the government service.

With the marvelous expansion of the industry of this country and the growing necessity of science to industry, the scientific bureaus have been utterly unable to hold their assistants against the competition of industry which is taking their highly trained men at salaries the government does not pay or even approach.

I feel very deeply that there ought to be more adequate compensation for the scientific and technical men in the government service so that none of them may be compelled to accept positions on the outside.

Many of these scientific men are of fine type for government work, care little for the commercial field, take an intense professional interest in their tasks and are of inestimable value to the government.

RESIGNATION OF PROFESSOR E. F. NICHOLS FROM THE YALE UNIVERSITY FACULTY

Announcement is made from Yale University that the resignation of Ernest Fox Nichols, Sc.D., LL.D., professor of physics, has been tendered and accepted. Professor Nichols has accepted the post of director of pure science in the Nela Research Laboratories of the National Lamp Works of the General Electric Company, at Cleveland, Ohio.

In offering his resignation Dr. Nichols wrote the following letter to the Yale corporation in explanation of the conditions which had led to his decision:

Sloane Laboratory,
Yale University,
New Haven, Connecticut,
April 21, 1920

The Corporation of Yale University.

Gentlemen: I have been offered the post of director of pure scence in the Nela Research Laboratories, National Lamp Works of the General Electric Company, at Cleveland, Ohio. The position offers complete freedom in the choice of research problems, and places at my unhampered disposal such human and material resources as no university I know of can at present afford.

I would like to accept this offer and therefore respectfully ask you to release me at the close of the present academic year from my post of professor of physics in Yale University.

The thought of leaving present colleagues and university surroundings is to me, in many ways, a source of deep regret, and I have hesitated long over my decision; yet the heightened opportunities of the new position are in everything else so advantageous that the offer becomes finally irresistible.

With appreciation and sincere regard,
Yours very truly,
Signed: Ernest Fox Nichols

Dr. Nichols went to Yale University in the fall of 1916 to occupy a new chair of physics, having resigned the presidency of Dartmouth College, in which capacity he had served since 1909, in order that he might have the desired opportunity to continue his scientific work. Professor Nichols is a graduate of the Kansas Agricultural College in the class of 1888, and has held professorships of physics in Colgate College, Dartmouth College and Columbia University. During the war from 1917 to 1919 he was absent from Yale University, to engage in research and development work for the navy.

THE ALLEGHENY OBSERVATORY

The following minute was adopted by the observatory committee and also by the executive committee of the board of trustees of the University of Pittsburgh at its meeting on January 14:

In complying with the request of Dr. Frank Schlesinger that he be relieved of his duties as director on April 1, 1920, to take charge of the Yale Observatory, the committee desire to express their appreciation of his fifteen years of active and fruitful service, during which the Allegheny Observatory has made many valuable contributions to astronomical science, and worthily upheld its international reputation created by Langley and Keeler. While we regret to lose the valuable cooperation and friendly personal relationship which our long association with Dr. Schlesinger has developed, we sincerely congratulate him on the enlarged and attractive field of scientific usefulness which his new position offers; and heartily wish for himself and family, continued health, happiness and success. Moreover, we look forward with pleasure to our continued cooperation in the solution of the great astronomical problems which are rapidly bringing into closer fellowship the astrophysicists of the world.

On the evening of March 22, a few days before Dr. Schlesinger's departure for New

Haven, a testimonial dinner was given to him by the observatory committee. Besides the committee there were present other members of the board of trustees and a few other guests.

Dr. H. D. Curtis has been elected director of the observatory and he is to assume charge early in July, 1920. Dr. Curtis has been connected with the Lick Observatory for about twenty years. For a number of years he had charge of the station of the Lick Observatory at Santiago, Chile; more recently he has had charge of the work with the Crossley Reflecting Telescope on Mount Hamilton.

Dr. Frank Craig Jordan, assistant professor at the Allegheny Observatory since 1908, has been promoted to a full professorship and has been elected assistant director of the observatory.

SCIENTIFIC NOTES AND NEWS

Members of the National Academy of Sciences have been elected as follows: Dr. James Rowland Angell, University of Chicago and the National Research Council, president-elect of the Carnegie Corporation, psychologist; Dr. Henry Prentiss Armsby, Pennsylvania State College, physiological chemist: Dr. Wilder D. Bancroft, Cornell University and the National Research Council, chemist; Dr. Hans F. Blichfeldt, Stanford University, mathematician; Dr. A. J. Carlson, University of Chicago, physiologist; Dr. William Duane, Harvard University, physicist; Dr. Lewis R. Jones, University of Wisconsin, plant pathologist; Dr. Elmer Peter Kohler, Harvard University, chemist; Dr. Charles K. Leith, University of Wisconsin, geologist; Dr. Clarence Erwin McClung, University of Pennsylvania and National Research Council, zoologist; Dr. Elmer V. McCollum, the Johns Hopkins University, physiological chemist; Dr. George Washington Pierce, Harvard University, physicist; Harris J. Ryan, Stanford University, electrical engineer; Dr. Joel Stebbins, University of Illinois, astronomer, and Dr. Bailey Willis, Stanford University, geologist. Arthur L. Day, of the Carnegie Institution, and T. H. Morgan, of Columbia University, were elected members of the council.

At a meeting held April 20, the Academy of Natural Sciences of Philadelphia, in recognition of their scientific accomplishments, elected as correspondents the following: William Berryman Scott, Merrit L. Fernald, Hans Frederick Gadow, Johann P. Lotsy, Daniel T. MacDougal, Raymond Pearl, William E. Ritter, William Schaus and William Lutley Sclater.

Dr. William Morris Davis, emeritus professor of geology at Harvard University, has been awarded the Vega medal of the Swedish Anthropological and Geographical Society.

At its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations for research: To Professor H. M. Randall, of the University of Michigan, in aid of his research on the structure of spectra in the infra-red, five hundred dollars; to Professor L. R. Ingersoll, of the University of Wisconsin, in aid of his research on the polarizing effect of diffraction gratings, one hundred and fifty dollars; to Professor A. G. Webster, of Clark University, in aid of his researches on new methods in pyrodynamics and practical interior ballistics, five hundred dollars.

Professor Jacques Hadamard, Sc.D., LL.D., of the Collège of France, is delivering at Yale University the thirteenth regular course of lectures on the Hepsa Ely Silliman Foundation. The first of M. Hadamard's lectures on "Some topics in linear partial differential equations" was given on April 23.

The second series of the LeConte Memorial lectures will be given in the Yosemite National Park during the months of June and July. These lectures were instituted in honor of the naturalist and geologist, Joseph Le Conte, who for thirty years was a member of the faculty of the University of California. This year the speakers and subjects are announced as follows: Dr. John C. Merriam, "The philosophy of Joseph Le Conte"; Dr. A. C. Lawson, "The geological history of the Sierra Nevada"; Dr. Joseph Grinnell, "The vertebrate animals of the Yosemite"; Dr. C. Hart Merriam, "Indian tribes formerly in Yosemite."

The University of Copenhagen has awarded the Salomonsen prize to Professor V. Ellermann for his work on leukemia in fowls. The fund for promotion of research on diabetes has been awarded to Dr. H. C. Hagedorn.

A preliminary committee has been formed to give to Sir George Thane, who recently resigned the chair of anatomy at University College, London, after forty-two years' service, some mark of the appreciation felt for him by his old pupils and colleagues. The intention is to ask Sir George Thane to sit for his portrait.

Claude Wakeland, deputy state entomologist of Colorado in charge of the alfalfa weevil investigation during the three years 1917–19, has accepted the position of state extension entomologist with the University of Idaho. Mr. Wakeland's permanent headquarters will be at Boise.

Dr. David Klein has resigned as associate professor of biochemistry in the Johns Hopkins University School of Public Health and Hygiene, and has taken a position with the Hollister Wilson Laboratories, Chicago, Ill., as director of research and control laboratories.

Ernest Jenkins Hoffman, who recently resigned as assistant chemist, U. S. Bureau of Mines, Pittsburgh, Pa., has accepted a position in organic research with W. B. Pratt, Inc., Boston, Mass.

Fixing their base of scientific operations in Death Valley at a level of 178 feet below the sea at the mouth of Furnace Creek Canyon which issues from the Funeral Mountains, Dr. Francis B. Sumner, associate professor and biologist in the Scripps Institute for Biological Research, and Joseph Grinnell, professor of zoology and director of the University of California Museum of Vertebrate Zoology, are now making special studies upon the mammals and birds of Death Valley. The expenses of the expedition are being defrayed from a special fund provided for the purpose by Mr. E. W. Scripps.

Neil M. Judd, curator of American archeology in the U. S. National Museum, left for northwestern Arizona on May 1 to continue his archeological investigations of the region north and west of the Rio Colorado. It is expected that a report on the prehistoric remains of this section of the southwest, covering researches of the past five years, will follow this season's work. At the request of the National Geographical Society, the secretary of the Smithsonian Institution has granted permission for Mr. Judd to direct the society's archeological reconnaissance of the Chaco Canyon region in New Mexico.

While returning from the recent meeting of the American Chemical Society at St. Louis, Dr. J. H. Ransom, director of chemical research at the Michigan Smelting and Refining Co., Detroit, Mich., stopped off at Purdue University and delivered a lecture on Non-Ferrous Alloys before the students of the school of chemical engineering. Dr. Ransom was formerly professor of general chemistry in this university.

It is requested that any material or facts of interest which will aid in the construction of a biographical memoir of the life and work of Henry Lord Wheeler, be mailed to Professor Treat B. Johnson, of Yale University, who is preparing a memoir of Professor Wheeler for the National Academy of Sciences.

The autumn meeting of the American Chemical Society will be held in Chicago from September 7 to 10, inclusive.

A special meeting of the Colorado Academy of Sciences which is the natural history section of the State Historical and Natural History Society of Colorado, was held at the State Museum, Denver, on April 2, when the following program was presented:

Work done and work that should be done by—

1. The Office of the State Forester, W. J. Morrill, state forester, Ft. Collins, Colo.
2. The Office of the State Geologist, R. D. George, state geologist, Boulder, Colorado.
3. The Office of the State Entomologist, C. P. Gillette, state entomologist, Fort Collins, Colo.

The annual convention of Sigma Gamma

Epsilon, the national undergraduate fraternity devoted to mining and geology, was held at Columbia, Missouri, on April 2 and 3. The fraternity passed resolutions urging the taking of steps to eliminate the fake mining engineer and geologist and offering its assistance to that end. A chapter of the fraternity is to be shortly installed in the University of Texas.

THE University of Arizona through the Arizona Bureau of Mines will this year conduct its annual field course in geology and mining for advanced students in the Dos Cabezas Mountains in southeastern Arizona. The region selected is one of complex and highly diversified geology, and several different types of ore deposits are under active development there. The party will enter the field on July 1, and will remain in camp for eight weeks.

PROFESSOR DAYTON C. MILLER, of the Case School of Applied Science, lectured under the auspices of the Research Committee of Oberlin College on April 14, on "Scientific Research at an army post."

PROFESSOR DOUGLAS JOHNSON, of Columbia University, addressed the Women's Canadian Club of Montreal, on March 19, on "The influence of topography on the war"; and a joint meeting of the Men's Canadian Club and the Women's Canadian Club of Quebec, on March 20, on "Geographic problems of the Peace Conference."

PROFESSOR MAX MASON, of the University of Wisconsin, lectured on April 7 and 8 before the department of mathematics and physics of the University of Iowa on the "Einstein theory of gravitation." He gave also a general lecture on "Methods used for the detection of submarines." Professor Mason is the inventor of apparatus for the detection of submarines.

DR. H. J. WHEELER, of Boston, recently addressed the agricultural faculty and graduate students in agriculture of the University of Minnesota on "The effect of crops upon those which follow," giving a summary of his earliest work on this subject in Rhode Island and of the continuation of it by Hartwell and Pember.

AT the Royal Geographical Society on March 17, Sir Ernest Shackleton gave an account of the geographical and scientific results of the 1914–1917 Antarctic Expedition.

DR. GEO. F. FREEMAN, botanist of the Société Sultanienne Agriculture, gave a lecture before the Cairo Scientific Society, April 1, on "The origin of agricultural plants."

THE New York Academy of Medicine held a memorial meeting in honor of the late Dr. Abraham Jacobi's ninetieth birthday anniversary on May 6. A bas-relief of Dr. Jacobi was presented by George McAneny and was accepted by the president of the academy, Dr. George David Stewart. The principal address was delivered by Dr. George E. Vincent, of the Rockefeller Foundation.

AT an International Conference of Red Cross Societies, held at Washington in 1912, it was decided to establish a medal both as a memorial to Florence Nightingale and to give international recognition to outstanding work by trained nurses in all parts of the world. Owing to the outbreak of the war in 1914, the first awards of this medal were postponed; but it is announced that it is intended to award fifty of these medals in January, 1920. The medal is in silver and enamel, consisting of a portrait of Florence Nightingale, "The Lady with the Lamp," with the words "Ad memoriam Florence Nightingale 1820–1910." On the reverse, surrounding a space reserved for the name of the recipient, is the inscription: "Pro vera misericordia et cara humanitate perennis decor universalis." The medal is attached to a white and red ribbon, on which is displayed a laurel wreath in green enamel surrounding a red cross on a white ground.

MR. CHARLES EDWARD GROVES, F.R.S., editor of the *Journal* of the London Chemical Society from 1884–1899, and vice-president of the society from 1899–1902, who died on February 1, aged 79, has left £10,000 to the Royal Institution for the "Groves Endowment Fund" for the promotion of scientific research, to take effect on the death of the last surviving member of his family.

The Lake Laboratory, which is now permanently located at Put-in-Bay on Lake Erie, will open for the summer of 1920 on June 21. Its facilities will be available for investigators until the middle of August. Courses for students in both plant and animal ecology, entomology, the structure of fresh-water vertebrates, and in icthyology will be conducted until August 1. The staff will be composed of Professor R. C. Osborn, director, Dr. F. H. Krecker, acting director, Professor S. R. Williams, of Miami University, Professor M. E. Stickney, of Dennison University, and Dr. C. H. Kennedy, of the Ohio State University. Some studies on fisheries problems were carried on last year and others are to be started during the coming session. It is desired to have the laboratory as well supplied as possible with recent biological literature and therefore investigators will be of direct service to the laboratory by including it in their mailing list. All reprints of such articles and all correspondence should be addressed to the Lake Laboratory, Ohio State University, Columbus, Ohio.

UNIVERSITY AND EDUCATIONAL NEWS

A bill recently passed by the Maryland legislature combines the Maryland State College of Agriculture with the University of Maryland School of Medicine under the name of the University of Maryland. The legislature appropriated $42,500, each year, for the medical school for the next two years and in addition appropriated $186,476 for the other departments of the university for 1921, and $165,416 for 1922. An appropriation of $203,000 was made for buildings and equipment.

Dr. William H. Nichols, of the General Chemical Company, has given $100,000 toward the endowment fund of New York University.

It is planned to erect a new chemistry building at Dartmouth College, which will involve an expenditure of about $350,000. Construction will be begun immediately.

The board of trustees of the College of the City of New York has authorized the granting of degrees of chemical, civil, electrical, and mechanical engineer on the satisfactory completion of a curriculum requiring five years. The announcement of the details of the curricula will shortly be issued. This is one of the steps taken by the College of the City of New York in the direction of closer cooperation between industry and colleges and colleges and universities.

Assistant Professor George E. Nichols, of Yale University, has been appointed to the teaching staff of the University of Michigan Biological Station for the coming summer session.

DISCUSSION AND CORRESPONDENCE

SINGING SANDS

Professor Richardson's recent article about "Singing Sands" of Lake Michigan, suggests to me that in analyzing the beach sands the students may have taken needless trouble, for the cause is certainly not dependent on their composition.

The fascinating pages of Marco Polo have numerous references to this phenomena, more or less exaggerated and tinged with superstition, and many travelers have discussed and some scientists have studied it.

A volume by Hanns Vischer confirms the previous statements of Commandant Gadel, Concerning the "voice of the mountain" near the oasis of Bilma, he, Vischer, says:

> There is a dark and forbidding rock frowning over Bilma near the southern end of the oasis. This mountain warns the inhabitants of the approaching arrival of a caravan; when it "sings" the men then know that a caravan is close at hand. The noise is produced by the blowing of the wind from a certain direction through crevices of the torn rock.

Says Gadel:

> On the sixth of October in the morning, the old Liman came to tell me that the mountain had spoken. On the eighth of October, at ten in the morning, the first Asbin caravan arrived, consisting of 4,851 camels and 857 men. The mountain had not lied.

There is every probability that Mr. Vischer is mistaken in his guess that the sounds are made by the blowing of the wind through a crevice in the rock, as will be seen by a general consideration of the subject, before I attempt to set forth the *probable* scientific explanation of the phenomenon. It is not confined by any means to the Sahara, or for that matter to desert places.

Near the coast of one of the Hawaiian Islands is an old graveyard. The winds blow ceaselessly across its barren expanse and it is fast being buried by *coral* sands. Passing fisher boats give this shore a wide berth, for when the wind is right, there arises from the white expanse a strange wail, like the howl of a dog, which is attributed to the restless spirits of the departed.

On the coast of Lower California, there is a locality which emits, at times, a bell-like sound. Here too the winds have piled up fine sand, and the peons declare that under its mounds lie buried the ruins of a convent, the bells of which toll with muffled tones, at the hour of prayer.

The infrequent traveler in the region of Mt. Sinai, camping at the mouth of the Wady el Dér, sometimes hears at sunset, a deep musical, booming sound, descending from the heights above. It is the great wooden gong of a monastery, perched upon the cliff. Such a gong is common in Arabia and is named a "Nagous." On the borders of the Isthmus of Suez stands a hill known as "Jebel Nagous"; that is, the Mountain of the Gong. The Arabs tell of weird sounds heard at this mountain—in storms, loud and wild, audible from a distance; in more quiet weather, low and musical. Jebel Nagous is alluded to in the "Arabian Nights." The American scientist, the late Dr. H. Carrington Bolton, some years before his death, organized an expedition to visit the mountain. After four days' journey from Tor, they went into camp at the base of the hill, which was found to be about 950 feet high. Dr. Bolton heard the music—a song of several notes, rising and falling, with one continuous deep undertone, like an organ note, and was able to ascertain the cause. Here, as in the other places named above, it is due to singing sands. The winds continuously blow this sand up against the sides of the hill, and impelled by the wind, it rushes up the slopes, emitting a multitude of tiny, tinkling notes, which when combined, make a considerable volume of sound. Then, just as the waves of the sea driven up the beach, rush downwards again, so the sand blown up the steep incline continually slides back, the angle of rest being about thirty-one degrees. It is the returning flow that gives out the steady undertone, increased by the echo from a sandstone cliff, and varying with the ever-changing wind.

What are singing sands? Every one has noticed the musical note made by the runners of a sleigh on a cold, clear night, which is caused by the impact of the snow or ice particles upon each other under the pressure of the vehicle. No ear could detect the sound made by *two* ice crystals, but when this is multiplied a thousand-fold, the combined effect is that of an instrument of music, playing one rather shrill note. Something of the kind is observed on parts of many sea beaches or other sand deposits; when they are walked upon, they give forth a note which varies with the locality. Ordinary "singing beaches" or "musical sands" are rather common, and the phenomenon has often been described and scientifically studied. The sounds are usually like the musical note which may be evoked when the wetted finger is rubbed around the edge of a glass bowl. Up to 1908, seventy-four localities had been noted in this country and eighteen abroad. In spite of this study, the true cause of the phenomenon is not yet certainly understood. It does not seem to make any difference whether the sands have been formed from crystalline or amorphous rocks. They differ widely in different localities in their mineralogical constituents, yet on the same beach, one place will give out a sound when disturbed, while another, a few yards away, is silent though apparently identical in structure. The property may be quickly lost or may be retained for months. When the sand is kept in a paper bag, its quality is best preserved; shaking in a tin or glass receptacle quickly dissipates it; once lost, it can not be restored. Observers have been able to detect the sound from a New England beach sand over 400 feet away, when a small bagful is suddenly shaken.

While the analogy to the snow crystals may account for part of the phenomenon in some cases, it can not account for the singing of limestone, coral or other non-crystalline sands. Moreover, when one walks barefooted on musical sands, or runs the hand through them, there is felt a distinct tingling sensation. To some, this has suggested an electrical property. The latest and most plausible theory is that upon clean, dry sands, atmospheric gases condense, just as gases will adhere to particles of some metallic minerals and not others, and that the sounds and the sensations described are due to the disturbance of these air cushions. At any rate, the sensation experienced when walking barefoot through a patch of musical sand is very similar to that felt when the hand is immersed in a solution in which nascent oxygen is being generated.

By the way, I wonder if it has ever occurred to any archeologist that a possible explanation of the "Vocal Memnon" which Strabo and other travelers attested some two thousand years ago, might be the presence near the colossi, of musical sands, long since buried by the drift from the Libyan Desert.

Albert R. Ledoux

MODERN INTERPRETATIONS OF DIFFERENTIALS

To the Editor of Science: Professor E. V. Huntington, in an article entitled "Modern Interpretation of Differentials" (Science, March 26), states with reference to the definition $\lim \Delta y = 0$, $\lim N\Delta y = dy$, that, "The inevitable consequence of such a definition is that $dy = 0$, which is futile." Every school boy in the theory of limits knows that this is not true when N varies.

To take his figure of a graph of a function $y = f(x)$, it is logically correct to denote a point on the graph by $P(x, y)$ without subscripts, and $P'(x + \Delta x, y + \Delta y)$ is any other point on the graph, where $PQ = \Delta x$, $QP' = \Delta y$. Produce PQ to $PR' = N\Delta x = \Delta' x$, and draw $R'S' = N\Delta y = \Delta' y$, parallel to OY. Then $S'(x + \Delta' x, y + \Delta' y)$ is any point on the produced chord PP' (*i. e., variation in the same ratio is along the chord*).

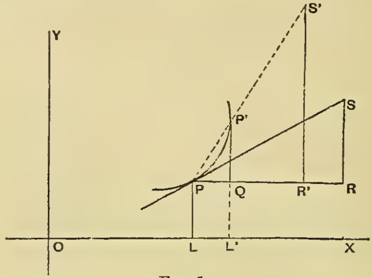

Fig. 1.

Professor Huntington asserts that $S'(x + \Delta' x, y + \Delta' y)$ inevitably approaches coincidence with $P(x, y)$ when Δx, Δy, approach zero, although it is obvious that it may, if N increase appropriately, approach any chosen point $S(x + dx, y + dy)$ *on the tangent at* $P(x, y)$, so that $\lim \Delta' x = dx$, $\lim \Delta' y = dy$. *Variation in the first ratio is therefore upon the tangent.*

Professor Huntington should also have investigated the historical questions involved before venturing to assert that the above theory of differentials "would prove highly misleading to the modern student." It is a sad commentary on the present state of the calculus in respect to its fundamental ideas, when we note the variety of explanations of these ideas by authors with little historical knowledge, all of whom, no doubt, would term their productions "modern," though most explanations will be found to date back several centuries, if they be anything more than vaporizing.

Sir William Rowan Hamilton in his Elements of Quaternions (Bk. III., p. 392) states that ordinary definitions by derivative methods do not apply in quaternions, and that after a careful examination of the Principia, he would formulate and adopt Newton's definition as follows:

Simultaneous Differentials (or *Corresponding Fluxions*) are *Limits of Equimultiples of Simultaneous and Decreasing Differences.*

As we have seen, Newton also made this definition in "Quadrature of Curves," essentially as Hamilton gathered it from the "Principia." Many better mathematicians than myself, or than Professor Huntington, have, in fact, examined this definition carefully, and have found it to be rigorous, simple, and of great generality.

The infinitesimal method of Leibniz is to be found essentially in Newton's first tract "De analysi per aequationen . . .," which Newton himself later rejected as illogical. A third method of explanation is that of Lagrange, which consists in assuming (for independent variables), $dx = \Delta x$, $dy = \Delta y$, and for a dependent variable z $dz =$ *principle part of* Δz, which Lagrange proposed to determine as *the terms of first degree in the expansion of* $z + \Delta z$ *in ascending powers of* Δx, Δy. Newton's dz is the same, if we put $dx = \Delta x$, $dy = \Delta y$. The adoption of the derivative method, led to devices to obtain the same significance of dz by derivatives, without assuming expansions in series. These involve various logical difficulties, especially when there are several independent variables. Also the differentials appear to change their values by changing the independent variables, whereas, Newton's method shows that for every equation between the variables, there exists (if differentiation be possible) a definite corresponding equation between their differentials, irrespective of the choice of independent variables.

Unquestionably, there has been a long continued propaganda, fostered at bottom to protect the claims of Leibniz, and aided by the inertia of established usage, to keep the methods of Newton in abeyance. Imagine, if the nationalities of these men had been reversed, the number of pamphlets that would have exploited the matter, and the number of textbooks in that method which would years ago have been published.

Arthur S. Hathaway
Rose Polytechnic Institute

CARBON DIOXIDE AND INCREASED CROP PRODUCTION

To the Editor of Science: In 1912, at the International Congress of Chemists held in New York, Professor Ciamician, of the University of Bologna, presented a paper on the "Photochemistry of the Future," in which, among other things, the suggestion was made that crop production might be increased by increasing the concentration of carbon dioxide in the air. Of course, the idea underlying such a suggestion is that since the carbon dioxide of the air is a necessary constituent in the synthesis of carbohydrate by the plant, and since, furthermore, the percentage of the gas in the air is comparatively small, any increase in the amount of carbon dioxide may tend to increase the amount of carbohydrate produced.

That such is actually the case has been found by a number of German chemists, according to the Berlin correspondent of the *N. Y. Tribune* (April 4). Working in greenhouses attached to one of the large iron companies in Essen, and utilizing the carbon dioxide (freed from impurities) obtained from the blast furnaces, the yield of tomatoes was increased 175 per cent. and cucumbers 70 per cent. Further experiments in the open air, on plots around which punctured tubes were laid, and through the latter of which the carbon dioxide was sent, gave increases of 150 per cent. in the yield of spinach, 140 per cent. with tomatoes and 100 per cent. with barley.

Benjamin Harrow

STRUCTURAL BLUE IN SNOW

To the Editor of Science: The recent blizzard began here with a heavy downpour of rain on the evening of March 5, which later turned into a glistening snow that was shattered by the furious wind and formed a crystalline-looking glittering coherent mass whose structure was maintained by the low temperature (about 20° F.).

When the sun finally came out on Saturday afternoon, I noticed that the shadows of the trees and the shadow masses of the distant snow, appeared unusually *blue*, and that the snow itself looked blue-white, like paper or sugar "blued" with ultra marine. Evidently the snow, because of its structure, reflected a larger proportion of the short wave-lengths of blue; and we have here another illustration of a structural blue color, which, according to Wilder D. Bancroft "may be obtained when we have finely divided particles of liquid or solid suspended in a gaseous medium (blue of the sky) or a liquid medium (blue of the eye or of the tree-toad); or when we have finally divided air-bubbles suspended in a liquid or solid medium (blue feathers).[1]

Incidentally there is some justification for the somewhat brilliant blues used by the artists in painting snow scenes, especially in the shadows; and we recall the story told of Whistler, who, when a lady visitor at his exhibition remarked, "I've never seen a sunset like that, Mr. Whistler," promptly replied, "Well don't you wish you could?"

JEROME ALEXANDER

RIDGEFIELD, CONN.

SCIENTIFIC BOOKS

How to Make and Use Graphic Charts. By ALLAN C. HASKELL, B.S., with an introduction by RICHARD T. DANA. 539 pages. First edition. Price $5.00.

The last years have seen a tremendous progress in the application of graphic methods and while these methods must be regarded as means rather than as ends they nevertheless play a most important part of scientific analysis.

To most persons except the trained engineer, biologist or statistician the principles of analytic geometry which are the basis of most graphic methods appear too difficult and intricate as that they would be used for practical problems of every-day life.

Mr. Haskell's book fills therefore a distinct demand when it contributes to a clear understanding and wider application and recognition of the graphic method. The treatment is written from the standpoint of the practical engineer who comes daily in contact with such problems which will lend themselves to the application of this form of analysis.

The 539 pages of the richly illustrated book are divided into 18 chapters which go exhaustively into every phase and detail of the possibilities and applications of graphic analysis. Special consideration is given to the current engineering problems of to-day. One whole chapter is devoted to the nomographic or alignment chart. This subject is treated in Chapter VIII. and taken up again in Chapter XVI., "Computation, arithmetical and geometrical" which devotes some thirty pages to this interesting subject.

The author deserves much praise for faithfully collecting the manifold material on this subject. On page 348 however I think it would be worth while to mention the graphic calculation of the polytropic curve based on the equation

$$(1 + tg\beta) = (1 + tg\alpha)^n.$$

The lack of space prevents a longer explanation but for the rapid design of isothermal and adiabatic curves in connection with combustion engine design, this method[1] is extremely valuable on account of its accuracy, rapidity and range covering all exponents $n = 1.10$ (isothermal) to 1.41 (adiabatic).

Chapter VII. would have had room for the smelting diagrams of Stead and Saklatwalla[2] and of Shepherd.

Chapter XVII. is devoted to the graphic methods of designing and estimating. The civil engineer will find much of value and interest here. I think however the chapter could be extended to the advantage of the mechanical engineer and his problems.

The wealth of references relating to the graphic methods which are given at the end of each chapter and which have been collected by Mr. Haskell make the book valuable as a source of information, in short the author has responded to a vital demand for a practical book, "How to make and use graphic charts." The practical man will find much material ready for use and easily understandable and

[1] See "The Colors of Colloids," VII., *J. Phys. Chem.*, Vol. 23, pp. 365–414.

[1] E. Braner, *Z. d. v. d.*, I., 1885, p. 433.

[2] *Journal of the Iron and Steel Institute*, 1908, No. 11, p. 92.

the scientist much inspiration for further research and investigation. R. VON HUHN
NEW YORK

SPECIAL ARTICLES

THE HEREDITY OF SUSCEPTIBILITY TO A TRANSPLANTABLE SARCOMA (J. W. B.) OF THE JAPANESE WALTZING MOUSE

IN 1916[1] the writer in collaboration with Tyzzer reported on the inheritance of susceptibility to a transplantable carcinoma (J. W. A.) of the Japanese waltzing mouse. This tumor grew in one hundred per cent. of the Japanese waltzing mice inoculated and in zero per cent. of the common non-waltzing mice. When these two races were crossed, the F_1 generation hybrids showed sixty-one out of sixty-two mice to be susceptible. In these mice growth was as rapid if not more so than in the Japanese waltzing mice themselves. The one exception may well have been due to faulty technique for a reinoculation test was not made.

The F_2 generation gave a very interesting result—only three out of 183 mice grew the tumor. At that time the results were explained on the basis of multiple Mendelizing factors[2] whose number was estimated at from twelve to fourteen. *Simultaneous presence* of these factors, themselves introduced by the Japanese waltzing race, was considered necessary for progressive growth of the tumor. The analogy between this case and that of coat color in wild mice, dependent upon the simultaneous presence of at least five known Mendelizing factors was at that time pointed out.

Later[3] while working with a transplantable sarcoma (J. W. B.) of the Japanese waltzing mouse, results were obtained which showed what semed to be a somewhat simpler quantitative condition of the same process. In this case, the parent races and F_1 hybrids behaved as before, but the F_2 hybrids gave a total of twenty-three susceptible, to sixty-six non-susceptible animals. It was previously estimated that from five to seven factors were involved. In order to determine more closely the number of factors, new experiments were devised as follows: F_1 hybrid mice themselves susceptible were crossed back with the non-susceptible parent race. This has recently given a back cross generation whose susceptibility would depend upon the factors introduced through the gametes received from their F_1 parent. If one factor was involved, the ratio of gametes containing it formed by the F_1 animal, to those lacking it would be 1:1, if two factors, 1:3; if three factors 1:7; if four factors, 1:15; if five factors, 1:31; if six factors, 1:63; and if seven factors, 1:127. Susceptible and non-susceptible *individuals* would occur in the back cross generation in similar proportions.

The actual numbers obtained were twenty one susceptible to 208 non-susceptible. This result may be compared with expectations on three, four, five, and seven factor hypotheses, as follows:

	Susceptible	Non-susceptible	Ratio
Expected 3 factor....	28	201	1:7
Observed	21	208	1:90
Expected 4 factor....	14	215	1:15
Expected 5 factor....	7	222	1:31
Expected 7 factor....	1.8	227.2	1:127

The observed figures fall between the three and four factor hypothesis. The numbers are not large enough to give a definite test, but the F_2 generation already mentioned is interesting as a supporting line of evidence. If we compare this with the expectation, we find that the observed figures lie between the

	Susceptible	Non-susceptible	Ratio
Expected 3 factor....	39	50	1:1.3
Expected 4 factor....	29	60	1:2.1
Observed	23	66	1:2.8
Expected 5 factor....	21	68	1:3.2

four and five factor hypothesis. In both cases the four factor hypothesis figures are close and the three and five factor hypothesis

[1] Little, C. C., and Tyzzer, E. E., 1916, *Jour. Med. Research*, 33: 393.

[2] Little, C. C., SCIENCE, N. S., 1914, 40, 904.

[3] Tyzzer, E. E., and Little, C. C., 1916, *Jour. Cancer Research*, 1: 387, 388.

are to be still considered as possibilities, though not probabilities. The six and seven factor hypotheses appear to be definitely eliminated.

The non-susceptible back cross animals which should by the multiple factor hypothesis contain in many cases part, but not all, of the factors for susceptibility are being tested by breeding back with the F_1 animals. If four factors are involved, as seems likely, of every fifteen such back cross animals approximately four or 26.6 per cent. should have three; six or 40 per cent. two; four or 26.6 per cent. one; and one or 6.6 per cent. none of the four factors necessary for continued growth of the tumor. When crossed with F_1 animals these back cross types should give the following ratios of susceptible to non-susceptible animals in their progeny.

Type of Back Cross	Ratio of Susceptible to Non-Susceptible Progeny
Having three factors	1: 3.7
" two factors	1: 6.1
" one factor	1: 9.7
" zero factors	1: 15

The first two categories should be easily recognizable and together form 66.7 per cent. of the back cross animals. Such tests have now been begun.

The sex chromosome has been eliminated as a probable carrier of any of the four factors as follows. If mice like other mammals have the female XX and the male XY in formula, the use of susceptible Japanese waltzing males to form the F_1 animals used, gives daughters carrying his X, and sons his Y chromosome. If now his *sons* only are used to produce the back cross generation by mating with common non-susceptible females, all the X chromosomes in the resulting animals will be derived from common non-susceptible mice. Unless therefore, crossing over between the X and Y chromosomes occurs frequently, any susceptibility factor borne in the X chromosomes of the original Japanese waltzing males used, has been eliminated.

While further investigations are in progress, we may conclude provisionally that:

1. From three to five factors—probably four—are involved in determining susceptibility to the mouse sarcoma J. W. B.

2. That for susceptibility the simultaneous presence of these factors is necessary.

3. That none of these factors is carried in the sex (X) chromosome.

4. That these factors Mendelize independently of one another. C. C. Little

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

The fifth annual meeting of the American Association of Petroleum Geologists was held in Dallas, Texas, March 18 to 20, with headquarters at the Adolphus Hotel. The annual meeting of 1919 also was held there, and Dallas was selected for a second time because of its accessibility to the southwestern oil fields, where large numbers of members are now working. Almost three hundred members and more than a hundred visitors were registered from all parts of the United States. The association was honored by the presence of Dr. George Otis Smith, director of the United States Geological Survey, who was made an honorary member of the association. Other distinguished members present from a distance were R. P. McLaughlin, oil and gas inspector of California; Dr. Ralph Arnold, consulting geologist, of San Francisco, New York and London; Professor Roswell H. Johnson, of Pittsburgh; and Everett DeGolyer and Donald F. McDonald, of New York.

The opening session was called to order by President I. C. White, state geologist of West Virginia, well known as the father of the anticlinal theory. Greetings were given by a representative of the Oil Development Committee of the Chamber of Commerce of Dallas, and by Robert H. Hill, president of the Southwestern Geological Society, and responded to by President White.

The general subject of this session was New Mexico and Northwestern Texas. Papers were given by Dr. John K. Knox, on "The geology of New Mexico as an index of probable oil resources," by Dan L. Garrett on "The stratigraphy of northeastern New Mexico"; by Wallace G. Matteson on the "Oil possibilities of northeastern New Mexico," and by Dr. Chas. N. Gould on "Types of structure at Amarillo, Texas."

The Thursday afternoon session was devoted to a consideration of the Louisiana and Texas fields, and papers were given by Chester A. Hammill on "The structure of northwest Louisiana"; by Sidney Powers on "The Sabine uplift," and by Dr. Irving Perrine on "Some problems of the Louisiana oil fields." A paper on "The geological structure of Eastland and Stephens counties, Texas," was read by H. H. Adams, one of the "Position of the Ellenberger formation in north central Texas"; by Dr. E. H. Sellards, and one on "Unconformities in the Texan Permian," by Dr. J. W. Beede. A paper by Dr. J. A. Udden, director of the Texas Bureau of Economic Geology, on "Suggestions of a new method of making underground observations," was read by Dr. Sellards.

On Thursday evening a public meeting was held in the City Temple, and the citizens of Dallas had the privilege of hearing Dr. George Otis Smith, director of the United States Geological Survey, in a lecture on "The public service opportunity of the oil geologist." Dr. Smith emphasized the responsibility of the oil geologist as a public servant and educator, and held that while it is the first duty of the oil geologist to find the oil, it is no less his duty to see that it is protected from the effects of improper operations in its recovery, and to raise his voice against the practise of mining oil with total disregard of underground property rights. He urged that membership in the association should carry its guaranty of both professional ability and moral reliability. The lecture was followed by an informal reception and smoker, to give members and visitors an opportunity to meet Dr. Smith.

A technical session was held in the municipal auditorium Friday morning, and most of the papers were illustrated by figures and diagrams. Dr. E. A. Stephenson and H. R. Bennett had prepared diagrams showing the decline of the Ranger oil field, and Glenn H. Alvey gave "Decline curve predictions." Papers were read by Charles V. Millikan on "The interrelation of the folds of Osage county, Oklahoma; J. L. Tweedy gave "A criticism of the 10 to 1 increase in Barrel Day prices"; and Professor Roswell H. Johnson and Alden W. Foster one on "Barrel Day" versus "One Day costs." Professor Johnson also gave a paper on "The cementation process in sandstone." A summary of the work of the California State Mining Bureau in petroleum and gas was given by R. P. McLaughlin. Mr. McLaughlin brought to the convention a very interesting model of a California oil field. This model was described and illustrated in the *Literary Digest* of February 28, 1920.

Friday afternoon was given to a consideration of the Kansas and Oklahoma fields. Dr. Eliot Blackwelder gave "Origin of the domes of central Kansas," Dr. Raymond C. Moore and F. L. Martin "The relation of granite to oil production in Kansas," and Dr. Moore and Dr. Winthrop P. Haynes "The outcrop of basic igneous rock in north central Kansas." Dr. J. W. Merritt's subject was: "Pennsylvania sedimentation around Healdton Island, Oklahoma," and Fritz Aurin gave "Pre-Pennsylvanian oil and gas horizons in Kay county, Oklahoma." A paper on "New oil development in Oklahoma," was given by C. W. Shannon, state geologist of Oklahoma, at an earlier session.

A preliminary business meeting followed the Friday afternoon program. The reports of officers and committees were presented, new business introduced, and nominations made. The business session was concluded Saturday morning, and this was followed by a regional session which was carried over into the closing session on Saturday afternoon. A paper by David A. Reger on "Recent oil developments in West Virginia," was read by Ray V. Hennen, and "Notes on the Canadian foothills belt," by Wesley Purdy, was read by E. DeGolyer. F. W. DeWolf, state geologist of Illinois, gave one paper on "The new Trenton development," illustrating it by maps and diagrams, and one on the "Blue sky laws of Illinois," showing that laws are being enacted for the protection of the public against unscrupulous promoters. A paper on the "Development of oil and gas in Wyoming," was given by C. H. Wegemann. Dr. Edward Bloesch gave a résumé of "Petroleum investigations in Switzerland," showing that the drill would have to decide whether oil was present in commercial quantities.

The engineer's side of the petroleum problem was given by A. W. Ambrose, head of the Petroleum Experiment Station at Bartlesville, Oklahoma, in a paper on "The petroleum production engineer and his relation to future production." Mr. Ambrose said that by present processes only a small percentage of the oil is recovered, and emphasized the necessity of more effective methods. The last paper of the session and of the convention was one read by Earl A. Trager, who gave a résumé of "The oil shale industry, with an outline of methods of distillation." This is a subject that will be given more attention as the demand for oil increases and the supply from wells diminishes.

The following papers were read by title: "Types of structures in Chaves county, Texas," J. W. Merritt; "Problems of production and methods of solving them," T. E. Swigart; "Oil shales of Wyoming,'' Professor E. F. Schramm; ''Recent oil developments in California,'' Robert B. Moran; ''Some geological problems in oil and gas recovery in Kentucky,'' W. R. Jillson; ''Probability of oil and gas in Montana,'' Professor J. P. Rowe. Prior to adjournment a vote of thanks was extended to the retiring president, Dr. I. C. White, and to the Dallas Chamber of Commerce and the Southwestern Geological Society, for courtesies during the convention. Invitations for the next annual meeting have been received from San Francisco, New York, St. Louis and Oklahoma City, and will be considered by the executive committee. The proceedings of the convention will be published as Volume IV. of the bulletin of the association.

The following officers were elected for the coming year: *President*, Wallace E. Pratt, chief geologist, Humble Oil Company, Fort Worth, Texas; *Vice-president*, Alex. W. McCoy, consulting geologist, Bartlesville, Oklahoma; *Secretary-Treasurer*, Charles E. Decker, associate professor, University of Oklahoma, Norman (reelected); *Editor*, Raymond C. Moore, state geologist of Kansas, University of Kansas, Lawrence, Kansas.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MINUTES OF THE EXECUTIVE COMMITTEE OF THE COUNCIL

The meeting was called to order by the president at 5 P.M., on April 26, 1920, in the Board Room of the Cosmos Club, and Dr. Howard was elected chairman for the meeting. The following members were present: Cattell, Fairchild, Howard, Humphreys, Livingston, MacDougal, Osborn and Ward. Mr. Woodward, the treasurer, attended the first part of the meeting.

1. *Grants.*—A resolution was passed to the effect that appropriations made to the Grants Committee shall be limited to the calendar year for which made. At the end of that year they automatically revert to the Treasury. (The executive committee may, of course, take special action before the end of the year, in cases where reversions would occur. For the year 1920 the amount of one grant made in 1919 and not withdrawn had been added to the 1920 appropriation of the grants committee, making this appropriation $4,500 instead of $4,000.)

2. *Life Memberships.*—A recommendation of the treasurer was adopted, to the effect that the treasurer is to pay to the permanent secretary three dollars each year for each life-membership requiring a subscription to the journal. (This special action was called for by the fact that the income from the fifty-dollar life-memberships is not sufficient to pay for the journal at the present rate.) At the beginning of the treasurer's fiscal year, the permanent secretary is to inform the treasurer in regard to the number of subscriptions to the journal to be thus cared for.

3. *Remission of Dues in Arrears.*—A resolution was passed to the effect that all members whose accounts show arrearage in dues for the years 1917–1919 (3 years), 1918–1919 (2 years), and 1919 (1 year), be *reinstated* as if back dues had been paid in full, providing they pay the annual dues for 1920 before the end of the present fiscal year. (This action was taken on account of war conditions.)

4. *Moratorium for Members Residing in Continental Europe.*—A resolution was passed to the effect that members residing in continental Europe may retain membership and receive the journal on account for three years (1920, 1921 and 1922) if specifically requested. (The preceding resolution of course also applies in these cases.)

5. *Toronto Meeting* (*1921–1922*).—The permanent secretary was instructed to accept with appreciation the invitation of the University of Toronto and of the Royal Canadian Institute and that he notify the secretaries of sections, of divisions and of affiliated societies to the effect that the annual meeting for 1921–1922 will be held at the Christmas season in Toronto.

The meeting was adjourned at 6 o'clock, to convene again at 7 in the private dining room of the Cosmos Club.

The adjourned meeting was called to order by President Howard. The following members were present: Cattell, Fairchild, Howard, Humphreys, Livingston, MacDougal, Noyes, Osborn and Ward.

6. *Science News Service.*—Mr. MacDougal presented a report on the organization of the Science News Service, supported by Mr. E. W. Scripps.

7. *Representatives for Conference with Science News Service.*—At the request of the Science News Service a committee was appointed, which consisted of Messrs. Cattell, Humphreys and George T. Moore, to confer with three representatives of the National Academy and three representatives of the National Research Council, and with representatives of the Science News Service, in the organization and operation of that service.

8. *Minutes of Last Meeting.*—The minutes of the last meeting were read and approved.

9. *Action of Committee during Interim.*—Mr.

Cattell reported that the office of permanent secretary had been filled by an arrangement with Mr. Livingston to devote two days a week on the average to this work, dating from February 1, 1920. Arrangement was made by which Mr. Howard would help the new permanent secretary in taking up the work.

10. *Permanent Secretary's Report on the Office.*—The former assistant secretary resigned and took up a new position on April 1, 1920. Mr. Sam Woodley was appointed to take charge of the office beginning March 15, 1920. The permanent secretary was given authority to employ the title of executive assistant for Mr. Woodley.

The business affairs of the office were stated to be nearly up to date.

The financial statement of April 26, 1920, showed an apparent balance in the bank of $22,634.75. (There may be alterations in this to be made when the vouchers of the former permanent secretary become available.)

From the report on membership it appears that there were 2,238 members owing the association for dues for one, two or three years. (These arrearages are to be cancelled according to resolution stated above—No. 3.) There were 8,034 members paid up for 1920.

11. *Election of Sectional Officers.*—On nomination of the corresponding sectional committees, Dr. Eliot Blackwelder was elected vice-president of Section E (Geology), Dr. Frederick L. Hoffman was elected vice-president of Section K (Social and Economic Sciences), Dr. Edwin W. Allen was elected vice-president of Section O (Agricultural), and Dr. Frank N. Freeman was elected secretary of Section I (Psychology).

12. *Spring Meeting of this Committee in Future.*—It was decided that, in order to have more time and to avoid conflicts with other meetings, the 1921 spring meeting of this committee will be called for 12 o'clock noon on the Sunday preceding the meeting of the National Academy.

13. *Autumn Meeting of this Committee.*—It was decided that the next meeting of this committee will occur on Sunday, October 17, in New York, at a place to be designated later.

14. *Report on the Southwestern Division.*—Mr. MacDougal reported that the Southwestern Division had been organized. The geographic limits are to include all members of the association resident in the states of Arizona and New Mexico and in Texas west of the Pecos River. At the wish of those involved some members will be transferred from the Pacific to the Southwestern Division.

The Constitution and By-Laws of the Western Division are appended.

This report was adopted and the organization of the Southwestern Division was ratified by this committee.

Mr. MacDougal presented the applications of 23 new members, who were duly elected to membership.

Seventy-three names of members of the Southwestern Division were nominated for fellowships and were duly elected.

Mr. MacDougal called attention to the desire of the officers and members of the Southwestern Division to have lectures in their region delivered by scientists from other parts and requested that the permanent secretary notify the secretary of the Southwestern Division whenever it may appear convenient, basing this notification on such information as the permanent secretary may have from time to time. It is understood that the Southwestern Division will pay extra expenses incurred by lecturers.

15. *Applications for Affiliation.*—The application for the affiliation of the National Geography Teachers was favorably discussed, but final action was deferred until the next annual meeting.

On motion duly made and seconded the Society of Sigma Xi was affiliated with the association.

16. *Correction of Published List of Affiliated Societies.*—Attention was drawn to the fact that the Wilson Ornithological Club has been listed as an affiliated society, whereas it has never been affiliated. It will remain on the list as an associated society.

17. *Books for Promoting Good Citizenship.*—A request from the American Library Association asking that the A. A. A. S. aid in a movement aiming to provide suitable literature to help in the Americanization of immigrants was referred to the president and permanent secretary with power to determine whatever action seems to be feasible.

18. *Preservation of Natural Conditions.*—A request from Dr. Shelford, representing the Ecological Society, asking that the association appropriate funds to be used for the promotion of a project of the society on this subject, was discussed but it was decided that the association was unable at the present time to comply with this request.

19. *Collection of Portraits and Letters of Presidents, A. A. A. S.*—A proposal that the association purchase at a price of $300 a collection of 74 portraits and 74 autograph letters of all the presidents of the association to date (which is now in the possession of Dr. Marcus Benjamin) was favorably

discussed, but action was deferred until the next annual meeting.

20. *Committee on Bibliography of Science.*—The permanent secretary read a letter from the chairman of this committee, Dr. C. B. Davenport, in lieu of a formal report. No action was taken.

21. *Publication of Proceedings.*—Plans for the publication (membership list) were discussed and it was decided to ask all members for the information needed in the preparation of the next membership list, this request to be made at the time the statements for the 1921 dues are sent out. It was decided that members who remit $1 extra for the *Proceedings* before the book goes to press may receive it at this price. After the book goes to press the price is to be $1.50. The price to nonmembers is to be $1.50. It is planned to publish about March or April, 1921.

22. *Terms of Office of Members of this Committee.*—Attention was drawn to the fact that the terms of elected members of this committee elected at the St. Louis meeting, had not been determined. This matter was taken up and lots were drawn, giving the following terms of office:

For the year 1920: Mr. Osborn and Mr. MacDougal;

For the years 1920 and 1921: Mr. Flexner and Mr. Humphreys;

For the years 1920, 1921 and 1922: Mr. Cattell and Mr. Ward;

For the years 1920, 1921, 1922 and 1923: Mr. Noyes and Mr. Fairchild.

23. *Plans for Chicago Meeting.*—It was decided that the official period of the Chicago meeting shall be December 27, 1920, to January 1, 1921, inclusive. On motion duly made and seconded, it was decided that the next council meeting shall be called for Tuesday, December 28, at 2. The general session is scheduled for the evening of Tuesday, December 28.

It was emphasized that a strong campaign for new members in the Chicago region should be carried out before the meeting by the local committee.

24. *Interpretation of New Fiscal Year.*—It was decided that members joining the association may defer the beginning of their membership and the beginning of the subscription to the journal until the beginning of the next year, if they so specify at the time dues are paid. (This action seems desirable on account of the fact that members entering between the time of the annual meeting and the beginning of the next fiscal year—October 1—do not receive the privileges of any annual meeting if their dues are credited to the current fiscal year.)

25. *Election of Members under the New Constitution.*—On motion duly made and seconded the permanent secretary was authorized to employ a card method for handling applications for membership without the requirement of two sponsors which has hitherto been in effect. The permanent secretary was authorized to act as a sub-committee on the election of members to the association after proper application and remittances has been received.

26. *Election of Fellows.*—As stated above (No. 14), 73 fellows were elected from the Southwestern Division. Eighty-one fellows were elected from the American Society of Zoologists.

The procedure to be followed in the election of fellows under the provision of the new By-Laws (Art. II., Sec. 4) was discussed, and it was decided that the secretaries of the sections of the association shall furnish the permanent secretary with a list of nominations for fellowship, at least once each year, the data for this list having been obtained from the secretaries of the affiliated societies concerned.

27. *Affiliation of Societies.*—The permanent secretary was instructed to prepare a list of scientific societies that presumably should be affiliated with the association, but which are not now affiliated, to the end that the affiliation of these societies may be arranged.

28. *Affiliation of Academies.*—Mr. Ward presented a report on this subject.

29. *Office Equipment.*—The permanent secretary was authorized to proceed with the geographic classification of the members and other related projects.

The committee adjourned at 11.07 to meet in New York at 11 o'clock on October 17, 1920.

Burton E. Livingston,
Permanent Secretary

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THE STIMULATION OF RESEARCH AFTER THE WAR[1]

At the time when I received from Dr. Cook the notice of my assignment to this topic, the phrase "after the war" seemed to be of rather indefinite and at least possibly remote significance. There was a chance at least that anything I might say would have time to be forgotten before its timeliness would be put to the test.

To-day we are face to face with the problem of stimulating research in this new epoch, which the political and social cataclysms of the past four years have ushered in. I am not one of those who are inclined to minimize the significance of the period through which we have just passed in its relations especially to the advance of knowledge. It is a reproach to biological science that we are not able to predict evolutionary trends, but it is perhaps on the whole a hopeful sign that we frequently differ so widely in our judgment of the significance of current events, and of the world problems which the great conflict involved.

It is for us, who conceive biology as in any true sense the science of life processes and activities in plants and animals alike from the lowest to the highest, to look to our fundamental conceptions and take thought of the responsibilities which our scientific pretensions involve. In my opinion we may find in the final assessment of responsibilities for the world war that a pseudo-scientific dogmatism, and the promulgation in popular form of superficial and wholly misleading views of such evolutionary concepts as the struggle for existence and the survival of the fittest, have had a share, both in the production of the false national and racial ambitions which lead up

[1] Read before Section G, American Association for the Advancement of Science, at the Baltimore meeting in the symposium on "Research after the War."

to the war, and the savage bitterness with which it was fought by its instigators.

It certainly behooves us as evolutionists to endeavor to clear up in a fashion not yet, in my opinion, adequately accomplished, the relation of Darwin's great concepts to such struggles, not that I assume that any one has the illuminating word now ready to be spoken. It is sufficiently obvious that a vast amount of further study of the problems and relations involved in the evolution of races, states, societies and civilization, as well as human individuals, is necessary before the concepts of struggle, progress, survival, etc., will attain a clearness which will finally prevent their use as the shibboleths of barbarism and savagery. As scientists we must all agree that in increased devotion to research and in the growth of that passion for understanding the living organism, its environment, its origin and its possibilities, our safety for the future lies. No ready made or lightly thought out theories will suffice. The danger from lightly conceived and lightly held political evolutionary theories promulgated by visionary and ill-trained statesmen and politicians, was never more real. The misuse of scientific half truths, misleading phrases and superficial analyses, was never more threatening than just now, when the central empires are endeavoring to regain their poise after their debauch of mad ambition. It is for scientists in the future to set an example of discriminating judgment and careful analysis of evidence of which they have not hitherto been capable.

The practical issues of the day we may say in a sense are still in the hands of men rather than of scientists and will be met and their problems solved instinctively and in accord with moral aspirations rather than by the application of established principles and concepts as to the nature and possibilities of further development of human societies and civilizations. The great men, the leaders, are so by virtue of an instinctive rather than analyzed feeling as to what is possible and achievable in the given conditions. The pragmatist with his worship of the man in the street may feel sure that this will always be the case, but in this assertion he loses whatever of truth there is in his philosophy and becomes the plain and familiar dogmatist of the past.

It is for us to see that a continually increasing number of those who are great leaders by virtue of their instinctive grasp of the significance of human movements and world situations, are also able to avail themselves of an increasing mass of analyzed and tested data bearing on the problems of life and evolutionary progress.

As a physiologist I may note that the stimulation of research does not involve the production of the fundamental motive power back of the advance of knowledge. Physiological stimuli liberate energies accumulated in the organism they guide and regulate activity but furnish no appreciable energy for its maintenance. They initiate reactions but do not cause them. The familiar illustrations of their nature and relations to organic activities are the pull on the trigger or the engineer's hand on the throttle. If there is no research mechanism well stocked with mental energy stimulation can do nothing. It may even weaken and destroy if the energies for normal reaction are not available.

Physiologically speaking the regulative stimuli, those wonderful activities of the enzymes and hormones which can accelerate or retard, direct and coordinate reactions so as to produce the complex and wonderfully adaptive phenomena of organic growth and behavior are those most interesting in present-day biological research and furnish the analogies on which the widespread demand for better control and coordination of scientific research is based. Why is it not our highest function as scientists to so regulate control and coordinate research that each problem shall receive its fit proportion of attention so that now when the world seems to need above all food supplies, a speedy physical rehabilitation to repair the wounds of war and a special set of political and social maxims for the use of nations in the transition from autocratic to more democratic governmental forms the whole energies of the world of science, political, social and biological, can be turned to producing these desiderata. This would be efficiency in the German sense and a reasonable regard for such demands is necessary and desirable. There are, however, it seems to me, some more fundamental viewpoints that under stress of immediate physical need may be overlooked. And first among these is the fact that as noted stimulation, initiation, regulation, coordination, do not furnish motive power, imply indeed an exhaustion of energy rather than its increase. The withdrawal of men from the active prosecution of their own investigations in order that they may spend time on commissions, boards and other executive agencies for controlling and directing the research of others is doubtless a necessary evil but is in danger of being regarded as a useful end in itself. The activity of such agencies in securing funds and thus contributing to the motive power back of research is quite another matter but even there it is deplorable when a man of first-class talent withdraws from his own work and devotes his energies to obtaining financial support for a group who thus become in a sense his subordinates. If he makes efforts to direct and coordinate in detail the activities of such a group with their diverse capacities and widely separated lines of activity, his influence may even be positively harmful. The importance and advantage of cooperation in research have been very adequately and effectively presented from many quarters. The socialistic trend is obvious here as in so many phases of modern thought and action and it is at least worth while to consider what may be said from other viewpoints. Of spontaneous cooperation individually initiated there can not be too much, but if it becomes the fashion to work only in groups and on problems in which group interest can be aroused in my opinion we shall be disregarding many obvious teachings of experience. You may gather from this that I am not hopeful that research can be socialized in any very significant degree. It seems to me that this is especially true of those higher efforts of the human mind when it actually breaks over age old barriers or enters on wholly new and hitherto unsuspected fields for thought and action. Routine solutions of definite and simple problems can be achieved by the factory and piece work system but the highest achievements of the mind are always individual and seem frequently to mock all attempts to relate them to the environment or the period of their occurrence. In my opinion the distinction between routine research on the problems which are already clearly stated and for which methods of attack are obvious from data available and the studies which really open up new fields of hitherto unperceived interest and importance or solve problems long given up as ridiculous, is more significant than that between so-called pure and applied science. This distinction, it seems to me, has been overworked at least in its relations to the development of research. On the other hand, whether or no we conceive ourselves as either practically or theoretically able, by taking thought, to influence the course of events, it may tend to clearness of thought about what is actually going on in these times of turmoil and excitement if we recognize more fully that there are these two types of research activity, each with its own clearly marked prerequisites. The war experience of the nation has shown plainly enough that when the money and incentive are at hand staffs of experts can be organized and laboratories equipped on short notice which can solve a vast number of important problems relating to the chemistry of dyes, high explosives, gas warfare, aeroplane engines, etc., with a high degree of promptness and efficiency. I am sure too that we should be mistaken if we expect from such efforts only new applications of already known theoretic principles. We are perhaps quite as likely to arrive at theoretically significant new conceptions of matter and energy in the study of the vastly practical problems of static disturbances in wireless telegraphy (which problems by the way the newspapers recently announced had been solved by work in the laboratories of a great commercial corporation) as in the study of the wave theory of electricity as such with no practical problem in mind.

A vast amount of useful and theoretically highly important work is being turned out yearly by investigators who either have definite problems assigned to them by others or who see a problem so clearly that they can at once present it to a board or committee or executive agency in charge of funds, and immediately win financial and other support for its study. We can not have too much of this sort of work and most of the research agencies now under consideration, such as the National Research Council, the various scientific departments of the national government, the research departments of the agricultural experiment stations, the great research institutions and commercial laboratories, are all well calculated to foster and develop work on problems whose possibility of solution is fairly evident or whose significance is already so fully understood that their study is suggested even though they seem for the time insoluble.

It seems to me equally obvious, however, that these agencies do not provide at all adequately for the second type of problems, those which at present lie outside of and beyond the domain of clear thought at least on the part of the majority of intelligent people, and this again quite regardless of whether the problems seem to relate to practical matters or to have only a theoretic or philosophical interest. I think we must admit that many of the great advances in knowledge have been made by some one's breaking over these bounds of the average scientists thinking and experimenting and attacking some problem which had been quite unthought of or was regarded so unclearly as to be considered wholly visionary, impossible of attack or even ridiculous. To illustrate, I think we must admit now that the Wright brothers were more favorably situated for the solution of the problem of human flight in heavier than air machines than was Langley. Langley was in a great government supported institution with supposedly all the resources for the attack on the problem from the mathematical, physical and experimental mechanical side at his command. The Wrights had to develop financial and other support as they went along. The case illustrates perfectly the weakness likely to inhere in governmentally supported research. Langley in his position, could not afford repeated failures in experimenting on a problem which was still regarded as chimerical if not ridiculous by the great mass of intelligent people of his time. The Wrights, working on their own initiative, with everything to win by final success and little to lose by temporary failure, with no explanations to make to governing boards or scientific societies, were in a vastly more helpful and normal environment, it seems to me, for establishing a new point of departure in a new field of activity. At least the Wrights succeeded and Langley was unable to push further his partial success in an achievement which if it had been followed up might have won him the distinction which went to the vastly less well supported efforts of the Wrights. Langley in his position under the eye of the government could not feel himself able to support temporary failure or even partial success, though in reality the endeavor was worth prosecuting through a thousand failures.

Another instance is the historic one of Pasteur's discovery of the relation of microorganisms to fermentation and decay. No more fundamental and enlightening work has been done in the whole history of biological research. It gave the final quietus to the doctrine of the spontaneous generation of germs in decaying organic matter and laid the foundations for a whole series of discoveries in theoretic pathology as well as applications in medicine and the practical arts. Yet if we accept the current accounts of the attitude of Pasteur's colleagues and the general public to his earlier work in these lines, we can see that it would have been quite impossible for him to have gained support in advance for his researches on problems supposed to be settled, or quite insoluble.

Pasteur, like the Wrights, won his way to popular support, but it is certainly a question whether the work, brilliant though it is, which has so far come from the great institute founded in his honor equals in significance the work done by the great master.

It is the despair of organizers of research that work of the first rank such as that of Pasteur and Darwin shows so little dependence on facilities, equipment, etc., and it is always to be remembered that the problems on which they worked, and the results they achieved were not such as would have enabled them to win in advance either financial support or substantial recognition by the general public or their scientific colleagues. Pasteur could win his institute only by achieved results, not on an advance program for laying the foundations of a new science of bacteriology. Darwin could hardly have made the origin of species seem a promising and feasible field of research before he had the evidence of the efficiency of selection which made the whole subject of evolution a new and vital one. It is hardly conceivable that Darwin himself would have been able or willing to attempt to formulate in advance a project which would have covered the main field of his researches. He was working out into lines of thought and experimentation where clearness and feasibility became obvious after, and not before the event. In these days when in certain quarters it is assumed that every research must be outlined and made to appear reasonable in advance, it is worth while to remember that really new fields of study are very likely to look unpromising if not hopeless or ridiculous to the executive mind. If we require for every research project that it appear promising and workable within a so-called reasonable time, we put a premium on problems of the easy and less fundamental type. There is also a psychological factor here. The man who conceives vaguely at first a great new possibility in the advance of knowledge, is sometimes quite disinclined to talk about it merely because it seems so vague, hopeless, and perhaps even ridiculous. If we organize research to such a degree that it shall become the customary, if not the inevitable routine for every worker in an experiment station or research institute to feel that he can only work on problems which can be made to appear plausible and possible of solution in advance, we shall, as in so many socializing schemes, put a premium on mediocrity, and penalize real originality of the kind which has led in the past to many of the really great advances in knowledge.

It is, however, always to be remembered that there is probably a greater practical danger of our institutions of research becoming the refuges of incompetents and visionaries than that their methods will nip incipient genius in the bud. The illustrations I have used are, of course, extreme cases, and represent the exceptions rather than the rule as to the mass of scientific work now being done and which has been done in the past. It may well be said that the Darwins and Pasteurs will take care of themselves and that our plans and organizations should be for the average run of scientific workers. Still this objection overlooks the possibility that the case of the scientists, like that of other matters of heredity, can not be adequately analyzed on the basis of the simple assumption of "presence and absence"—in this case of genius. There are many grades of research ability. I have attempted to differentiate two classes of problems: first, those clearly conceived, and appearing more or less readily capable of solution; and second, those which, though obviously of vast importance if solved, are imperfectly conceived, or appear hopeless, or even fantastic. Still it is obvious enough that many if not most scientific problems lie somewhere between these extremes. Any problem which is worthy of serious effort will probably involve in its solution many lines of effort which were not foreseen at the beginning, and many important problems will seem, even to their projectors, too hopeless of solution to have any wide appeal, or to win adequate cooperative support, or even the approval of colleagues or superiors in attacking them.

In considering the whole problem of the stimulation of research we should recognize the limitations of controlled and directed effort, and learn if possible whether in our schemes provision can not also be made for that free and untrammeled environment where personal inclination and initiative are the major factors. Control and executive supervision become necessary in direct proportion as research is paid for directly as such. This is inevitable if government bureaus and research institutions are to be sure of some return for their money. It is the special advantage of the universities that in them research can in a sense be regarded as a utilization of by-products—not infrequently in modern industry a very important source of real profits. The member of a university faculty can give a return for his salary in the form of teaching—the relatively prosaic, but important work of passing on to the new generation the achieved results of the science, literature and arts of the past with all which that implies of stimulus and moral development. This is his modicum of contribution, but beyond this, the spirit of the university, the environment of young students, the seminar, the scientific conferences, the intercourse with colleagues in related but diversified fields—all these are stimulants to research of the highest efficiency, and constitute at once that free and untrammeled environment which incites to effort in purely ideal lines where no consideration save the intrinsic interest of the work in itself, and the desirability of the solution to be attained need intrude. The universities because of their functions in teaching, are the natural homes for research on problems whose appeal is to the desire of the human mind to understand and control its environment.

I need hardly stop to add that all universities as yet do not furnish in the highest degree possible this sort of environment. It is enough for us that there is no intrinsic reason why they should not all become such centers of stimulation and motive power in research. And for the warning of those who are too much given to reforming that which is already reasonably good, be it said that the tyranny of majorities and of professorial trade unions is quite as likely to meet with passive resistance and the undermining effects of indifference and superior interest in the real work of teaching and research, as the attempts at financial, social, intellectual and executive overlordship which have in the past been regarded as the most insidious foes of our much-prized and too frequently little understood academic freedom.

The further fundamental consideration which confronts us is that after all research is hard work and that the most important stimulus thereto is the force of example. After the exhibition of the past four years it is hardly necessary to emphasize that man is still very much of an animal. One of the oldest if not the primitive mental trait is imitation. We shall stimulate research in direct proportion as we plunge into it ourselves each on the problems that look large and appeal to him especially. With the socializing tendencies of the present day and the vast emphasis which is being laid on organization it may sound like serious heresy but I am willing to stand for the proposition that in peace times at least no one is justified in assuming executive work or work in the planning and direction of the research of others to the exclusion of his own research work. On those minded to do so I would urge first at least the need of research that the justification of their viewpoint be made more clear than it is at present. With all our present-day divergence of views we can perhaps agree that the advance of knowledge in the future depends most on the possibility of winning the brightest minds of the rising generation for research and for accomplishing this it seems to me the most important factor is that we convince our students by our own examples that research is really an absorbing and satisfying occupation that it is interesting in itself even independently of the immediately obvious value of the results obtained. Not by preaching research or organizing research or talking about the stimulation of research, but by showing a deep, insatiable curiosity about the things of nature and of life, we shall advance and win others to engage in the pursuit and practise of knowledge R. A. Harper

Columbia University

JAMES M. MACOUN

James M. Macoun, chief of the Biological Division of the Geological Survey, Canada, died January 8, 1920, aged 58. He was well known as one of the best informed systematic botanists, not only throughout Canada but also in other countries, and was an expert on the fur-seal industry.

During the summer of 1919, while conducting botanical field work in Jasper Park, Alberta, Mr. Macoun was taken ill but finished his field work before returning to Ottawa early in October. He became gradually worse and went to a hospital, but was found to be beyond surgical help.

Mr. Macoun was born in Belleville, Ontario, in 1862. The members of the Macoun family are known for their endeavors in scientific lines and as staunch workers for democratic good citizenship. Mr. Macoun was the son of Professor John Macoun, naturalist of the Geological Survey, Canada, now residing at Sidney, Vancouver Island, British Columbia. He was the brother of Mr. W. T. Macoun. Dominion Horticulturist at the Central Experimental Farm, Ottawa. The Macoun name is connected with practically all the botanical research work of Canada, and many of the plant species of Canada bear the name of Macoun. This alone is evidence of their authoritative standing in the botanical world. When young, James M. Macoun attended Belleville High School, and Albert College, where his father was then professor of botany.

In 1881, when nineteen years of age, he accompanied his father to the field on an exploration of the territory between Portage la Prairie, Manitoba, and the head waters of the Assiniboine.

In 1882, when his father, Professor Macoun, moved to Ottawa to take charge of the botanical and other natural history work of the Geological Survey, James came as his assistant, and he became a regular worker as a civil servant of the Dominion Government in 1883. In this service he continued for thirty-seven years, dying in harness. Mr. Macoun specialized in botany from the time he entered the service. He assisted his father in the preparation and publication of his monumental botanical work, and the two editions of the annotated list of the birds of Canada.

Mr. Macoun was appointed assistant naturalist of the survey in 1898. Since 1912, when his father moved to British Columbia, much greater responsibility was thrown on him, and he was appointed botanist in 1917. In 1918, because of his wide knowledge, he was appointed chief of the Biological Division.

In 1891, when the fur-seal industry of the Pacific Islands was a subject of diplomatic concern between Great Britain, Canada, and the United States, he was chosen by Dr. George M. Dawson, then director of the Geological Survey and Behring Sea Commissioner for Canada, to accompany him on a trip of investigation to Behring Sea. His services in the study of the life history and habits of the fur seal were so valuable that he was retained on this work in 1892 and 1893, and was sent to Europe as an expert in connection with the fur-seal arbitration.

In 1896 and in 1914 he was again sent to Behring Sea. In 1911 he spent 10 weeks in Washington as one of the Canadian representatives at the fur-seal conference. For his special international work in connection with the fur-seal he was highly commended by Lord Bryce, then British Ambassador at Washington, and received a C. M. G. for his services.

Mr. Macoun had his full share in the field work of the staff of the Geological Survey, which takes the members to many parts of Canada and mainly to the outlying or least civilized areas. On some of the expeditions he endured very severe hardships; for instance, in 1910, while studying the flora and fauna of the west coast of Hudson Bay, his ship was wrecked and the party had to attempt the return to civilization in a small boat. Fortunately they were rescued and taken to Fort Churchill, from where they made the overland trip to Lake Winnipeg on foot in the depth of winter, reaching the telegraph line after having been almost given up for lost. Mr. Macoun was always the leader in the morning and brought up the rear in the evening to see that no one was left behind to freeze. He always depreciated his own hardships on this trip and the importance of his effort, but it is no small task to bring forty men unacquainted with snowshoe travel, from Hudson Bay to Winnepeg in winter without loss of life or limb.

To Mr. Macoun and his father is due the

National Herbarium of the Geological Survey, containing over 100,000 specimens of the flora of Canada, and about half of the 14,000 ornithological specimens in the museum. Both were among the founders of the Museum of the Geological Survey.

Mr. Macoun was remarkably genial, had great ability as a clever conversationalist, and possessed a faculty to help those in need. He made many friends in all walks of life. "Labor" in particular will miss him greatly. His motto was "Equal opportunity for all," and this he strongly proclaimed through many organizations, whether wholly, in part, or not at all devoted to the interests of labor. Both labor and capital had so much faith in his fairness that they allowed him to act as sole arbitrator between them in the case of strikes. In this service he prevented much suffering among the ranks of labor, loss to capital, and inconvenience to the public. He took an active part in all work for the progress of humanity, engaging especially in work for the blind. During the war he was energetic in aiding relief measures; since then in assisting the returned soldier.

One of the most prominent civil servants of Canada, he did much to place the Civil Service Association on a firm basis, and was always a strong supporter of it. He was one of the founders of the People's Forum of Ottawa, and for a considerable time was its chairman.

He was active in municipal, provincial and Dominion affairs, and his interest in sociological questions took a practical turn. He was unostentatious in his wide philanthropies.

He was an individualist whose chief characteristics were his humanness, and his democratic life. He was affectionately and respectfully known as "Jim" across the continent, and prouder of it than of his C. M. G. He was never too busy to grant a word of advice and offer a word of cheer to any worker in any branch of science, to any one needing help, and to any worker for the common good.

Harlan I. Smith

Geological Survey,
Canada

SCIENTIFIC EVENTS

THE ANGLO-AMERICAN UNIVERSITY LIBRARY FOR CENTRAL EUROPE

It is proposed to establish in Central Europe under British-American auspices libraries of recent English books indispensable to university teachers. The work is being organized on a broad, non-political, non-sectarian basis, so as to enlist the widest possble cooperation. These libraries will supply on loan books needed by the faculties of the different universities in Central Europe. They will be under the charge of British and American representatives, and committees of the foreign universities will be asked to superintend the local administration. A committee of the six most important learned societies in Germany and Austria has been formed for the carrying out of the plan which, in addition to the loan library, will include a system of exchange of publications and duplicates between any libraries and institutions willing to cooperate. The preliminary statement of the trustees says:

> By thus taking the initiative in extending the hand of fellowship to colleagues in former enemy countries, British and American scholars are seizing a timely opportunity of helping to heal the wounds of the war and of exemplifying in a practical and convincing way the true "international mind."

Viscount Bryce, Lord Robert Cecil and other English public men have expressed their approval of the plan and have promised their cooperation in carrying it out. The supporters of the plan in Great Britain include: Gilbert Murray, Oxford; A. E. J. Rawlinson, Oxford; C. S. Sherrington, Oxford; Walter Raleigh, Oxford; A. E. Shipley, Cambridge; J. J. Thomson, Cambridge; A. S. Ramsay, Cambridge; Joseph Larmor, Cambridge; Horace Darwin, Cambridge; W. B. Hardy, M.A., Cambridge; Alfred Hopkinson, Glasgow; Col. E. H. Hills, Woolwich; Henry A. Miers, Oxford; Alex. Hill, Cambridge; George Paish, London; Rickman G. Godlee, London, and Michael Sadler, Leeds.

University teachers in the United Kingdom and American are requested to give their approval and cooperation to the plan by sending their names to the secretary, Mr. B. M. Headicar, librarian of the London School of Economics (University of London), Clare Market, London, W.C.

PUBLICATIONS FOR EUROPEAN NATIONS

Owing to the depreciated currency of Europe and the financial difficulties in which many European nations find themselves, the publication of some European serials has been temporarily discontinued, others have decreased in size, while the publication of still others is irregular. Furthermore, the purchase of American books at the present rate of exchange is practically impossible.

Since it is essential for the intellectual life of mankind, that students of all countries should be in close touch, and since it seems of importance to America that the results of our intellectual activities should be known, the undersigned urge all publishers, publishing institutions and publishing societies to exchange their publications on the most liberal terms with libraries, publishers, journals and publishing institutions and societies of all European countries, disregarding for the near future the question whether the amount of printed matter received in exchange corresponds with the amount sent.

(*Signed*) Felix Adler, James R. Angell, Franz Boas, Charles W. Eliot, J. Cardinal Gibbons, Arthur T. Hadley, David Starr Jordan, Harry Pratt Judson, E. H. Lewinski-Corwin, A. Lawrence Lowell, John Bassett Moore, Henry Fairfield Osborn, George Foster Peabody, M. I. Pupin, Jacob Gould Schurman, Ellery Sedgwick, F. J. V. Skiff, Munroe Smith, Antonio Stella, Henry Suzzallo, Harlan F. Stone, William H. Taft, F. A. Vanderlip.

TABLES OF THE MOTION OF THE MOON

The "Tables of the Motion of the Moon," by Ernest W. Brown, Sc.D., professor of mathematics in Yale University, has now been published through the Yale University Press. It is the result of thirty years of research and preparation.

The first tables of the moon, founded on the law of gravitation, were published by Clairaut in 1752, but the tables published in 1857 by Hansen were the first which permitted the position of the moon to be computed from theory with an accuracy comparable with that of observation. The only other set of like importance is the tables founded on Delaunay's theory, appearing in 1911 under the final direction of Radau. These have been used for the ephemerides of the moon since their publication. The appearance of Professor Brown's tables is expected to constitute a new epoch in the history of astronomical tables, and to exercise a marked effect on navigation.

Professor Brown, a graduate of Christ's College, Cambridge, has held the chair of mathematics at Yale University since 1907, having previously been professor at Haverford College. He is the author of "Treatise on the Lunar Theory," 1896; "A New Theory of the Moon's Motion," 1897 to 1905; and of many papers on the lunar theory and on celestial and general mechanics. He received the gold medal of the Royal Astronomical Society in 1907, and the Royal Medal in 1914. The latest honor which has come to him is the Bruce medal of the Astronomical Society of the Pacific, which he recently went to San Francisco to accept.

Professor Brown is a fellow of the Royal Society and of the Royal Astronomical Society, a member of the London Mathematical Society, the Cambridge Philosophical Society, the American Philosophical Society, the American Mathematical Society, of which he was president from 1914 to 1916, the American Association for the Advancement of Science, being vice-president of Section A in 1910, and the American Academy of Arts and Sciences.

The work of Professor Brown has been printed in three parts, bound in paper covers in order that the various purchasers of the tables may bind them to suit their individual needs. The book has been printed on hand-made paper, by the Cambridge University Press in Cambridge, the size of the page being $10\frac{1}{4}$ by $13\frac{5}{8}$ inches. In concluding his preface to the "Tables of the Motion of the Moon" Professor Brown has made the following statement:

This volume brings to a close the work started thirty years ago with a study of Hill's papers made at the suggestion of my former teacher and friend, George Darwin. The undertaking of a complete recalculation of the moon's motions and later of tables which should make the theory available for practical and scientific use was no ambitious plan formed at the beginning but grew naturally out of the desire to continue the work as each stage in it was reached. Some part of it has always been in progress and there have been long periods during which it has been my sole occupation outside of the duties connected with an academic position and of the hours given to recreation. The word "finis" brings with it some feeling of regret. The time spent in actual calculation was often a relief from attempts to solve more difficult problems in other lines. To what extent it has been worth while as a contribution to the subject must be left to the future and to others for judgment. My hope is that it will give some aid in unravelling the tangled skeins of problems which our nearest celestial neighbor has never failed to present, and that the satisfaction to myself in seeing the work finally brought to a conclusion will be shared by those who have been interested in watching its progress.

THE DIRECTOR OF THE BUREAU OF MINES

The nomination of Dr. Frederick G. Cottrell for director of the Bureau of Mines, Department of the Interior, was sent to the Senate on May 5 by President Wilson, to take the place of Dr. Van. H. Manning, resigned. Dr. Cottrell was the assistant director of the bureau under Dr. Manning.

Frederick G. Cottrell, chemist, metallurgist and inventor, was born in Oakland, Calif., January 10, 1877. He attended school in Oakland and matriculated at the University of California in 1892. As a university student he gave especial attention to science, particularly chemistry. After graduation in 1896, with the degree of bachelor of science, he was a Le Conte fellow at the University in 1896–1897 and taught chemistry at the Oakland High School in 1897–1900. Then he went to Europe, where in 1901 and 1902 he studied at the University of Berlin and the University of Leipzig, receiving from the latter the degree of doctor of philosophy in 1902. On his return to this country in 1902, he was appointed instructor in physical chemistry at the University of California, and in 1906 was appointed assistant professor, holding this position until 1911. While at the university Dr. Cottrell's chief contributions to science were researches relating to the electrical precipitation of fume and fine particles suspended in the gases of smelter, blast furnace or cement works flues, and he finally evolved what is known as the Cottrell process for this purpose. This invention was first utilized at the Selby smelter in California for removing fumes from the waste gases of a sulphuric acid plant at the smelter, thereby abating a nuisance that threatened to necessitate shutting down the works. Subsequently this electrical precipitation process was installed at other smelters to remove fume and solid particles contained in the escaping gases, and it was also successfully used at cement plants, notably near Riverside, Calif., to prevent the dust from calcining kilns from damaging nearby orange groves and vegetation. To-day the Cottrell process of fume and dust removal is in world-wide use, and is recovering materials heretofore wasted to the value of many thousands of dollars. One of the latest installations is at a large smelting plant in Japan; while the largest installation is at the Anaconda smelter, Anaconda, Mont. Dr. Cottrell in a desire to encourage scientific research turned over his extensive patent rights to a non-dividend-paying corporation, known as the Research Corporation, a body formed for that purpose. A fundamental requirement in the incorporation is that all net profits shall be devoted to the interests of scientific research.

In 1911 when Dr J. A. Holmes, the first director of the Bureau of Mines, was serving as a member of commissions appointed by the government to study alleged damages from smoke and fumes from the Selby and the Anaconda smelters, and the Bureau of Mines was investigating at length the smelter-smoke problem, Dr. Cottrell, because of his scientific attainments and his special knowledge of metallurgical problems, was appointed chief physical chemist in the bureau. In 1914 he was appointed chief chemist, in 1916, chief metallurgist, and in 1919, assistant director.

Aside from his work on smelter smoke Dr. Cottrell has been intimately connected with work on the separation and purification of gases by liquification and fractional distillation. During the world war and subsequently the development of the Norton or Bureau of Mines process for the recovery of helium from natural gas has been his special care, and it was chiefly through his efforts that a plant for recovering helium on a large scale for military aeronautics has been erected near Petrolia, Texas.

Dr. Cottrell is a member of the American Chemical Society, Mining and Metallurgical Society of America, the American Electrochemical Society, the American Institute of Mining and Metallurgical Engineers, and the American Association for the Advancement of Science. He was awarded the Perkin medal by the New York Section of the Society of Chemical Industry in 1919 in recognition of his work on electrical precipitation.

SCIENTIFIC NOTES AND NEWS

Dr. Augustus Trowbridge, professor of physics at Princeton University, during the war lieutenant colonel and head of the sound ranging service of the A. E. F., has accepted appointment as chairman of the division of astronomy, mathematics and physics of the National Research Council for the year beginning on July 1.

Dr. Hubert Work, of Colorado, first speaker of the house of delegates of the American Medical Association, has been elected president of the association.

The council of the British Medical Association, at the meeting of April 14, resolved unanimously to recommend the Annual Representative Meeting that Dr. David Drummond, should be elected president of the association for the year 1921–22, to take office at the Annual Meeting to be held at Newcastle-on-Tyne in 1921. Dr. Drummond is vice-chancellor and professor of medicine, University of Durham, and consulting physician, Royal Victoria Infirmary, Newcastle. The council decided also to accept an invitation from the Glasgow and West of Scotland Branch to hold the annual meeting of 1922 in Glasgow.

Dr. Otto Klotz, director of the Dominion Observatory, has been elected president of the Seismological Society of America.

Dr. William H. Welch and Dr. Ira Remsen, both of Johns Hopkins University, have been appointed to the Board of Electors for the Hall of Fame of New York University.

Dr. John H. Finley has received the gold medal of the Geographical Society of Paris, in recognition of the English edition of his book, "The French in the Heart of America." The French edition of the same work was crowned by the *Academie* with an award of 1,500 francs.

Professor Ray S. Owen, of the department of topographic and highway engineering of the University of Wisconsin, has been made Officier d'Academie by the French government for his work in the intelligence department of the army.

The Howard Taylor Ricketts prize of the University of Chicago for 1920 has been awarded to Ivan C. Hall for his work on "Studies in Anaerobiology." This prize is awarded annually on May 3, this being the anniversary of the death of Dr. Ricketts from typhus fever while engaged in investigative work on this disease in Mexico City in 1910.

The Boylston Prize of $300 has been awarded to Messrs. Stuart Mudd, Samuel B. Grant and Alfred Goldman, fourth year students of medicine, for their research on "The Effect of Chilling on the Mucous Membrane of the Throat and Tonsil," performed in the pathological laboratory of the Washington University School of Medicine.

Dr. Lyman J. Briggs, formerly physicist in the Bureau of Plant Industry, U. S. Department of Agriculture, who had been on temporary assignment to the Bureau of Standards for research on aeroplane problems during the war, has been transferred permanently to the staff of the Bureau of Standards.

H. H. Hansen, chemist in charge of feeding stuff analysis in the West Virginia Experiment Station, has been appointed state chemist of Delaware in charge of a new laboratory which has been equipped in Dover, by the State Department of Agriculture to conduct the chemical and seed testing work of the state.

Dr. Arthur W. Dox has resigned as chief in chemistry of the Iowa Agricultural Experiment Station to accept the position of research chemist for Parke, Davis & Co., Detroit, Mich.

Dr. E. H. Starling, professor of physiology in the University of London, who has gone to India to advise the British government with regard to the foundation of a central medical research institute for India, will visit Bombay, Poona, Bangalore, Calcutta, Delhi and Kasauli.

Professor Richard P. Strong, of Harvard University, will attend the annual congress of the British Royal Institute of Public Health, which is to be held this year, upon special invitation from Belgium, from May 20 to 24, in the city of Brussels.

Joseph T. Singewald, Jr., associate professor of economic geology at the Johns Hopkins University, who has been on leave of absence since December to carry on geologic investigations in Peru, has returned to Baltimore.

Dr. Willard J. Fisher, assistant professor of physics in the University of the Philippines, and since July, 1919, acting head of the department, is leaving the university to return to the United States this summer.

Mr. Calvert Townley, president of the American Institute of Electrical Engineers, visited the sections of that body at Chicago, Milwaukee, Ann Arbor, Detroit and Toronto during April. He delivered addresses at each place.

The meeting of the New York Section of the American Chemical Society on the evening of May 7 was devoted to papers on the general subject of Colloids and Colloidal Chemistry in accordance with the following program: "The general chemistry of gelatine," by Jacques Loeb; "Silica gel and its uses," by W. A. Patrick, and "Electroendosmosis," by T. R. Briggs.

A Liebig museum was opened at Giessen on March 26, when an address was given by Professor Burger on the relation of Liebig to medicine.

Applications for three Ramsay memorial fellowships for chemical research will be considered by the trustees. They must be received by June 15, by Dr. W. W. Seton, organizing secretary, Ramsay Memorial Fund, University College, London. The fellowships will each be of the annual value of £250, with, possibly, a grant of not more than £50 per annum for expenses, and tenable for two years, with the possible extension of a year.

Dr. E. Schwalbe, director of the pathological institute at the University of Rostock, was killed during the recent rioting.

UNIVERSITY AND EDUCATIONAL NEWS

The Mississippi legislature has appropriated $250,000 for a new chemical building at the University of Mississippi which will provide laboratory and other facilities for students in the medical school. An additional appropriation of $10,000 was made to secure permanent equipment for the medical school, exclusive of chemistry. Additional funds were appropriated for the university with which salaries of all teachers could be reasonably increased. The total appropriation for the university exceeds $1,000,000.

Mr. F. A. Heron has given to Queen's University, Belfast, the sum of £5,000 to provide the necessary equipment for teaching physical chemistry, and £1,000 towards the provision of accommodation for the department.

James T. Jardine, investigator for the United States Forest Service, has been elected director of the Oregon Agricultural College Experiment Station.

A. H. FULLER, director of engineering at Lafayette College, and previously dean of engineering at the University of Washington, has been appointed head of the civil engineering department of Iowa State College at Ames, and will take up his new duties about the first of July.

DR. OTTO V. HUFFMAN, who has resigned as dean of the Long Island College Hospital and has resumed practise in New York City, has been appointed a member of the faculty of the New York Post Graduate Medical School and Hospital in the department of internal medicine.

PROFESSOR F. B. ISELY, of Central College, Fayette, Mo., has accepted the position of dean and professor of biology at Culver-Stockton College, Canton, Mo., and will begin work in June.

AT Yale University instructors have been appointed as follows: Leonard H. Caldwell, in engineering drawing; Arthur H. Smith, in physiological chemistry; Wilbur Willis Swingle, in biology; J. H. Fithian, Jr., and Howard B. Meek, in mathematics.

MR. JOHN B. FERGUSON, formerly of the Geophysical Laboratory, of the Carnegie Institution of Washington, and now a member of the research department of the Western Electric Company of New York City, has accepted a position as associate professor of chemical research at the University of Toronto.

DR. J. H. ANDREW, chief of the Metallurgical Research Department of Sir W. G. Armstrong, Whitworth, and Co., Manchester, has been appointed to the chair of metallurgy in the Royal Technical College, Glasgow, vacant by the transfer of Dr. Desch to the University of Sheffield.

DISCUSSION AND CORRESPONDENCE

THE AURORA OF MARCH 22, 1920

THE bright aurora of March 22 was first noticed at Urbana about 7:00 P.M. It must have developed quickly, for I had glanced over the entire sky looking for clouds at 6:45, without noticing anything unusual. Soon after 7:00 the illumination was covering more than half of the sky but it was a couple of hours before the streamers were well marked near the magnetic zenith. This aurora was the longest in duration I have ever noticed at Urbana, as it was followed continuously from 7^h to 13^h, and observations of the apparent radiant were made at times during two hours. My assistant, Mr. C. C. Wylie, was also watching the display from a position a quarter of a mile distant from the observatory, and our independent estimates of the apparent radiant or focus of the streamers high up in the south, are given in the table. The times are Central Standard Time, 6 hours slow of Greenwich Mean Time.

C. S. T.	Declination	Hour Angle	Observer	Remarks
9^h 05^m	20°.8	+4°.0	S	
9 08	21.3	+3.8	S	
9 22	20.6	+1.2	S	
9 25	19.0	+1.1	W	Fair
10 05	20.4	−4.8	W	Fair
10 09	20.7	+2.5	S	Fair
10 21	19.6	+3.0	S	
10 22	22.3	+2.0	W	Good
10 25	20.0	+2.8	S	Good
10 34	20.7	+0.2	S	Good
10 55	21.0	−1.6	W	Good
11 12	20.5	+1.5	S	Fair
11 12	19.1	+0.0	W	Good
11 18	20.5	+0.2	S	Fair
Mean of S's	20°.5	+2°.1		
Mean of W's	20.4	−0.7		
Mean of all	20.5	+1.1		
Magnetic zenith	21.2	+1.1		
Difference	0.7	0.0		

The mean of all estimates differed by only 0.°7 from the magnetic zenith, as defined by the magnetic elements for Urbana determined by Mr. Merrymon of the Coast Survey in 1917. This agrees with previous results.[1]

The auroral light interfered with our photometric observations at the telescope that evening, because of the variable bright sky background for any star. A few rough measures gave the result that a patch of auroral streamer equal in apparent area to the full moon gave about as much light as a second

[1] SCIENCE, 47, 314, 1918.

magnitude star. This refers to the blue light which most affects the photo-electric cell, which is not very different from the photographic plate in color sensitivity.

Joel Stebbins
University of Illinois Observatory

THE RECENT AURORAS AND SUN SPOTS

The object of this preliminary communication is to call attention to the coincidence with the recent magnetic displays of a huge disturbance on the sun approximately parallel to the sun's equator and over 205,000 miles long so situated that the whole of it approximately passed centrally requiring at least two days for its passage over the sun's center. The group of spots consisted of at least six larger and numerous smaller ones, all stringing along in a line. My first observation of it was on the 23d of March when most of the group had already passed the center by about a day. If the group existed prior to the 23d without essential modification, it began to pass the center between the 20th and 21st, showing a lag in the propagation from the sun to the earth, if there be such, of something like two days. This seems to favor Professor Snyder's recently announced statement that there is a lag of 48 hours. The observation seems at least to point to the fact of there being some kind of propagation. The central passage required about two days and the aurora was evident on the evenings of the 22d and 23d at least.

Again on the 16th of April a medium-sized spot became central. It was probably one of the six spots of the before mentioned group. It was followed by a small spot some 200,000 miles after and also central about two days later. It was possibly another remnant of the old group, but too small to be of any consequence. It had disappeared by the 19th. Two or three days before the medium-sized spot became central, I remarked to several of my colleagues that I would not be surprised at auroral display or at least magnetic disturbances after it passed the center. I saw no aurora, the sky was unfavorable, and probably also the time, but on the morning of the 17th telegraph operators noticed a disturbance, which must have been due to the alleged propagation. If so the lag was about one day in this case.

My measurements of the positions of all the spots were made on the sun's disc directly with the micrometer and will yield heliographic latitudes and longitudes of all the points observed, but I have had no time to make the computations. I would wish this communication to be considered as a first approximation to more accurate values.

E. D. Roe, Jr.
Syracuse University,
April 24, 1920

POSSIBLE CONNECTION BETWEEN SUNSPOTS AND EARTHQUAKES

In Monthly Notices of the Royal Astronomical Society for April, 1919, Professor H. H. Turner has discussed data taken from the Catalogue of Destructive Earthquakes compiled by Milne and from the Catalogue of Chinese Earthquakes. He publishes tables of earthquakes extending back to 49 A.D. and refers to old Chinese records dating to 1820 B.C.

From these data he slightly modifies two suspected earthquake periods, first published in the Report of the Seismological Committee to the British Association in 1912. The short period is shown by him to have minor and major limits of 14.8421 and 14.8448 months. The long period is taken as seventy-eight years. His tables show these periods almost certainly as real.

Nine times the limits of the short period give 11.1316 and 11.1336 years. Newcomb has derived the sunspot period as 11.13 years and Larmor and Yamaga as 11.125 years. The chance that this close commensurability is accidental is as the difference, which is less than one one-hundredth of a year, is to the period of about 1.24 years. That is about one in two hundred and fifty.

If the short period is so nearly commensurable the long period must be also. Seven times the sunspot period is 77.91 years, agreeing to 0.09 years with his round figure of seventy-eight years.

It would be interesting in this connection to analyze the counts by months of sunspots through several cycles to find whether there is any evidence of a short-period variation of this length, no matter how small. I hope to be able to do this within the next few months.

DINSMORE ALTER
UNIVERSITY OF KANSAS

SOME MICRO-PLANKTON FROM SALTON SEA

As is generally known Salton Sea is a body of water covering a part of the Imperial Valley in southern California which is 230 feet below sea level, and it is formed by overflow of flood waters, or by waters diverted for irrigation, from the delta of the Colorado River.

On December 16, 1919, Captain W. C. Crandall, of the Scripps Institution for Biological Research of the University of California, Dr. H. C. Bryant, of the California State Fish and Game Commission, and of the museum of vertebrate zoology of the University of California, and Dr. Will F. Thompson, of the California State Fish and Game Commission, started over the recently completed San Diego and Arizona railroad for a four days' biological investigation of Salton Sea.

Captain Crandall made a few plankton catches in Salton Sea and secured a number of water samples, temperatures, etc., besides making some rough physiographic observations. Dr. Bryant found about fifty different kinds of birds. Dr. Thompson's fishing equipment did not get through so he was not able to make the expected studies of fish. It was found, however, that Salton Sea is regularly fished for mullet which reach large size and are found in commercial quantities at present.

Four hauls were made for microplankton in Salton Sea with a fine (Number 25) silk net such as has been in use for some time for marine work. The catches thus made were purely qualitative and were taken at the surface under adverse conditions. One catch indicated a rather abundant microplankton. Catches made at other points showed very little. The presence of the following organisms was noted in a hasty examination of the catches: *Keratella quadrata* (Müller), *Brachionus pala* Ehr., (most of these had female eggs attached), *Anabæna* sp., *Oscillatoria* sp., *Cœlastrum* sp., *Amphiprora alata* Kuetz., *Fragillaria crotonensis* Kitton, *Navicula* sp., and *Surirella* sp.

Physiographic features of Salton Sea are very remarkable. There has been a fairly constant reduction of level at the rate of about one foot per year for some years. Consequent recession of the water has left exposed numerous mud geysers, hot and cold springs, various types of mineral springs and some excellent paint pigments almost ready for use. In the sea itself, near the mouths of its tributaries, it is notable that the water is in two layers, the heavy saline water below and the relatively fresh above. It thus resembles ocean conditions near tributaries.

The primary purpose of this memorandum is to call general attention to the fact that the Salton Sea locality offers extraordinary favorable conditions for continuous studies throughout the year in the lines of physiography, hydrography and biology. Since the microplankton is the biological group which gives the clearest index to biological conditions in water, it would be especially desirable to have that particular phase of biological study carried on. There is probably no other body of water in the world so favorably situated and conditioned for segregation and evaluation of major factors involved. It would be most fortunate for the progress of science in general if a biological station could be established in this region and its work assisted by that of a competent physiographer and hydrographer.

W. E. ALLEN
SCRIPPS INSTITUTION,
LA JOLLA, CALIFORNIA

CONDITIONS IN HUNGARY

TO THE EDITOR OF SCIENCE: I have just received a letter from a professor in Hungary, which should, I think, be shared with the readers of SCIENCE. The writer is one of the leading scholars in that country in his department, and with him for many years prior to the war I have had a most pleasant acquaintance. I know that only real suffering on the part of his friends and himself could have induced him to write this letter, from which I take the following extracts:

. . . "The middle classes are suffering frightfully in the present depreciation of money. Our salaries (which are for the present being paid) seem high according to the figures, but they are insufficient for the purchase of even the ordinary necessities of life. We may, for instance, possibly once a week have a bit of meat, but for the rest of the time we have to rejoice if we can get enough bad bread and vegetables to appease hunger. Sugar is enormously dear and never to be had in sufficient quantities. Clothing we can not buy, for a single simple suit would cost more than a month's salary. It is the same with underclothes and shoes. What our present conditions will lead to in the near future it is impossible to conceive."

. . . "You can imagine it is in the highest degree painful for me to write you such a letter, and only real suffering would justify it."

. . . "While we are suffering in Austria from actual need of food, packages of food sent by individuals in America rarely reach their destination. Money is practically of no value, for there is little food to be purchased with it."

Professor ———, whose name I withhold, writes that the American Relief Administration (whose office in this country is at 115 Broadway, New York), has established an American food warehouse in Vienna, from which food is distributed that has been shipped from this country.

Jas. Lewis Howe

Washington and Lee University,
Lexington, Virginia

JOURNALS FOR PRAGUE

To the Editor of Science: Dr. M. Kojima, surgeon-commander, Japanese Navy, has but now arrived from Tchecho-Slovak where he visited Professor A. Biedl. The latter has sent through him a message to American scientists asking if they can arrange to have sent to him the various scientific publications and periodicals, since he is unable to purchase the same on account of the rate of exchange, lack of funds, and general disturbed conditions in Tchecho-Slovak. It seems to me that the least we can do is to arrange through our editing boards some procedure by which Dr. Biedl may receive current numbers of our scientific periodicals. I would appreciate greatly your giving this communication publicity in "Science." Dr. Biedl's address is Das Institute fur Experimentelle Pathologie, Prag, Tchecho-Slovak.

Frederick S. Hammett

NOTES ON METEOROLOGY

THE SUPPOSED RECURRENT IRREGULARITIES IN THE ANNUAL MARCH OF TEMPERATURE

"The belief that periods of unseasonable heat and cold tend to recur at or about the same time from year to year has prevailed over a great part of the world for many centuries and has been the subject of extensive scientific investigation." This is the opening sentence in an extensive, scholarly discussion of the "Literature concerning supposed recurrent irregularities in the annual March of temperature," by C. Fitzhugh Talman, librarian of the Weather Bureau.[6]

Most of the literature deals with a cold period in May.

Over a considerable part of continental Europe it has been popularly believed since the Middle Ages that destructive frosts were likely to occur at a certain period in the month of May, and with the elaboration of the ecclesiastical calendar these frosts became definitely associated with the days dedicated to Saints Mamertus, Pancras and Servatius (May 11, 12, 13), or, in south-central Europe, Saints Pancras, Servatius and Boniface (May 12, 13, 14), hence known as the "ice saints." . . . With the construction of synoptic weather charts, the barometric conditions that accompany depressions of temperature gradually became apparent. . . . [This cold period] was found to occur when, owing to the rapid warming of the land regions as compared with the ocean, a center of low barometric pressure develops over southeastern Europe while high pressure prevails over the ocean

[6] *Monthly Weather Review*, August, 1919, Vol. 47, pp. 555–565.

to the northwest, a situation that gives rise to cold northerly and northeasterly winds in central Europe. . . . While the immediate causes of these interruptions of temperature has thus been made clear, it is not yet certain whether or to what extent such interruptions, with their attendant barometric conditions tend to recur from year to year on certain dates, such as the days of the ice saints. Irregularities in a curve showing the mean annual march of temperature as deduced from a record of 50 or 100 years may be due to excessive departures in particular years rather than to a real tendency to recurrence on particular dates, and, on the other hand, a tendency to recurrence might not manifest itself in the mean curve, especially, if as some students have surmised the phenomenon is one that undergoes periodic fluctuations.

Bearing on this question is a mathematical discussion by Professor C. F. Marvin, entitled, "Normal temperatures (daily): are irregularities in the annual march of temperature persistent?"[7] Average annual temperature curves based on the averages of the means of each week over a period of years, may be well-covered mathematically in a curve of one or two harmonics. The residuals, which in a given period are much the same over a large part of the eastern United States, are mostly due to some extreme departures occurring in a single year of the record: which throws doubt on the existence of recurrent irregularities.

Professor Marvin's mathematical analysis of only 15-year averages shows that it is possible to get a surprisingly accurate, smoothed, normal annual temperature curve from a short record.

NOTES

The *Monthly Weather Review*[8] contains so much material that these occasional notes in Science have by no means covered even a majority of the 150 contributions, not to mention hundreds of abstracts and other items of meteorological interest, published during the past year. For a brief summary and mention of many of the important contributions published during 1919, and the reader is referred to the American Year Book; and for the articles and notes themselves, to the *Monthly Weather Review* files maintained at all Weather Bureau stations, and at a few hundred college, university and public libraries.

[7] *Ibid.*, pp. 544–555, 4 plates, fig.

[8] Government Printing Office, Washington, D. C., printed for the Weather Bureau.

Hereafter, these notes on meteorology and climatology for Science will be continued by Mr. C. LeRoy Meisinger, assistant editor of the *Monthly Weather Review*.

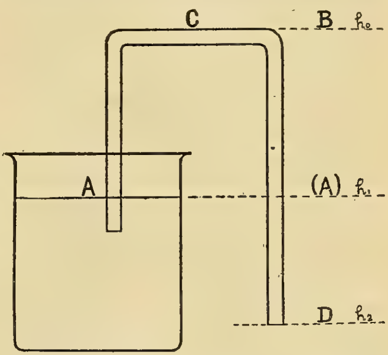
Charles F. Brooks

Washington, D. C.

SPECIAL ARTICLES

THE SIPHON IN TEXT-BOOKS

The treatments commonly accorded to the siphon in text-books of physics of college grade may be classified in three groups. I have attempted to reduce the characteristic features of each group to a typical or stand-



ard form. There is no intention to quote and italics are strictly mine. Reference is made to the diagram, which will serve in common for the three methods of treatment.

I. The pressure at A is the resultant of an *upward* pressure equal to the atmospheric pressure and a *downward* pressure due to the column of liquid AB. The pressure at D is the resultant of an *upward* pressure equal to the atmospheric pressure and a *downward* pressure due to the column of liquid DB. As DB is greater than AB, the resultant pressure *upward* at A is greater than that at D. The liquid *must therefore flow* from A to D.

It is evident from this discussion that a siphon can not operate if AB is greater than the barometric height for the liquid in question.

II. If we consider the pressures *acting at C* we will find that the pressure *toward D* is the atmospheric pressure minus the pressure represented by a column of liquid AB, while the pressure *toward A* is the pressure of the atmosphere less the pressure represented by the column of liquid DB. The resultant pressure is therefore *toward D, determining a flow* in that direction.

It is evident from this discussion that a siphon can not operate if AB is greater than the barometric height for the liquid in question.

III. The end D being closed, and the siphon filled, the pressure at D will exceed atmospheric pressure by an amount represented by the column of liquid DA, since all points at the level of A are now at atmospheric pressure. Upon opening D this excess pressure causes the flow, and the atmospheric pressure at A keeps the tube filled.

It is evident from this discussion that a siphon can not operate if AB is greater than the barometric height for the liquid in question.

The refrain with which each treatment concludes is a noteworthy element of uniformity, to be considered below. Special features of criticism are as follows.

I. Pressure at a point within a body of fluid is not upward or downward, to left or to right, north, east, south or west. It is without direction.

The pressure at A, whether inside the tube or outside, and whether the siphon be flowing or not flowing, is never greater than the pressure at D.

The flow of a liquid between two points does not necessarily take place from high to low pressure. See the discussion below, based on Bernoulli's principle, of this particular case.

II. As above stated, pressure in a body of fluid is without direction. The pressure at C is neither toward A nor toward D, and certainly does not have unequal components in these two directions.

III. Except the concluding refrain, this treatment correctly represents the facts, and shows at least why the siphon ought to start flowing. Curiously enough, Bernoulli's principle and the law of diminution of potential energy having been known for a long time, little attempt is made to show what happens, and why, when the siphon is actually working, the discussions being chiefly hydrostatic.

If we assume that the siphon gives an example of steady frictionless irrotational flow of an incompressible fluid, an assumption probably justified as a first approximation, we can apply Bernoulli's principle.

Then, for any given stream tube

$$p + hdg + \tfrac{1}{2}dv^2 = \text{constant},$$

in which p represents fluid pressure, h height above any assigned zero level, g acceleration of gravity, d density of the fluid, and v the speed with which it is moving.

Considering now the siphon when in steady flow, and assuming the reservoir indefinitely large, we find that the stream lines begin at the free surface, widely spread, the liquid flowing here at a speed approaching zero; converge into the orifice of the short limb, with much increased speed; traverse the entire length of the tube, supposed of uniform cross section, without change in speed, and that the stream emerges finally at this speed.

At the surface A *outside the tube* the pressure is atmospheric. Inside the tube it is less than atmospheric, for the stream has gained speed at the same level. As the stream ascends, at uniform speed, the pressure diminishes continuously, the least pressure being reached at the highest point. Descending, at constant speed, the pressure increases until at the lower orifice D the pressure is once more atmospheric, and the stream emerges in pressure equilibrium with the air surrounding it.

Taking a stream tube beginning at surface A outside the tube, and ending at D we have

$$p_1 = p_2 = P \text{ (atmospheric pressure)},$$

$$v_1 \doteq 0,\ v_2 = V \text{ (constant speed through tube)},$$

and applying Bernoulli's principle

$$P + h_1 dg = P + h_2 dg + \tfrac{1}{2} dV^2,$$

whence

$$V^2 = 2g(h_1 - h_2) = 2g\overline{DA},$$

which expresses a simple interchange of potential and kinetic energy, corresponding strictly with the facts upon the assumption that the operation is frictionless.

It will be easy to express the reduced pressure at the level A, inside the tube, by comparing two points at level A, one outside, the other inside

We have, outside

$$p_1 = P \quad v_1 \doteq 0,$$

inside

$$h_1' = h_1 \quad v_1' = V,$$

and thus

$$p_1' + h_1' dg + \tfrac{1}{2} dV^2 = P + h_1 dg,$$
$$p_1' = P - \tfrac{1}{2} dV^2,$$

but

$$\tfrac{1}{2} dV^2 = dg(h_1 - h_2);$$

therefore

$$p_1' = P - dg(h_1 - h_2).$$

We can now discuss the invariable refrain or *coda* found in all the type treatments. It appears to be based upon the assumption that a liquid can not exist with a negative pressure, or as sometimes expressed, under tension. This is hardly true; there is considerable experimental evidence to the contrary. Let us make this assumption, however, and limit the working height of the siphon to that which makes the pressure zero at the highest point.

Comparing points C (at level B) and D we have

At C

$$p_0 = 0,\ v_0 = V.$$

At D

$$p_2 = P,\ v_2 = V.$$

$$h_0 d g + \tfrac{1}{2} dV^2 = P + h_2 dg + \tfrac{1}{2} dV^2;$$

whence

$$(h_0 - h_2) dg = P.$$

Now $h_0 - h_2$ is the difference in level between D and B, which is thus shown to equal the barometric height for the given liquid, in the assumed limiting case. The ordinary statement asserts that AB equals the barometric height in the limiting case, the loss of pressure at A inside the tube being overlooked, and the concept being hydrostatic rather than hydrokinetic.

This discussion is not original in substance; see some good treatises on hydrodynamics.

Harold C. Barker

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

The seventy-second meeting of Section E (Geology and Geography) of the American Association for the Advancement of Science was held in the Soldan High School building in St. Louis, Mo., on December 30 and 31. In the absence of Professor Charles Kenneth Leith, the vice-president elect of Section E, Dr. David White, chief geologist of the U. S. Geological Survey, was voted chairman for the St. Louis meeting, and presided.

The address of the retiring vice-president, Dr. David White, upon the subject, "Geology as Taught in the United States," was given on the morning of December 31 in the main auditorium, before a joint session of the Association of American Geographers, the American Meteorological Society, and Section E. This address will be printed in full in Science.

The vice-president of Section E for the coming year will be elected by the executive committee at its meeting in April. Dr. Nevin M. Fenneman, of the University of Cincinnati, was elected member of the council.

The program which was so full that each session overran the allotted time, comprised the following papers:

The origin of glauconite: W. A. Tarr. Glauconite is a hydrous silicate of iron and potash. The composition is variable, but the amount of potash rarely exceeds 8 per cent. The mineral is amorphous, and is usually some shade of green. It occurs as rounded grains and irregular areas in dolomites, limestones, conglomerates, marls, sandstones and shales. It is found in the Cambrian formations of Missouri, Oklahoma, Texas, South Dakota and Wyoming, and in the Cretaceous and Eocene formations along the Atlantic and Gulf coasts. Geographically and geologically, glauconite is associated with granites, usually being deposited after a period of base leveling, when weathering had been proceeding a long time. This long-continued weathering is thought to have furnished colloidal silica, iron, potash and alumina to the sea water, where through the action of the saline matter in the sea water the silica and alumina were precipitated, while the iron was thrown down by oxidation. These colloids mingled in varying amounts and then absorbed the potash from the sea water, thus forming glauconite.

A Mauch Chunk Island in the Mississippian Seas of eastern Kentucky: WILLARD R. JILLSON, state geologist of Kentucky, Frankfort, Kentucky. In the eastern Kentucky coal fields on the divide between the Licking River and the Levisa Fork of the Big Sandy River, there exists an elongated structurally elevated area of between 700 and 1,000 square miles. This structural high has been called the Paint Creek uplift and is located so as to overlap parts of Magoffin, Morgan, Elliott, Lawrence, Johnson and Floyd counties. The Paint Creek uplift has a slight east of north major axis as mapped structurally on the Pottsville Fire-Clay coal. The normal dip at the surface is slightly to the south of east. The Paint Creek uplift culminates in two pinnacles, the Paint Creek Dome and the Laurel Creek Dome. There exists a maximum reversal of about 250 feet. The considerable amount of oil and gas prospecting drilling on these structures during the past two years has resulted in defining two pronounced oil and gas fields, one on either dome. Production is secured principally from the Weir sand which correlates with the Cuyahoga sandstone in the Waverley group toward the base of the Mississippian system. An examination of the well records of recent drillings in this locality shows an increasing interval between the Fire Clay coal of the Pottsville and the Big Lime (St. Genevieve-St. Louis) of the Mississippian, as one proceeds away from the highest structural points.

A summary conception of the structure of the Weir sand shows it to be much more steeply tilted than the persistent coals of the surface Pottsville. The absence of expected thicknesses of the Mauch Chunk on the top of this structure and the thickness of the Pottsville and Mauch Chunk on the sides coupled with the steeper inclinations of the Weir sands suggests an anticlinal island in the Mississippian seas at this point during the latter part of the Mauch Chunk period with unconsolidated Mauch Chunk sediments, subjected to subaerial erosion. Following early Pottsville times, quiescent subsidence is conceived to have taken place, which was followed during the time of the Appalachian overthrusts by folding and faulting along, and transverse to, the major axis of the original Mississippian anticline.

A Geological Section from St. Louis to Kansas City: E. B. BRANSON.

The Pre-Moenkopi unconformity of the Colorado plateau: C. L. DAKE. The area over which the unconformity was studied embraces the region from the Zuni uplift in New Mexico west to the Little Colorado River in Arizona, and northwest to the vicinity of the Henry Mountains in Utah. Sudden changes in the thickness of the Moenkopi amounting to two hundred feet or more, in short distances, show local erosion of at least that magnitude during the pre-Moenkopi erosion interval. Data gathered by the writer tend strongly to confirm a hypothesis advanced by Cross that the Permian rests on progressively younger beds as the unconformity is traced westwards, the erosion amounting perhaps to all the Kaibab, the Coconino and the Supai formations. In other words the Moenkopi Red beds rest on the Kaibab formation in the area about the Grand Canyon and probably west of the Henry Mountains, while farther east they rest on the Goodridge (correlated by Girty with the Redwall) in the San Juan region, and probably on equivalent beds near Moab. This would involve the erosion of approximately two thousand feet of Pennsylvanian strata in the eastern portion of the area under discussion, the equivalents of which are present farther west. This conclusion, if true, would place the pre-Moenkopi unconformity among those of larger significance in geologic history.

Notes on the geology of the Cove areas of east Tenesese: C. H. GORDON, University of Tennessee, Knoxville. Within the western foothills of the Unaka or Great Smoky Mountains in east Tennessee are a number of irregular open valleys known locally as "coves." The largest of these is Tuckeleeche Cove on Little River. Wear Cove to the northeast and Cades Cove on the southwest are about half as large. The coves are underlaid by the Knox dolomite uplifted in broad irregular domes with the overlying Wilhite slates outcropping in broad irregular bands around them. The more fertile soils of the coves early attracted settlers and each is now the locus of a prosperous settlement. This and the region to the southwest is the typical region of Safford's Ocoee rocks consisting of sandstones, conglomerates and slates more or less metamorphosed. These rocks were placed by Safford in the Cambrian a reference at first questioned by the government geologists but afterwards accepted. In this area the Ocoee slates overlie the Knox dolomite the larger part of which is Ordovician. These relations indicate, therefore, the presence here of a great overthrust fault whereby the lower Ocoee rocks have been thrust over the Knox dolomite to the distance of eight or ten miles. Two periods of faulting are recognized in the region, the first of which is recorded in the above-mentioned overthrust of the Cambrian upon the Knox. Later came another stage of folding and faulting in which the faults of the first period were involved giving rise to complex structures not always easily decipherable. It was during this second period of movement that most of the great faults of the valley were produced.

The Oriskany sandstone faunule at Oriskany Falls, New York: Harry N. Eaton. The type locality of the Oriskany sandstone is at Oriskany Falls, in the southern part of Oneida county, New York, where a lower Devonian section is exposed. This occurrence has been known in the literature since 1839 when Vanuxem noted it in his state survey report. Structurally, the sandstone is a small lens, ten feet thick, whose southern edge only can be observed. The faunal list is interesting chiefly because it is larger than formerly supposed, and as showing relations to other faunules in New York and Ontario. This study was incidental to more detailed work on the Oriskany in another New York locality.

Salem limestone outliers in central Missouri: Courtney Werner.

Geology of the Sullivan county, Indiana, oil field: Stephen S. Visher. Approximately 30 miles south of Terre Haute, and only a few miles from the Illinois boundary, there are seven producing oil pools aggregating in area about 12 square miles. About 500 wells are being pumped. The daily production was recently about 1,000 barrels. No report on the geological conditions in this oil field has been published. A study carried on recently under the direction of State Geologist Logan, has revealed several interesting facts. Production is from four sands. The highest of these, at a depth of approximately 620 feet, seems clearly to be along the unconformity between the Allegheny and the Pottsville divisions of the Pennsylvania Formation. The three lower sands are in the Mansfield division of the Pottsville. The second sand is about 660 feet below the surface; the third about 740 and the fourth about 800 feet. The presence of more than one oil sand has not been recognized by most drillers. Many wells have been abandoned only a few feet above a sand in which wells not far away obtain profitable production. No proof of local folding or doming was obtained. The evidence at hand indicates that the oil pools are lenses of sand along the buried valley of an ancient aggrading river or rivers. The Indiana Geological Survey is publishing the full report.

The late Pleistocene submergence in the Columbia River valley: J. Harlen Bretz.

The latest glacial features in the United States: Herman L. Fairchild. These features are depicted on maps of a forthcoming Bulletin of the New York State Museum, proofs of which are here exhibited. The locality is the north boundary of New York. Here, on the point of the northern salient of the Adirondack mass the waning Quebec (Labradorian) glacier made its last stand on American territory with the effect of impounding glacial waters. Probably the ice sheet abandoned northern Maine somewhat later. The extinction features of Lake Iroquois, the last and most interesting of the long series of glacial waters, lie here; these being the second outlet channel through Covey pass and the shoreline phenomena on the west. On the Champlain side of the highland are the remarkable denuded rock areas and channels produced by the latest glacial drainage held to high levels by the Champlain lobe of the wasting glacier. Beneath these glacial stream features on the east side of the salient, and the Iroquois shore on the west side, lies the shore of the sea-level waters, which had followed the receding ice front up the Hudson-Champlain valley. This "marine" shore, strongly marked by heavy cobble bars and deltas, curves around the north end of the salient (Covey Hill) and passes back into New York north of Chateaugay village. At Covey pass the Iroquois plane is to-day 1,030 feet altitude, and the marine beach is 740 feet. The difference, 290 feet, is the altitude of Lake Iroquois at the time of its down-draining into the Champlain Sea, which figure is the master key to the quantitative study of land deformation in the Ontario-St. Lawrence valley.

Springfield, Missouri and the frontier of 1820: Lewis F. Thomas. About 1820 white settlers began to move into the Osage county of Missouri and settle in the more favored localities. One of these was the site of Springfield, which on account of a favorable combination of natural advantages outstripped all the other settlements. An abundant supply of sparkling water and a magnificent stand of walnut and oak timber determined the location of the cabins and stores. The near by grass lands were easily broken by the plow into fertile fields or left as open range lands for cattle. The greatest advantage was the location of the settlement, situated as it was on the broad undulating surface of the White-Osage River divide where an old north-south Indian trail intersected an east-west White River trail. These trails passed through the stages of road and pike to railroad. Back and forth over them moved the settlers and freight which gave life to the city and made it the social, political, manufacturing and commercial center of southwestern Missouri. Thus Springfield has been from the beginning of settlement a densely settled population outlier in the sparcely settled Ozark region.

The Chester series in Illinois: Stuart Weller. The original section of the Mississippian formation is that along the Mississippi River in Iowa and Illinois. The upper portion of this section constituting the "Chester Group" of Worthen is typically exposed in southern Illinois. This succession of strata is now considered to be of *Series* rank, and the upper Mississippian is now called the Chester Series, while the name Iowa Series is suggested for the lower Mississippian. In the course of detailed mapping in southern Illinois, in progress since 1911, the Chester Series has been subdivided into sixteen distinct formational units. In the more complete section, as exhibited in Pope and Johnson counties, these formations are alternately sandstone and calcareous members, the calcareous members being made up of considerable amounts of shale interbedded with limestone. The names used for these formations are as follows: *Upper Chester*—16, Kinkaid limestone; 15, Degonia sandstone; 14, Clore limestone; 13, Palestine sandstone; 12, Menard limestone; 11, Waltersburg sandstone; 10, Vienna limestone; 9, Tar Springs sandstone. *Middle Chester*—8, Glen Dean limestone; 7, Hardensburg sandstone; 6, Golconda limestone; 5, Cypress sandstone. *Lower Chester*—4, Paint Creek limestone; 3, Yankeetown formation and Bethel sandstone; 2, Renault limestone; 1, Aux Vases sandstone. The limestone members of this series of formations, with the possible exception of the Vienna, exhibit a continuous distribution across the state from Hardin county at the southeast to Randolph and Monroe counties at the northwest, but most of the sandstones are not continuously present. The Aux Vases sandstone has its greater development in the Mississippi River section and thins out to the southeast, being very certainly wanting in the section east of Union county. The Bethel, Cypress, Hardensburg and Tar Springs sandstones have their great development in the southeast and are either wanting in the Mississippi River section, or are represented by more or less discontinuous, thin beds. The Waltersburg sandstone has its great development in Pope and Johnson counties and thins out both to the east and the west. The Palestine and Degonia sandstones are about equally developed across the entire Chester area in the state.

Correlation of the Upper Paleozoic rocks of the Hueco Mountain region of Texas: J. W. Beede.[1] Three great groups of rocks, the Mississippian, Pennsylvanian and Permian, each separated from the beds beneath them by unconformity, are represented in the Hueco region of Hudspeth county, Texas. The Mississippian is composed of some 500 feet of limestones and shales, and is referred to the Chester Group by Weller. Eleven hundred feet of Magdalena beds composed of limestones and marls represent the Des Moines Group of the Pennsylvanian system. The Manzano Group corresponds to the Wichita beds of central Texas and the Neva limestone to Summer Series of Kansas. The Abo sandstone of New Mexico appears to be wanting at localities studied; but belongs to Upper Pennsylvanian system. These beds are followed by strong unconformity carrying 100 feet of foreign conglomerate which cuts diagonally across the upper beds and the Diablo plateau to the northern Salt Flat. It is followed by part of the Leonard formation and farther south the Word formation comes in. This unconformity appears to be the one at the base of the Leonard formation in the Glass Mountains which extends from Salt Flat southwest to the Hueco and southeast to the Glass Mountains. From there northeastward to eastern Coke county and Red River, and probably into Kansas. It is the surface on which the Double Mountain beds were deposited.

The Devonian rocks of southwestern Illinois: T. E. Savage. The Devonian rocks in the lower Mississippian embayment have an aggregate thickness of nearly 1,000 feet. Of these, a thickness of more than 800 feet occur in southwest Illinois. In this state these rocks do not extend as far north as St. Louis, and their outcrops are restricted to

[1] Published by permission of the director of the Bureau of Economic Geology and Technology, University of Texas.

a belt a few miles wide near the Mississippi River. In this succession of strata all of the series, or larger divisions, of the Devonian system recognized in the New York section are present, as shown in the following table of formations:

Devonian formations present in southwest Illinois:

Upper Devonian.
- Chautauquan series.
  - Mountain Glen shale, 45 feet.
- Senecan series.
  - Alto formation, 90 feet.

Middle Devonian.
- Erian series.
  - Lingle limestone, 90 feet.
  - Misenheimer shale, 35 feet.
- Ulsterian series.
  - Grand Tower limestone, 125 feet.
  - Dutch Creek sandstone, 30 feet.
  - Clear Creek chert, 300 feet.

Lower Devonian.
- Oriskanian series.
  - Rocks of this age are not known to occur in the state, but they are present farther northwest in Missouri; and farther southeast, in western Tennessee. Remnants are probably present in Illinois, but concealed beneath younger strata.
- Helderbergian series.
  - Back-bone limestone, 65 feet.
  - Bailey limestone, 100 feet.

Rollin T. Chamberlin,
Secretary

(*To be continued*)

THE AMERICAN GEOPHYSICAL UNION

The first annual meeting of the American Geophysical Union was held in the forenoon of April 23, 1920, at the offices of the National Research Council in Washington. At this meeting the permanent organization of this body was completed, amendments to its statutes were adopted, by-laws were enacted, officers of the Union were elected and the elections of officers of the sections conducted by mail ballot were ratified.

Reports were submitted by the American officers of the sections of the International Geodetic and Geophysical Union describing the progress made in the organization of these international sections. A report was submitted from the acting executive committee covering the work of preparation for the annual meeting.

A brief exposition was given of the status and functions of the American Geophysical Union, on the one hand, in relation to the parent bodies, the International Research Council, the National Research Council and the International Geodetic and Geophysical Union, and on the other, in relation to the branches of science embraced under the term "geophysics" and specifically included in the sections of the union.

For each of the sections addresses were made by the chairman, setting forth in outline various problems of interest to the sections. These addresses constituted brief surveys of the research needs of the various branches of geophysics. They will be prepared for publication and issued at a later date.

Officers were elected to serve from July 1, 1920, as follows: American Geophysical Union: *Chairman*, Wm. Bowie for two years; *Vice-chairman*, L. A. Bauer, for two years; *Secretary*, H. O. Wood, for three years; Section (*a*), Geodesy; *Chairman*, Wm. Bowie, for two years; *Vice-chairman*, J. F. Hayford, for two years; *Secretary*, H O. Wood, for three years; Section (*b*), Seismology; *Chairman*, H. F. Reid, for two years; *Vice-chairman*, J. C. Branner, for two years; *Secretary*, H. O. Wood, for three years; Section (*c*), Meteorology, *Chairman*, C. F. Marvin, for two years; *Vice-chairman*, W. J. Humphreys, for two years; *Secretary*, A. J. Henry, for three years; Section (*d*), Terrestrial Magnetism and Electricity, *Chairman*, L. A. Bauer, for two years; *Vice-chairman*, W. F. G. Swann, for two years; *Secretary*, J. A. Fleming, for three years; Section (*e*), Physical Oceanography; *Chairman*, G. W. Littlehales, for two years; *Vice-chairman*, tie vote, no election; *Secretary*, J. T. Watkins, for three years; Section (*f*) Volcanology; *Chairman*, H. W. Washington, for two years; *Vice-chairman*, R. A. Daly, for two years; *Secretary*, H. O. Wood, for three years.

Harry O. Wood,
Secretary

THE NATIONAL ACADEMY OF SCIENCES

The program of the scientific sessions of the annual meeting, held in Washington on April 26 and 27, was as follows:

MONDAY, APRIL 26

Morning Session

Conservation of natural resources as a proper function of the National Academy: John M. Clarke.

On the rate of growth of the population of the United States since 1790 and its mathematical expression: Raymond Pearl.

Growth and development as determined by environmental influences: Franz Boas.

Plural births in man: Charles B. Davenport.

Dynamical aspects of injury, recovery and death: W. J. V. Osterhout.

The importance of the presence of both sympathetic superior cervical ganglia to the maintenance of life; and their possible relations to respiratory diseases: Samuel J. Meltzer.

The National Research Council: James R. Angell.

A psychological study of the medical officers in the Army: Robert M. Yerkes.

Afternoon Session

Spectroscopic phenomena of very long vacuum tubes: Robert W. Wood.

The measurement of small time intervals and some applications, principally ballistic (introduced by Arthur G. Webster): L. T. E. Thompson, C. N. Hickman and N. Riffolt.

The effect of molecular structure upon the reflection of molecules from the surface of liquids and solids: Robert A. Millikan.

The Springfield rifle and the Leduc formula: Arthur G. Webster.

On the internal ballistics of the Springfield rifle: Arthur G. Webster.

The 100-inch Hooker telescope of the Mt. Wilson Observatory: George E. Hale.

The vertical interferometer: Preliminary tests in an attempt to measure the diameter of the stars; A modification of the Foucault method adapted to long-distance measurement of the velocity of light: A. A. Michelson.

Preliminary measurements on the pressures in the "Onde de Choc": Arthur G. Webster.

On the specific heat of powder gases: Arthur G. Webster.

Thermal conductivity of metals: Edwin H. Hall.

Evening Session

The scale of the universe: Harlow Shapley, Mount Wilson Solar Observatory, and Heber D. Curtis, Lick Observatory (open to the public). U. S. National Museum (main auditorium). (William Ellery Hale Lectures.)

TUESDAY, APRIL 27

Morning Session

Distribution and villages of the Indian tribes of the Klamath River region, California: C. Hart Merriam.

Significance of correlation in function between the dentition and skeleton of the Sabre-tooth tiger: John C. Merriam.

On the colonial nervous system of Renilla: George H. Parker.

The genus Botrychium and its relationships: Douglas H. Campbell.

The influence of cold in stimulating the growth of plants: Frederick V. Coville.

Some common foods as sources of vitamines: Thomas B. Osborne and Lafayette B. Mendel.

The physico-chemical properties of hæmoglobin: Lawrence J. Henderson.

The direct combination of nitrogen and chlorine: William A. Noyes.

Valance and chemical affinity: Gilbert N. Lewis.

Afternoon Session

Shock of water ram in pipe lines with imperfect reflection at the discharge end and including the effect of friction and non-uniform change of valve opening: William F. Durand.

Recent notable progress in the theory of numbers: Leonard E. Dickson.

Geodesics and relativity: Edward Kasner.

The use of alternating currents for submarine cable transmission (introduced by G. O. Squier): F. E. Pernot.

Improvements in telegraphy: George O. Squier.

The air resistance of spheres: Lyman J. Briggs.

The possibilities of the rocket in weather forecasting: Robert H. Goddard.

The distribution of land and water on the earth: H. Fielding Reid.

The alterations of limestones in contact-metamorphism: Waldemar Lindgren.

Structure of Marrella and allied middle Cambrian crustaceans: Charles D. Walcott.

On a single numerical index of the age distribution of a population (by title): Raymond Pearl.

Biographical memoir of George Jarvis Brush (by title): Edward S. Dana.

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

LOCAL ANESTHETICS[1]

SINCE earliest times, those who have resorted to surgery for the relief of their fellow creatures, have desired to mitigate their procedures by the exclusion of pain. Generally speaking, this has been brought about by a complete abolition of consciousness, whence the term *anesthesia* ("without sensation").

To those cases in which sensation is removed by the application of a drug only at the point of operation is applied the term *local anesthesia;* substances used for this purpose are termed local anesthetics. Some authorities consider this designation inaccurate because during the employment of these substances consciousness is fully retained. They might therefore be described as local *analgesics* ("without pain") but the other term has the sanction of usage.

Historians cite abundant instances of the employment in ancient times of general anesthesia, the oldest being a case of removal of a rib. For this purpose we are told that "the Lord God caused a deep sleep to fall upon Adam," the patient. The commonest of the age-old general anesthetics are alcohol opiates and mandragora, all of which were given separately or mingled with other ingredients.

Local anesthesia, on the other hand, was attempted with comparative infrequency before the last century. Perhaps the earliest authentic description of an approach to this method is that which emanates from the school of Salerno,[2] in the twelfth century. In those days was practised a form of general anesthesia by causing the patient to inhale the vapors of so-called "soporific sponges," the chief ingredients of these being poppy, hen-

[1] Lecture given before the Brooklyn Institute of Arts and Sciences, February 7, 1920.

[2] Cited by Husemann, *Deutsch. Zeitschr. f. Chirurgie,* 1896, 42, 585.

bane and mandragora. As moist poultices the same substances were sometimes laid upon the area where cutting, burning, or some other surgical procedure was to be done. We are told that sensation was thus removed and no pain experienced, but the instance must be assigned with great caution to the category of local anesthesia. The abolition of pain may have resulted only after absorption of these drugs into the circulation, by which means if carried to the brain in sufficient quantity they would, by their central action, produce general stupefaction. From what we know of the action of these substances the remote rather than the local action would be expected. From among such old-time local applications there has come down to us "lead and opium wash," but modern pharmacologists are most skeptical as to the efficiency of opium applied externally.

Prior to the school of Salerno, it is known, of course, that oils and salves were frequently applied to wounds and other painful areas. For example Dioscorides refers to the employment as an eye lotion, of rose oil, a substance about which we shall have more to say later. Of the use of local applications during actual surgical procedure in those days I am aware of no direct evidence.

Many writers refer to the Memphis Stone, of which the oldest descriptions are those of Dioscorides and of Pliny, neither of whom apparently saw it used. Husemann cites conflicting descriptions of its mineralogy. It was called blunt, thick, the size of a pebble; a soft black and hard white variety were aplied to the forehead to relieve headache, while an ash-gray variety was said to be of value for snake bites. This talisman and panacea according to both Dioscorides and Pliny was of Egyptian origin and was used to produce local anesthesia, for which purpose it was sometimes powdered and mixed with vinegar. In view of the fact that it was described as a variety of marble the untenable hypothesis has been suggested that the local anesthetic effect was the result of the evolution of carbon dioxide from this mixture when applied to the area of operation.

A second local anesthetic of Egyptian origin and referred to in the sixteenth century by a Dutch physician, Ronsseus, was crocodile fat. In a Latin poem, "Venatio Medica," this author tells us that crocodile fat and a salve of oil and burnt lizard skin were efficient as local anesthetics if applied before cutting or burning.

In the seventeenth century, we are informed of the use of another method of producing local anesthesia, namely the application of cold (for example, by ice and salt mixtures). This was practised by Thomas Bartholinus, who learned it apparently from a distinguished Danish physician, Marc Aurelio Severino. Modern developments of this include the employment of ethyl chloride and other substances of very low boiling point to freeze the skin for minor operations.

The story of modern local anesthetics begins with the isolation in 1860, by Niemann in the laboratory of the German chemist, Wöhler,[3] of the alkaloid cocaine. From Lima, had been brought the leaves of *erythroxylon coca,* a plant which had for years attracted the attention of travelers in Peru and Bolivia on account of its widespread use by the natives as a stimulant. The plant, native to the slopes of the Andes, is a shrub attaining a height of about six feet, with bright green leaves, similar in size and shape to those of tea, which are rapidly replaced when picked. The annual consumption of these leaves in South America is now estimated at one hundred million pounds.

The "coqueros" or chewers of coca leaves had ascribed wonderful properties to them, not only of abolishing hunger, fatigue, bodily discomfort, etc., but also of psychic stimulation of various sorts. When put to the test in Europe these claims were but poorly substantiated owing, according to some, to deterioration of the properties of the leaves in transportation, but probably more to a difference in the subjective conditions of the test; that is, the European investigators were probably neither as hungry and fatigued nor con-

[3] Wöhler, F. W., *Ann. der Chem. u. Pharm.*, 1860, 114, p. 213.

stitutionally as emotional as the "coqueros." Nevertheless sufficient nervous stimulation is derived to render cocaine a dangerous habit-forming drug.

After the manner of chemists with a new product, Wöhler tasted cocaine and noted (to translate literally), that "it is bitter and exerts upon the tongue nerves a characteristic effect in that the point touched becomes temporarily numb, almost without sensation." Twenty-four years elapsed before the significance of this finding was fully appreciated; Koller, a Viennese oculist, in 1884 introducing it as a practical local anesthetic for the eye. In the meantime, however, Parisian workers had noted anesthesia of the tongue when the leaves were chewed with alkali (De-Marle, 1862); and Moréno y Maiz (1868), had suggested the employment of the drug as a local anesthetic. A number of fundamental pharmacological facts about cocaine were demonstrated by Von Aurep[4] (1880).

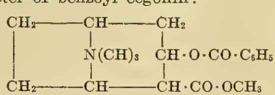
From the eye clinic the use of the drug spread to laryngology and rhinology and later to general surgery. As it is typical of a large class of local anesthetics its action may now be somewhat more fully detailed.

Cocaine is classed as a "general protoplasm poison," since relatively small amounts exhibit the power to interrupt or suppress the life process both of lower and higher organisms. In mammals it attacks nerve tissue in particular and there are acute and chronic types of brain poisoning, the latter, of course, being illustrated in the widespread abuse of the drug. Acute poisoning (motor excitement and high temperature followed by convulsions) has been noted in all attempts at anesthetization of animals by intravenous injection or other means of introducing the drug into the general circulation. The local or peripheral action can not be obtained by such methods.

The portions of the nervous system upon which the action is useful are the nerve trunks and their sensory endings, and as may be judged from the above, one problem of the surgeon is to keep the substance limited as far as possible to these regions. On the nerve trunks it has a selective action in blocking afferent or sensory impulses much more readily than efferent or motor impulses, both of which are carried by the same bundle of nerve fibrils. Its selective action is further illustrated by the abolition, upon application to the nerve ends, of pain and touch sensations, while the perception of heat and cold remains uninterrupted. Again, on the tongue, in addition to touch and pain, the perception of "bitter" taste is completely eliminated, yet those sensations which we describe as "sweet" and "acid" taste are still dimly perceived, while the presence of salt may still be appreciated as well as ever.

That cocaine is not an ideal local anesthetic can be readily appreciated. Aside from its disadvantages as a habit-forming drug and the possibility of the development of toxic symptoms if unskillfully employed, there are minor objections which include the possibility of injury to the tissues or interferences with natural processes of repair if given in too concentrated a solution and the fact that solutions if sterilized by boiling undergo some decomposition.

Since these facts began to receive attention the production and testing of synthetic substitutes for cocaine has been a nearly continuous performance. As the structural formula of the alkaloid shows, it is the methyl ester of benzoyl ecgonin:



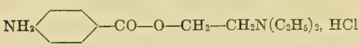
Cocaine

Its decomposition products are methyl alcohol, benzoic acid and the tropine-like base ecgonine. Investigations by Filehne, Paul Ehrlich, and others, were undertaken to determine in which of these chemical groups or in what combination of radicals the anesthetic virtues resided. The benzoic acid radical was soon indicated as being of importance; for example, neither ecgonin nor methyl ecgonin were found at all like cocaine in their action. On the other hand the isomer of cocaine in which the methyl and benzoyl radicals were

[4] Von Anrep, B., *Pflüger's Archiv. der Physiologie*, 1880, 21, 38.

made to exchange places, exhibited no local anesthetic properties; when, however, the benzoic acid radical was replaced in the cocaine structure by other homologous acids, substances with cocaine-like action were evolved.

Einhorn, who had earlier been associated with Ehrlich's work, introduced as a local anesthetic orthoform. This is the methyl ester of an oxy-benzoic acid modified by the introduction of an amino group to replace the very complicated base ecgonine. This substance, while poorly soluble, has found a place in surgery as an anesthetic dusting powder. Einhorn[5] next modified the orthoform grouping in such a way as to produce more soluble compounds, but achieved his greatest success by the introduction of the "alkamine" esters of benzoic acid, notably procaine (known also by the trade name of novocaine):



Procaine.

In other synthetic compounds (stovain, alypin, and B-eucaine), no amino group appears on the benzene nucleus. In still another series of compounds, the benzoyl group has by an intervening side-chain been attached to the nitrogen of the ecgonine molecule. This work was reported recently by Wichura[6] (1918) and one of the compounds, apparently giving promise, is known as eccain.

Another natural alkaloid has been obtained from the small coca leaves of Java. This substance, tropacocaine, was found by Dr. Arthur P. Chadbourne[7] (1892), of Boston, to possess valuable anesthetic properties. Similar in structure to cocaine (of which it is in many ways the equal) it contains pseudotropine in place of the ecgonine radical.

In the group of antipyretic drugs also are found substances of value as local anesthetics, although these are chemically quite unrelated to cocaine. Among them are holocaine, a phenacetin derivative, and quinine, which is used in combination with urea. In 1913, Morgenroth showed that certain quinoline derivatives have a similar action, including a group of substances which also give promise of a specific value in the treatment of pneumonia. Antipyrine may be included in this and in the following group.

In 1888, Liebreich[8] called attention to the fact that a large number of substances are capable of producing "anesthesia dolorosa." This term is applied to the phenomenon of smarting followed by loss of sensation. Among the substances which he enumerated were sodium bromide, ammonium chloride, lead acetate, ferric chloride, resorcin, and even the glucosides saponin and napellin. Carbolic acid affords the most conspicuous example of this type, its action culminating as is well known in the death of tissue.

In spite of the untoward effects of carbolic acid, which is an aromatic alcohol, certain closely related aromatic side-chain alcohols are now yielding much promise of practical value. Dr. David I. Macht,[9] of Baltimore, the pioneer in this field, a few years ago noted the anesthetic effect of benzyl alcohol upon the tongue, demonstrated its highly innocuous character, and was instrumental in introducing it into surgery.

In our laboratory three similar side-chain aromatic alcohols have been tested, chiefly by Dr. Axel M. Hjort,[10] whose work has been aided by the Committee on Scientific Research of the American Medical Association. As will be seen from the following summary of Dr. Hjort's findings, two of these, rose oil and benzoyl carbinol, possess a high degree of anesthetic efficiency combined with a low degree of toxicity.

[5] Einhorn, *Liebig's Annalen*, 1908, 359.

[6] Wichura, Wilhelm, *Zeits. für Exper. Path. and Therapie*, Vol. 20, p. 1.

[7] Chadbourne, A. P., *Brit. Med. Jour.*, 1892, II., 402.

[8] Liebreich, *Verhandl. de 7 Kongr. f. inn. Medizin*, 1888, S. 245.

[9] Macht, D. I., *Jour. Pharm. and Exp. Therap.*, 1918, XI., 263.

[10] Hjort, A. M., and Kaufmann, C. E., *Proc. Soc. Exp. Biol. and Med.*, January, 1920.

	Formula	Minimal Lethal Dose White Mice. Mgs.	Minimal Effective Anesthetic Concentration (Rabbits' Cornea) %	Minimal Effective Anesthetic Concentration in (Human Skin) %
Benzyl Alcohol..	 CH_2OH	50	1.25	1/30
α Phenethylol ..	 $CHOHCH_3$	20	0.75	1/40
β Phenethylol (rose oil)	 CH_2CH_2OH	40	1.00	(1/40)
Benzoyl Carbinol	 $COCH_2OH$	40	0.50	1/40

Rose oil, or β-phenethylol, it will be remembered, was one of the preparations mentioned by Dioscorides as an eye wash; roses apparently were considered effective in many diseases at that time. Blondel[11] (1889) describes the use of essence of rose for its stimulant properties, its action when taken by mouth not differing essentially from that of other volatile oils. This substance as well as its isomer α-phenethylol are liquids, the latter exhibiting greater toxicity, the probability of which we had deduced from the fact that it contains an asymmetrical carbon atom. Benzoyl carbinol is a solid at ordinary temperatures and of all the group has yielded the most promising results.

While it is more practicable to make the detailed toxicity tests upon mice, it is important to control the results by tests upon higher mammals. In dogs it was found that, like benzyl alcohol, rose oil and benzoyl carbinol fail to cause more than the most transitory symptoms when injected rapidly into the veins in doses of 200 mgms. per kilo. This contrasts very favorably with the toxicities of the commonly used local anesthetics which have been carefully determined by Drs. Robert A. Hatcher and Cary Eggleston,[12] of New York. These investigators found, for example, that by rapid intravenous injection in cats 40–45 mgms. per kilo of procaine or 15 mgms. per kilo of cocaine are fatal. Thus the benzyl alcohol and rose oil appear at least five times as safe as procaine.

The toxicity of benzoyl carbinol in comparison with a series of common local anesthetics may be illustrated graphically by the following adaption of Eggleston and Hatcher's diagram:

Fatal Dose. Mgms. per Kilo	Relative Toxicity
> 200......	Benzoyl Carbinol, benzyl alcohol, etc.
40– 45......	Procaine
30– 35......	Nirvanine
25– 30......	Stovaine
18– 22......	Tropacocaine
20......	Apothesine
15......	Cocaine
10–12.5......	Beta-Eucaine
10......	Alypine and Holocaine

Hatcher and Eggleston point out that with local anesthetics, as with other drugs, the degree of toxicity may depend upon the rate of injection or absorption into the circulation. They show that slow injection allows time for destruction by the liver.

On the basis of the results in dogs it would appear that a man could safely tolerate the throwing of solutions containing one half ounce of pure rose oil or of benzoyl carbinol directly into the circulation; used as a locally applied anesthetic, therefore, poisoning would scarcely be anticipated.

For "surface" or "mucous membrane" anesthesia the rabbits' eye is a valuable test object. Anesthesia of the surface of the rabbit cornea may be identified by the failure of the animal to respond by a wink when the center of the eye is touched. Schlüter has published interesting experiments in which after a drop of local anesthetic was instilled into the eye the threshold for touch sensation was followed by means of hairs of different weights. He showed that when solutions of equal strength are compared, procaine is quite inferior to cocaine as a surface anesthetic. Benzoyl carbinol, as shown below, is particularly efficient in this respect, yielding complete anesthesia of the cornea in 0.5 per cent.

[11] Blondel, R. E., Thesis, "Les Produits Odorants des Rosiers," Paris, 1889.

[12] Eggelston, C., and Hatcher, R. A., *J. Pharm. and Exp. Ther.*, 1919, 13, 433.

concentration. This is the first of the aromatic side-chain alcohols to equal cocaine as a surface anesthetic.

The following diagram (adapted from Sollmann) illustrates the comparative efficiency of phenolic side-chain alcohols and the commonly used surface anesthetics:

Minimum Anesthetic Percentage	Relative Efficiency for Surface Anesthesia
0.5	Cocaine, holocaine, benzoyl carbinol
0.75......	α-phenethylol
1.0	Beta-Eucaine, rose oil
1.25......	Benzyl alcohol
2	Tropacocaine, alypin, quinine-urea
4	Apothesine
8	Novocaine
10	Antipyrine

The intracutaneous method of testing local anesthetics was introduced by Hoffmann and Kochmann (1914) and consists in the production of wheals resembling mosquito bites, by driving the anesthetic substance in between the layers of the epidermis, under pressure, with the hypodermic syringe. The subject of the experiment, who is, of course, prevented from watching the procedures, is required to give a signal every time he perceives the touch of a straw tipped with absorbent cotton. None of our phenolic alcohols are found irritating by this method and all destroy sensation in a concentration of about 1/40 of 1 per cent., as low a strength as has proved sufficient for any known anesthetic substance.

This is illustrated by the following diagram (also adapted from Sollmann):

Minimum Anesthetic Percentage	Relative Efficiency for Intracutaneous Anesthesia
1/40	Benzoyl carbinol, rose oil, α-phenethylol
1/30–1/32......	Benzyl alcohol, cocaine, novocaine, tropacocaine, alypin
1/16	Beta-eucaine
1/8	Quinin-urea
1/4	Apothesine, antipyrine, K_2SO_4

Dr. Arthur D. Hirschfelder,[13] of Minneapolis, and his collaborators, have recently announced the results of experiments with similar side-chain aromatic alcohols. A number of these are based upon the salicylic acid radical. From Hirschfelder's results it is obvious that saligenin in 2 per cent solution is likely to prove a very valuable anesthetic. In his hands this has given a 28–45 minute human subcutaneous anesthesia and has completely anesthetized the mucous membranes of the eye.

Several benzyl alcohol homologues, therefore, which are more stable than benzyl alcohol itself, better surface anesthetics than procaine, and at least five times less toxic, and which further are presumably very unlikely to become habit-forming drugs, are now receiving practical trials.

The two above described tests, surface and intracutaneous, represent the most important of the procedures employed by the surgeons. Clinically, there are five main varieties of local anesthesia, namely, (1) surface, (2) terminal, (3) regional, (4) spinal, (5) venous.

1. To anesthetize mucous membranes such as the linings of the eye, nose, and throat, the solution requires only to be painted upon the surface.

2. To anesthetize the nerve ends in the skin, however, it is necessary that the drug be injected into the skin by means of the hypodermic needle. This is owing to the fortunate circumstance that the living layers of the epidermis are quite impermeable to most solutions with which they may come in contact. Obviously where deper incisions are to be made, subcutaneous injections must follow. Schleich[14] modified the method of terminal anesthesia very acceptably by showing that if hypotonic solutions be injected under pressure to the point at which the tissues become rigid, the anesthetic may be reduced in concentration. This is in accord with findings that either hypotonic or hypertonic solutions of salts tend of themselves to produce local anesthesia, apparently owing to the fact that in swelling or shrinking respectively,

[13] Hirschfelder, A. D., A. Lundholm, H. Norrgaard, American Chemical Society, Division of Biochemistry, September 4, 1919.

[14] Schleich, C. L., "Schmerzlose Operationen," Berlin, 1906.

the vital processes of the cells are partly interfered with.[15]

3. To anesthetize the area supplied by a given nerve, it is only necessary to inject a sufficient amount of solution directly into the nerve trunk. This often effects a great saving of labor and material. The larger nerve trunks were first blocked in this manner by Dr. Harvey Cushing, of Boston.

4. Anesthetics are occasionally injected under the sheath of the spinal cord itself. Spinal anesthesia was introduced in 1885 by Dr. J. Leonard Corning, of New York, in the same year in which Dr. Halsted, of Johns Hopkins, began his pioneer work in cocaine surgery. Many of you may recall that in the closing years of the last century a substance known as stovaine, belonging to the orthoform group, was widely heralded in connection with spinal anesthesia.

5. To produce venous anesthesia an area is made bloodless by tight bandaging and the anesthetic solution injected backwards into the vein which ordinarily transports blood away from that area.

Certain substances have been tested as adjuvants, to be added to local anesthetic solutions. Among these epinephrin has been found extremely valuable and is universally employed, while sodium bicarbonate and potassium salts are deserving of mention.

For terminal anesthesia procaine is injected in solution with epinephrin, the active principle of the adrenal gland. A concentration of 1–100,000 of the latter suffices to blanche the tissues by contracting the small blood vessels with which it comes in contact. This serves two useful purposes, to make the operation practically bloodless and to prevent any rapid carrying off of the drug into the circulation.

[15] Terminal used in combination with general anesthesia is believed to rob the latter of some of its disadvantages, for while the patient, narcotized by ether, chloroform, or nitrous oxid, does not perceive the afferent nerve impulses set up by surgical procedures, these reach the central nervous system nevertheless and may contribute to the untoward condition known as "shock." Local anesthesia tends to prevent the transmission of such impulses. (Crile.)

Sodium bicarbonate as an adjuvant to local anesthetics was suggested by Gros[16] (1910), who believed that bringing the alkaloids into their basic forms, would aid them in penetrating the tissues. Dr. Torald Sollmann,[17] of Cleveland, has found that it does in fact enhance the action of such alkaloids when they are applied to mucous surfaces. On the other hand, he denies that it has any special value in terminal anesthesia.

With regard to potassium salts it may be mentioned, that Hoffmann and Kochmann[18] (1912) claimed that potassium sulphate powerfully potentiates the action of procaine in intracutaneous anesthesia. Dr. Sollmann's results conflict with this claim as do also the results of a number of unpublished experiments which I have made in association with Professor Bernard E. Read, of Peking. In short, salts of potassium, which in fairly high concentration produce a certain amount of intracutaneous anesthesia, when given in combination with such a substance as procaine, yield a result representing merely the algebraic sum of the results obtained by giving the two substances separately.

The theory of action of local anesthetic drugs has not yet reached a satisfactory state. Gros believes that their anesthetic power runs parallel to the amount of free base which is present and that esters such as cocaine and procaine must therefore be hydrolyzed before anesthesia can take place. The extent of the anesthesia would therefore depend upon the degree of hydrolysis of the drug taking place in the tissues. The new findings concerning substances of the benzyl alcohol series show that phenolic alcohols contain all that is essential to local anesthetic action and that for introduction into the field of operation it is not necessary to mask them as esters.

Exactly what happens to the nerve tissues when brought into contact with a local anesthetic drug has not been determined.

[16] Gros, O., *Arch. f. exp. Pathol. u. Pharmakol.*, LXIII., 1910.

[17] Sollmann, T., *J. A. M. A.*, January 26, 1918, p. 216.

[18] Hoffmann, A., and Kochmann, K., *D. M. W.*, 1912, 38, 2264.

We can say, however, in view of the results of work initiated by Dr. A. P. Mathews, that the vital processes in nervous tissue become retarded. This is indicated by the lowered carbon dioxide production exhibited by a nerve exposed to cocaine. Niwa[19] (1918) states that "there is a close relationship between the rate of nerve metabolism and the state of excitability of the nerve" and that "anesthesia in general is probably brought about by interference with the tissue metabolism." This does not differ greatly from Verworn's theory of anesthetic action.

While practise in this case, pending the perfection of theory, proceeds with a tolerable degree of satisfaction, we still await the demonstration of the ideal local anesthetic. This form of anesthesia, however, is extending its usefulness through an ever widening field. Few are the types of major operations which can not now be successfully conducted under its sole employment, always provided that numerous external conditions are satisfied. Among the advantages ascribed to it when thoroughness of operative procedure is not thereby sacrificed are its high degree of safety and rapidity of induction, the exclusion of shock and often of after-pain, the necessity for fewer assistants, the shortening of convalescence, and the absence of post-anesthetic complications. An additional factor of importance is the better mental attitude with which many patients approach such a procedure rather than an operation involving the surrender of consciousness. Some enthusiasts go so far as to say that many an operation assumes the character of a social rather than a surgical occasion, the patient perhaps smoking throughout and enjoying a good meal directly thereafter.

While we are not so advanced that serious ceases are made thus attractive, the day of ideal surgery will doubtless be hastened by the replacement of older for better local anesthetics.

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[19] Niwa, Shuichi, *Jour. Pharm. and Exp. Therap.*, 1919, 12, 323.

PHENOMENA IN THE ULTRA-VIOLET SPECTRUM, INCLUDING X-RAYS

At the recent St. Louis meeting of Section B, of the American Association for the Advancement of Science, there was held a symposium devoted to a comparative discussion of the phenomena involved in the ultra-violet "light" and "X-ray" spectra. The following abstracts of the papers have been prepared by the authors:

A. Quantum Emission Phenomena—Radiation, by David L. Webster, Massachusetts Institute of Technology.

This paper contained a review of the laws of excitation of radiation by electron impact in the best known cases in X-rays and light, in which it appeared that the most essential difference is the existence in light of the so-called "single-line spectrum" which is unknown in X-rays. The phenomena are explainable on any theory of stable electron positions, such as the Bohr theory, if we assume: (1) that in the normal atom all positions involved in X-ray production are full (Kossel), and (2) all positions above the one corresponding to the series term 1.5S are empty (Van der Bijl).

Such theories are very unsatisfactory for absorption phenomena, especially since absorption is a continuous process but results in the production of photoelectrons, each with an absorbing oscillator and a gradual accumulation up to the value required for the photoelectron. If energy is thus stored it seems probable that it would be available to help in the production of X-rays or light by impact, and to produce other effects to be expected from it. But no such evidence of it can be found. The storage hypothesis is made only because it is demanded by the law of the conservation of energy. But this law has been observed only statistically, and the best way to reconcile these phenomena of electron impact with other radiation phenomena seems to be to assume that the law holds only statistically and does not apply to every oscillator at every instant.

B. Quantum Emission Phenomena-Electrons, by R. A. MILLIKAN, University of Chicago.

Experiments on the potentials necessary to apply to just prevent the escape of photoelectrons from different metals, combined with measurements on the contact E.M.F.'s between the same metals demonstrate, not that the energy *absorbed* by an electron which is being photoelectrically ejected is $h\nu$, but rather that the *kinetic energy* with which the electron *escapes* from the atom under the influence of incident radiation of frequency ν is $h\nu$, and hence that *the absorbed energy must always exceed $h\nu$ by the amount of the work necessary to detach the electron from the atom.* In other words the absorption of energy can not take place *quantum-wise* at all

The energy which must be absorbed to cause the escape of an electron must always be more than a quantum and may exceed that amount by any fractional part thereof. It is only the kinetic energy of the escaping electron which is always an exact quantum.

The emission of electromagnetic radiation may or may not take place quantum-wise. Characteristic or fluorescent radiation appears to be emitted quantum-wise but scattered radiation is not so emitted.

C. Spectrum Series, by WILLIAM DUANE, Harvard University.

There is presented for discussion the following four topics: (*a*) The combination law applied to the series spectra of ordinary light, and a somewhat similar law for characteristic X-rays; (*b*) the meaning of these laws in terms of the energy of the radiating atom from the point of view of the theory of radiation in quanta; (*c*) the law of constant angular momentum as used by Bohr in explaining some of the details of series spectra; (*d*) Bohr's theory applied to characteristic X-rays, with special reference to critical absorption data.

(*a*) It has been found empirically that the frequencies of vibration (or the wave numbers) corresponding to the lines in series spectra may be represented as the differences between any two of a set of terms, which may be denoted by symbols of the forms $(1S)$, $(1P)$, (mP), (mD), (mF), $(1s)$, (mf), etc. These terms may approximate to, but do not exactly equal a certain constant divided by the square of a whole number. The differences between the correct values of various pairs of terms, however, appear to represent the wave numbers with great precision.

Turning to X-rays we find that the form of the "terms" is much more complicated. It is possible, however, to obtain empirically a relation between the X-ray emission and absorption frequencies that resembles the above combination law. Mr. Shimizu and I recently published[1] the results of experiments, which indicate that an emission frequency equals the difference between two absorption frequencies. From the data for the K and L series of tungsten, it appears that the law is correct to about one fifteenth of a per cent. Since we presented this research to the Physical Society some measurements by Dr. Stenstrom of the absorption frequencies in the M series of uranium and thorium have come to hand, and these together with de Broglies' values for the L absorption frequencies and Seigbahn's values for the L emission frequencies furnish data by which the law can be tested. The calculations indicate that the differences between the L and M absorption frequencies equal the frequencies of some of the L emission lines to within one per cent.

Theories of the mechanism of radiation such as that suggested by Bohr lead to laws similar to the combination law, and Kossel has deduced from these conceptions relations between the emission frequencies themselves. One of these relations is that the difference between the $K\beta$ and the $K\alpha$ frequency equals the $L\alpha$ frequency. This relation is not exact, however, for $K\alpha$ represents a group of lines and recent experiments have shown that $K\beta$ also is not a single line. We get a much closer agreement, if we take the frequencies of the individual lines in the groups.

(*b*) For a long time spectrum analysis remained a purely descriptive science, containing data of extraordinary accuracy, it is true,

[1] *Physical Review*, July, 1919.

but of very little fundamental significance. Recently, however, this data has furnished evidence of great importance as to the structure of matter and the mechanism of radiation. This is largely due to two fundamental laws: Planck's law of radiation in quanta, and Bohr's law of constant angular momenta.

According to the first law the amount of energy radiated from an atom is proportional to the frequency at which it is radiated, the constant h being the factor of proportionality. In other words the atom changes from one state into another when it radiates, and the difference between the energy it possessed before and after the radiation equals the frequency of vibration multiplied by h, thus:

$$h\nu = W_1 - W_2.$$

According to this conception the terms in the combination law represent the energy of the atom in its various states of equilibrium divided by h, plus, of course, an additive constant.

The complete expression of the law is

$$\tau h\nu = W_1 - W_2,$$

where τ denotes any whole number, but spectrum lines corresponding to values of τ greater than 1 have not been observed. They may be very faint, except, perhaps, in the infra red spectrum. The chance of τ's being greater than unity (in black body radiation) is very small for high frequencies of vibration.

Extraordinary success has attended the application of Bohr's theory to the case of a single electron revolving about an atomic nucleus. In this theory the angular momentum of the electron equals some whole number multiplied by a universal constant, $h/2\pi$, thus

$$mva = \tau(h/2\tau).$$

The value of the universal angular momentum may be regarded as chosen to fit the facts, *i. e.*, to give the correct value for the Rydberg fundamental frequency, or we may assume, with William Wilson, that a certain integral equation, occurring in the theory of quanta, expressed in generalized coordinates, namely,

$$\int pdq = \tau h,$$

applies to the revolving electron. Since the force acting on the electron is a central force, the angular momentum p is constant, and, if we take the integral over a complete period during which the angle q varies by 2π, we have

$$2\pi mva = \tau h.$$

As an example of the application of Bohr's theory let us consider the values of the Rydberg constant for hydrogen and for ionized helium. In each case a single electron revolves about an atomic nucleus. The theory assumes that the attraction between them is given by Coulomb's law, and from this together with the two laws mentioned above the various unknown quantities can be calculated, including the frequency of the emitted radiation. Since the helium nucleus is nearly four times as heavy as the hydrogen nucleus, the common center of gravity, about which the electron and the nucleus revolve, is slightly nearer the center of the helium nucleus, than is the case with hydrogen. Bohr predicted that on account of this fact certain lines in the hydrogen spectrum should have wave-lengths slightly longer than certain lines in the enhanced helium spectrum, and experiments prove this to be true. Further, the ratio of the mass of the electron to that of the hydrogen atom, and the ratio of the charge to the mass of the electron can be calculated from accurate measurements of the wave-lengths of these lines. The values of these ratios calculated from data obtained by Pashen are very nearly the same as the values deduced from other methods of experiment. In fact, granting the general truth of the theory, they are, perhaps, the most accurate estimates we have of these important ratios.

The Rydberg constant for the spectra of ordinary helium, in which we may suppose that there is one electron revolving in an inner ring about the nucleus, appears to be slightly less than that for the spectrum of ionized helium. Bohr's theory would seem to account for some such decrease in the value of the constant, for the influence of this electron on electrons in outer rings is slightly greater than would be the case, if it were actually in the nucleus itself. The theory, applied to cases where more than one electron revolve about the nucleus, does not appear as yet to be thoroughly satisfactory.

Bohr's theory has been applied to the characteristic X-ray spectra with some success in particular cases. For instance, Sommerfeld's calculation of the frequency difference between the lines in the $K\alpha$ group by means of elliptic orbits, etc., seems to represent the facts to a considerable degree of precision.

In general the theory does not indicate the distribution of the electrons among the various orbits, and this distribution must be determined by other considerations, or else it must be chosen to fit the X-ray data. The latter procedure has been followed by Debye, Kroo, Wiggard and Sommerfeld. The calculation of the frequency of the α_1 line in the K series by Sommerfeld seems to agree with the facts to a remarkable degree of accuracy. None of the formulas, however, appear to give the frequencies of all the lines in the X-ray spectra.

It might be interesting to calculate the frequencies of the critical absorption associated with the K series, using a distribution of electrons similar to that adopted by Lewis and Langmuir in their theory of a static atom. In this theory the inner shell contains two electrons, the second shell contains two layers of 8 electrons each, the third, two layers of 18 each, etc. Translating this distribution from the static atom over into the dynamic atom I shall assume that the inner orbit of one quantum ($\tau = 1$) contains 2 electrons; that outside this are two orbits of two quanta ($\tau = 2$), one just outside the other and each containing 8 electrons etc.

K ABSORPTION FREQUENCIES

The table contains the data. Two columns of calculated values are given, one corrected for the mutual influence of neighboring rings of electrons on each other and one uncorrected. The observed values represent our measurements of the critical absorption frequencies,[2] which are the highest X-ray frequencies known to be characteristic of the chemical elements. Except for aluminium the observed values differ from the calculated values by less than the correction for the influence of the rings on each other. Considering that none of the quantities used in the calculations have been taken from X-ray data, the agreement may be regarded as good, especially for the chemical elements of high atomic number.

The above distribution of electrons does not give the proper values for the frequencies of the emission lines of chemical elements of low atomic numbers, so that the problem can not be said to have been solved.

$$
\begin{aligned}
\frac{\nu}{\nu_0} = 2\left(N - \tfrac{1}{4} - \phi_1\right)&\left(1 + \tfrac{1}{4}\beta_1^2 + \tfrac{1}{8}\beta_1^4 + \cdots\right) \\
&- (N - \phi_2)^2\left(1 + \tfrac{1}{4}\beta_2^2 + \tfrac{1}{8}\beta_2 + \cdots\right) \\
&+ \Sigma \frac{n}{\tau^2}(N - n_1 - n_2 - \cdots - s_n - \phi)^2 \\
&- \Sigma \frac{n}{\tau^2}(N - n_1 - n_2 - \cdots - s_n - \phi + 1)^2.
\end{aligned}
$$

$$\beta = \frac{2\pi e^2}{ch}(N - \phi).$$

$$n_1 = 2,\ n_2 = 8,\ n_3 = 8,\ n_4 = 9,\ n_5 = 9.\ \cdots.$$

$$\tau_1 = 2,\ \tau_2 = 2,\ \tau_3 = 3,\ \tau_4 = 3,\ \cdots.$$

ν_0 = Rydberg Fundamental Frequency

Chemical Element	Atomic Number	ν/ν_0 Calculated (Uncorrected)	ν/ν_0 Observed	ν/ν_0 Calculated (Corrected
Aluminium....	13	116.7	114.8	118.5
Phosphorus ...	15	157.0	158.4	163.9
Manganese....	25	479.2	482.8	500.8
Bromine	35	968.9	993.6	1000.0
Rhodium	45	1696.0	1711.0	1717.0
Caesium	55	2584.0	2648.0	2643.0
Terbium	65	3752.0	3803.0	3812.0
Tungsten	74	5056.0	5109.0	5118.0

D. The Origin of Radiation, by A. W. Hull, of the Research Laboratory of the General Electric Co.

The rapidity with which our theories of atomic structure have advanced during the last ten years has left the impression that each new contribution was a new theory, and that one must choose between these appar-

[2] *Physical Review*, December, 1919.

ently conflicting theories. The purpose of this paper is to show that these contributions not only do not conflict, but that all of them are essential parts of a picture, which is nearer completion than most of us realize. The main contributions may be summarized as follows:

Ritz showed that by assuming the nucleus to be magnetic, so that the force determining the vibration of the electron depends on the velocity instead of the position of the electron, one obtains a frequency law involving only the first power of the frequency, in accordance with observations.

The essential part of Bohr's beautiful theory is the mechanism by which he accounts for Ritz's combination principle namely, that the frequency of radiation depends not on where the electron is, or where it came from, but upon both.

J. J. Thomson added the idea that Bohr's stable orbits, and the quantum relations connected with them, are due to a skeleton structure of the nucleus and not to any discontinuity of energy.

Sommerfeld extended Bohr's theory to atoms of higher atomic weight, and has drawn a beautiful picture. His main contribution is the idea that the orbit may be either a circle or an ellipse of definite eccentricity, which accounts with extreme precision for the separation of doublets both in X-ray spectra and the hydrogen spectrum.

Langmuir showed that all known chemical properties are satisfied by an atom with relatively stationary electrons, arranged in concentric shells about the nucleus.

By combining these contributions, namely, the magnetic nucleus of Ritz, Bohr's stable orbits, Thomson's skeleton nucleus, Sommerfeld's elliptical orbits, and Langmuir's stationary electrons, we arrive at a composite picture which represents our present knowledge remarkably well. The rotating point electron is replaced by a ring-shaped electron. The constant angular momentum of the rotating electron is replaced by constant magnetic moment of the ring. In the case of hydrogen and ionized helium the ring surrounds the nucleus, and the picture is identical with Bohr's. In the case of the other elements the rings lie on the surface of concentric shells, in positions corresponding to Langmuir's cells. The condition of constant angular momentum of each ring electron holds for all atoms, and Sommerfeld's picture of the circular and elliptical rings is applied to the shape of the ring electron.

The discussion following the symposium was of necessity brief. Emphasis was given to the clear advantage of preferring a theory of atomic structure that gives correct quantitative results.

G. W. Stewart,
Secretary Section B

SCIENTIFIC EVENTS

PUBLICATIONS AND MEMBERSHIP OF THE NATIONAL ACADEMY OF SCIENCES

At the recent meeting of the academy the home secretary presented the following report:

The President of the National Academy of Sciences.

Sir: I have the honor to present the following report on the publications and membership of the National Academy of Sciences for the year ending April 26, 1920.

Two parts of Volume 14 of the Memoirs of the National Academy of Sciences have been completed and distributed: the second memoir, "Complete Classification of Triad Systems," by H. S. White, F. N. Cole and L. D. Cummings, and the fourth memoir, "Minor Constituents of Meteorites," by G. P. Merrill.

The third memoir, "Tables of Minor Planets," by A. O. Leuschner, A. E. Glancy, and S. H. Levy, and the fifth and final memoir of Volume 14, "Tables of the Exponential Function," by C. E. Van Orstrand, are now in page proof and will be issued shortly, as will also Volume 15, "Psychological Examining in the United States Army," by Robert M. Yerkes.

Volume 16, first memoir, "Lower California and its Natural Resources," by E. W. Nelson, and the second memoir, "Studies upon the Life Cycles of Bacteria," by F. Löhnis, are now in galley proof. The third memoir, "A Recalculation of Atomic Weights," by F. W. Clarke, is now in the hands of the printer.

Volume VIII. of the Biographical Memoirs has been completed with the publication of the biographies of Benjamin Osgood Peirce, and Cleveland Abbe, and the bound volume distributed. The following biographies forming a part of Volume IX. have been completed and distributed: William Bullock Clark by John M. Clarke; Arnold Hague by Joseph P. Iddings; Eugene Waldemar Hilgard by Frederic Slate; James Dwight Dana, by L. V. Pirsson; James Mason Crafts, by Charles R. Cross; Lewis Boss, by Benjamin Boss, and Alpheus Spring Packard, by T. D. A. Cockerell. That of Charles Sedgwick Minot is now in page proof.

The Report of the National Academy of Sciences has been issued and the fourth Annual Report of the National Research Council will be issued in separate form in a few days. The Proceedings have reached the third number of the sixth volume.

Since the last meeting, two members have died. Louis V. Pirsson, elected 1913, died December 8, 1919, and Horatio C. Wood, elected in 1879, died in 1919. This leaves an active membership of 175 members, 1 honorary member and 31 foreign associates. Gustav Retzius, foreign associate, died on July 12, 1919.

C. G. ABBOT,
Home Secretary

MATHEMATICAL MEETINGS AT THE UNIVERSITY OF CHICAGO

THE twenty-seventh summer meeting and ninth colloquium of the American Mathematical Society will be held at the University of Chicago during the week beginning Monday, September 6, 1920. The sessions of the Mathematical Association of America will occupy Monday morning and afternoon. The council of the society will meet on Monday evening. The regular sessions of the society will occupy Tuesday morning and afternoon and Wednesday morning. The joint dinner of the society and the association will be held on Tuesday evening.

The University of Chicago will open two of its dormitories, one for men and one for women, during the week of the meeting, and meals will be provided on the university grounds. Advance information on these matters can be obtained from Professor H. E. Slaught.

The colloquium will open Wednesday afternoon and will extend through Saturday morning. It will consist of two courses of five lectures each, as follows: I. Professor G. D. Birkhoff, of Harvard University: "Dynamical systems." The last forty years have witnessed fundamental advances in the theory of dynamical systems, achieved by Hill, Poincaré, Levi-Civita, Sundman, and others. The lectures will expound the general principles underlying these advances, and will point out their application to the problem of three bodies as well as their significance for general scientific thought. The following topics will be treated: Physical, formal, and computational aspects of dynamical systems. Types of motions such as periodic and recurrent motions, and motions asymptotic to them. Interrelation of types of motion with particular reference to integrability and stability. The problem of three bodies and its extension. The significance of dynamical systems for general scientific thought.

II. Professor F. R. Moulton, of the University of Chicago: "Certain topics in functions of infinitely many variables." I. On the definition and some general properties of functions of infinitely many variables. II. On infinite systems of linear equations. III. Infinite systems of implicit functions. IV. Infinite system of differential equations. V. Applications to physical problems.

THE SOUTHWESTERN DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A MEETING of the council of the American Association for the Advancement of Science, held in Washington on April 26, approved the organization of the Southwestern Division of the Association, which was tenatively made in a meeting of delegates held at the University of Arizona, Tucson, Arizona, on Saturday, April 10.

At that meeting Dr. D. T. MacDougal was delegate from the American Association. Local delegates came from Prescott, Phoenix, and Tucson, Arizona Albuquerque, New Mexico and El Paso, Texas.

Dr. Edgar L. Hewett, of the School of American Research, director of the Archaeological Institute, director of the State Museum at Sante Fe, N. M., and the Archaeological Museum in San Diego, was elected president of the Southwestern Division; Elliott C. Prentiss, M.D., of El Paso, Texas, was elected vice-president and chairman of the executive committee; and Dr. A. E. Douglass, of the University of Arizona, was elected secretary and treasurer.

The executive committee in its membership besides the three officers just mentioned consists of Dr. John D. Clark, Albuquerque; A. L. Flagg, Phoenix; Fabian Garcia, Mesilla Park; Arthur Notman, Bisbee; Richard S. Trumbull, El Paso; Milton Updegraff, Prescott; and Charles T. Vorhies, Tucson.

A constitution was adopted. The area included in this Division will be Arizona, New Mexico and West Texas.

Dr. Edgar L. Hewett, the newly elected president of the Southwestern Division, gave a lecture entitled "Our Place in Civilization," at the University of Arizona, Tucson, on April 28 and at El Paso, Texas, on April 30. In connection with the formation of this division also Dr. A. E. Douglass, of the University of Arizona, gave a lecture entitled "The Big Tree and its Story," in Phoenix, Arizona on April 1.

THE RESIGNATION OF PRESIDENT DRINKER OF LEHIGH UNIVERSITY

Dr. Henry S. Drinker has addressed to his fellow-alumni of Lehigh University, the following letter:

I have felt for some time and have so stated, informally, to the members of our board of trustees, that as I reach the age of seventy this year, it would be the part of wisdom for me to retire from the presidency of the university. I have therefore tendered my resignation to take effect at the close of the commencement exercises on June 15th next. So far as I know, I am in perfect health and in good strength, but I wish to retire while my friends still feel they desire my services to continue. I am not willing to hold on for some time, as I might do, and then feel that increasing years and failing powers compel my retirement.

From the time of my graduation in June, 1871, I have been devoted to the service of the university's interests, and have served as secretary of the alumni, president of the alumni, alumnus trustee, trustee and president, and now in proposing to drop out of active presidential duties, I have no thought of lessening my interests in the alma mater, nor is my retirement from the presidency prompted by any thought except that I have accomplished the things for which I came here, and I now wish to see the leadership of the university pass into the hands of a younger man, one qualified by educational training and actual large experience in educational work, and possessing marked executive ability. I am satisfied that the university has reached a stage in its existence requiring for its leadership and guidance, a man possessing these characteristics.

It has been my privilege to bring to the service of the university energy, devotion and business experience. It was thought at the time of my election, when the university was in financial strain, and in need of greater facilities in plant and equipment and a larger teaching force, that the energies of its friends should be directed to these ends, and I was asked to undertake the task. To-day, with our plant in greatly improved shape, with our faculty increased from 15 in 1905, to 33 in 1920, the entire teaching force raised from 57 to 89, with our financial situation greatly improved and comparing favorably with that of our competitors, our present need is, as above stated, for a man experienced and trained in educational methods, and with good executive ability; I feel content in the knowledge that our board of trustees will well consider the situation, and fittingly serve our university's needs.

SCIENTIFIC NOTES AND NEWS

At the recent meeting of the National Academy of Sciences the following foreign associates were elected: Frank Dawson Adams, McGill University; Marie Ennemond Camille Jordan, Collège of France; François Antoine Alfred Lacroix, Musée d'Histoire Naturelle, Paris; Heike Kamerlingh Onnes, University of Leyden; Sir David Prain, Royal Botanic Gardens, Kew, Surrey; Santiago Ramon y Cajal, University of Madrid.

The National Academy of Sciences has recommended to Columbia University that the Barnard medal be conferred on Albert Einstein "for highly original and fruitful development of the fundamental concepts of physics through the application of mathematics." The Agassiz medal has been awarded to Admiral C.

D. Sigsbee, U. S. N., retired, "for his important contributions to oceanography, both by actual research, by publication of his results and invention of new methods."

In recognition of successful scientific research in the prevention of disease and the conservation of health, Dr. Theobald Smith, head of the Laboratory of Comparative Pathology of the Rockefeller Institute and formerly of Harvard University, has been voted the M. Douglas Flattery Medal and $500 in gold by the Harvard Corporation. The medal is awarded to the man of science whose efforts have proved of the greatest value to mankind in fighting disease.

A portrait of Dr. William H. Welch, of the Johns Hopkins University, president of the University Club of Baltimore, was presented to the club recently at its monthly meeting.

Dr. W. W. Keen has been elected an honorary fellow of the Royal Society of Medicine, London, and of the American Surgical Association.

Dr. Raymond F. Bacon, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, who during 1918, was a colonel serving as chief of the Technical Division of the Chemical Warfare Service, A. E. F., has been awarded a citation by General Pershing for exceptionally meritorious and conspicuous services in France.

Professor Sadao Yoshida, of Osaka Medical College (Japan), has been awarded the Katsurada prize and medal of honor established by the Japanese government to be given periodically to some distinguished worker on tropical diseases. Professor Yoshida is spending his sabbatical year in research at the Parasitological Laboratory of the University of Illinois.

Mr. Vilhjalmur Stefansson has been awarded the La Roquette Medal of the Geographical Society of Paris. He had previously been awarded the following medals: In December, 1918, the Daly Medal of the American Geographical Society, New York; in December, 1918, the medal of the Explorers Club of New York; in January, 1919, the Hubbard Medal of the National Geographical Society, Washington; in January, 1919, the Kane Medal of the Geographical Society of Philadelphia; in March, 1919, the Cullum Medal of the Chicago Geographical Society. All these medals are known as gold medals but at Mr. Stefansson's request they have been struck in bronze and the difference in cost has been given to Madame Beuchat, the mother of the distinguished scientific man, Henri Beuchat, who died on the expedition.

Professor Konrad Roentgen retired from his chair of experimental physics at the University of Munich and resigned the charge of the Physikalisches Institut at the end of the winter semester.

The board of trustees of the University of Pennsylvania has accepted the resignation of Provost Edgar Smith to take effect June 30. Dr. Smith presented his resignation last February. In accepting it now the board made him emeritus professor of chemistry and placed at his disposal the Harrison laboratory, where Dr. Smith expects to devote the greater part of his time to research work.

Dr. Edward T. Reichert, professor of physiology in the Medical School of the University of Pennsylvania, has retired from active service.

At the annual meeting of the Kentucky Academy of Science held in Lexington on May 8, the following officers were elected: *President,* Professor W. H. Coolidge, Centre College, Danville, Ky.; *Vice-President,* Professor George D. Smith, Eastern Kentucky State Normal School, Richmond, Ky.; *Secretary,* Dr. A. M. Peter, Experiment Station, Lexington, Ky.; *Treasurer,* Mr. J. S. McHargue, Experiment Station, Lexington, Ky.

Dr. A. Hrdlička, of the U. S. National Museum, has returned from a trip to the Far East He visited Japan, Korea, Manchuria, northern China and Hawaii.

Mr. Irving Perrine, vice-president of the American Association of Petroleum Geologists, is moving his office from Hutchinson, Kansas, to 1415 West 31st Street, Oklahoma City, Okla., and will there continue his work as a consulting petroleum geologist.

Dr. Ira Remsen, of the Johns Hopkins University, will deliver the commencement address at West Virginia University on June 15.

Dean W. M. Wheeler, of Bussey Institution, Harvard University, delivered an address under the auspices of the Society of Sigma Xi of Syracuse University, on May 6. The address, which was on "Worm-lions, ant-lions and some eighteenth-century entomologists," covered the observations made by Réaumur and other early naturalists upon the habits of the worm-lion and ant-lion; and included the studies of the lecturer upon the structure and behavior of the worm-lions of California.

Dr. G. M. Stratton, professor of psychology at the University of California, has given the Nathaniel W. Taylor lectures at the Yale School of Religion.

Dr. George F. Kay, head of the department of geology, State University of Iowa, and state geologist of Iowa, lectured on April 21 before the chapter of Sigma Xi of the University of Minnesota, on "The History of Glaciation in the Mississippi Valley."

Dr. C. E. Kenneth Mees, director of the research laboratories of Eastman Kodak Co., landed in England April 27. While there he will deliver the following lectures before various scientific bodies: "Some Photographic Phenomena in Relation to Astronomy," "Some Results of Recent Investigations on the Theory of Development," "Photography of the Air," "Reaction of the Eye to Light," "A Photographic Research Laboratory," "The Production and Supply of Synthetic Organic Chemicals in the United States," "Rochester and the Kodak Works," "Scientific Research and Industrial Production," "The Theory of Tone Reproduction with a Graphic Method for the Solution of Problems."

Dr. Harry N. Holmes, head of the chemistry department of Oberlin College and chairman of the National Research Council's Committee on Colloids is on a five weeks lecture tour to the Pacific coast. The series of from one to four lectures on "Colloid Chemistry" will be given at Northwestern University, Los Angeles, San Francisco and Seattle Sections of the American Chemical Society, University of Washington, State College of Washington, Montana School of Mines, Montana State College, State College of North Dakota, University of Wisconsin, Iowa State College (Ames), Leland Stanford University and the University of California.

Dr. Joseph Simms, a well-known lecturer and traveler, who died of cerebral hemorrhage in New York City on April 11, in his eighty-seventh year, bequeathed his body to Dr. Edward A. Spitzka for scientific study. The brain of Dr. Simms, removed eighteen hours after death, weighed 1,520 grams (53.58 onces avoirdupois) and has been preserved by Dr. Spitzka for the detailed study of its morphologic features in comparison with the brains of other notable men.

It is stated in *Nature* that botanists in Great Britain have been considering the practicability of holding an Imperial Botanical Congress in London at which botanists from the overseas Dominions might meet their colleagues at home for the discussion of matters of common interest. Many subjects are ripe for discussion, such as the methods of training botanists for service abroad, the relation between the pure science and its applications and between the botanist and the commercial men interested in industries in which botanical knowledge should play an important part, more helpful cooperation between the home and the overseas botanist, botanical surveys of overseas Dominions, and others. After careful consideration it has been decided that it would be inadvisable to hold such a congress during the present year.

UNIVERSITY AND EDUCATIONAL NEWS

The medical departments of Columbia, Harvard and the Johns Hopkins Universities receive $5,541,401 each, in the distribution of the estate of Captain Joseph R. De Lamar. The will, disposing of a sum of thirty-two million dollars, provides these funds for the study and teaching of the origin and cause of disease and its prevention and for the study and teaching of dietetics.

Howard University School of Medicine, Washington, has been promised $250,000 by the General Education Board, provided the medical school succeeds in raising the rest of a total sum of $500,000.

The trustees of the University of Southern California, on April 13, decided to suspend temporarily the medical department because of inadequate endowment with which to maintain it.

Dr. Cornelius Betten, secretary of the State College of Agriculture at Cornell University, has been appointed vice-dean of the college.

Curt Rosenow (Ph.D., Chicago, 1917), of the Juvenile Psychopathic Institute, Chicago, has accepted an assistant professorship in psychology at the University of Kansas.

Dr. A. Richards, professor of zoology at Wabash College, has been appointed to a professorship of zoology in the University of Oklahoma, where he will be head of the department.

Dr. Fred Hoffmann Rhodes has been appointed professor of industrial chemistry and will begin his work in the autumn at Cornell University.

General Sir Arthur Currie has accepted the position of principal of McGill University in succession to Sir Auckland Geddes, who resigned to become British Ambassador at Washington.

DISCUSSION AND CORRESPONDENCE

FORMULÆ GIVING THE DAY OF THE WEEK OF ANY DATE

To officials who are required to fix the dates of events beyond the end of the current year and to historians who may desire to know the day of the week of events in past years, for which calendars are not ordinarily available, the formulæ given below may be of considerable interest.

When the days of the week are numbered thus:

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1	2	3	4	5	6	0

the day of the week of any date in the Gregorian (New Style) calendar is the remainder, R, in the division

$$(Y + 3C + F + L + M + D)/7 = Q + R/7,$$

in which the symbols used have the following meanings:

Q is the integral part and R the remainder obtained in the division indicated in the first member of the equation.

Y is the year in which the date occurs.

C is the number formed by striking out the last two digits of the year. Thus, for dates in the year 1920, $C = 19$.

F is the number of preceding leap days occuring in centennial years. These occur in the years 400, 800, 1200, 1600, etc. Thus, for dates between

Jan.	1,	1, and Feb. 29,	400,	inclusive,	$F = 0$
Mar.	1,	400, " " "	800,	"	$F = 1$
Mar.	1,	800, " " "	1,200,	"	$F = 2$
Mar.	1,	1,200, " " "	1,600,	"	$F = 3$
Mar.	1,	1,600, " " "	2,000,	"	$F = 4$

L is the number of leap days between the date and the last centennial year (not inclusive). It it the quotient obtained by dividing by four the number formed by the last two digits of the year in which the last preceding leap day occurred.

M is a number which varies from month to month as follows:

Jan.	Feb.	Mar.	Apr.	May	June
0	3	3	6	1	4
July	Aug.	Sep.	Oct.	Nov.	Dec.
6	2	5	0	3	5

D is the day of the month.

Examples:	Oct. 21, 1492	Feb. 22, 1732	Oct. 22, 1863
$Y=$	1492	1732	1863
$3C=$	42	51	54
$F=$	3	4	4
$L=$	23	7	15
$M=$	0	3	0
$D=$	21	22	22
	$7)\overline{1581}$	$7)\overline{1819}$	$7)\overline{1958}$
	$225\frac{6}{7}$	$259\frac{6}{7}$	$279\frac{5}{7}$
$R=$	6 = Fri.	6 = Fri.	5 = Thu.

For dates in the Julian (Old Style) calendar the formula is

$$(Y + 4C + L + M + D + 5)/7 = Q + R/7,$$

in which the various symbols have the same meanings as above.

Examples:	Oct. 12, 1492	Feb. 11, 1732	July 4, 1920
$Y=$	1492	1732	1920
$4C=$	56	68	76
$L=$	23	7	5
$M=$	0	3	6
$D=$	12	11	4
	5	5	5
	7)1588	7)1826	7)2016
	$226\frac{6}{7}$	$260\frac{6}{7}$	$288\frac{0}{7}$
$R=$	6 = Fri.	6 = Fri.	0 = Sat.

W. J. Spillman

ORIGIN OF THE SUPPOSED HUMAN FOOTPRINTS OF CARSON CITY, NEVADA

During the summer of 1919 the writer found occasion to visit Carson City, Nevada, and, through courtesy of members of the prison staff at the Nevada State Penitentiary, was enabled to examine a number of specimens of fossil mammals collected in the prison yard during past quarrying operations for building stone. In the material preserved in the collections were fragments of a skull and a cervical vertebra belonging to a ground sloth. Warden R. B. Henrichs, of the Nevada prison, was kind enough to loan the remains recovered during the excavations to the department of paleontology, University of California, and further study indicates that the ground sloth specimens pertain to an individual of the genus *Mylodon*.

Many years ago the discovery of footprints, bearing a superficial resemblance to imprints made by a human foot, in a shale stratum exposed in the yard of the penitentiary at Carson City, gave rise to the view that the existence of primeval man in Nevada was definitely established—a view that has taken a particularly tenacious hold. The possibility that the footprints were in reality those of a ground sloth, presumably of a form related to the South American *Mylodon*, was, however, advocated by Joseph Le Conte,[1] O. C. Marsh[2] and others. In 1917, the writer[3] contrasted the outline of the so-called human footprints with that of a complete hind foot of *Mylodon harlani* reconstructed from remains of this species secured in the asphalt deposits at Rancho La Brea. The great resemblance which the articulated foot bore to the impressions, both in outline and in size, seemed certain proof that the latter were left by *Mylodon*.

The actual occurrence of osseous remains of *Mylodon* in the Pleistocene deposits at Carson City, Nevada, removes still farther the possibility that the Carson footprints are to be attributed to a member of the Hominidæ and materially substantiates the suggestions of Le Conte and Marsh. Further, the presence of material referable to a mylodont sloth gives a high degree of probability to the contention that the footprints were made by *Mylodon* rather than by some other quadruped.

Chester Stock
University of California

SCIENTIFIC PHOTOGRAPHY

To the Editor of Science: The Royal Photographic Society of Great Britain is holding its sixty-fifth annual exhibition in September and October of this year. This is the most representative exhibition of photographic work in the world, and the section sent by American scientific men heretofore has sufficiently demonstrated the place held by this country in applied photography. It is very desirable that American scientific photography should be equally well represented in 1920, and, in order to enable this to be done with as little difficulty as possible, I have arranged to collect and forward American work intended for the scientific section.

This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy,

1 Le Conte, J., *Proc. Calif. Acad. Sci.*, 10 pp., August 27, 1882.

2 Marsh, O. C., *Amer. Jour. Sci.*, Ser. 3, Vol. 26, pp. 139–140, 1883.

3 Stock, C., Univ. Calif. Publ. Bull. Dept. Geol., Vol. 10, pp. 284–285, 1917.

radiography, biology, etc. Photographs should reach me not later than Thursday, July 1. They should be mounted but not framed.

I should be glad if any worker who is able to send photographs will communicate with me as soon as possible so that I might arrange for the receiving and entry of the exhibit.

A. J. Newton

Eastman Kodak Company,
Rochester, N. Y.,

QUOTATIONS

COMPETITION IN RESEARCH

The resignation of Professor Ernest Fox Nichols from the department of physics at Yale University in order to continue his research work upon a larger scale in the Nela Research Laboratories of the National Lamp Works at Cleveland, offers a new impression of the possible utilization of professional talent. Professor Nichols resigned the presidency of Dartmouth College to come to Yale where there was a greater promise of his continuing his scientific work, and now leaves Yale to enter the employ of a private corporation whose opportunities for scientific work on a much enlarged scale are even greater.

The loss to Yale of the fine influence of Dr. Nichols' personality is obvious. That is something to be deeply regretted but, taking him as a type of trained scientists, whether the withdrawal of such men from the universities of the country and their employment by large corporations whose interest in scientific research is more direct is to the common disadvantage may seriously be questioned. The limitations which are necessarily set upon work of this character even in the best equipped of university laboratories disappear in corporations where no limitations are set when the importance of the end sought is realized. In the case of Dr. Nichols the work which he wishes to accomplish has such great importance in its actual accomplishment that his transfer must be considered as of greater general advantage because it may be accomplished the earlier under private rather than under university encouragement. The theoretical disadvantage which results to the university is in all likelihood offset by the practical advantage to be commonly gained.

Speculation is here invited as to what the effect will be upon the teaching force of a university if the labor of research work of a scientific character is to be taken over by private corporations. We might imagine affirmative and the negative coming to blows over this thesis at least until the lessons of experience have been written into the record. —*The New Haven Journal-Courier.*

A NEW STATISTICAL JOURNAL

There has recently been founded a new international statistical journal called *Metron.* It is published at Padua, Italy, at a subscription price of 40 lire per year. The printer, where subscriptions should be sent, is the *Tipografia Industrie grafiche Italiane,* Via Viscovado, Padova, Italy. The journal will appear quarterly, each number comprising 150 to 200 pages.

The founder and chief editor of *Metron* is Professor Corrado Gini, of the University of Padua. The fact that so brilliant and sound a worker as Professor Gini is to be in charge at once guarantees the scientific standing of the journal in the statistical field. An international editorial board has been formed, which now includes the following persons:

Professor A. Andreadès, de science des finances a l'Université de Athenes (Greece),

Professor A. E. Bunge, directeur de la Statistique de la Republique Argentine, Buenos Ayres (Argentine),

Dr. F. P. Cantelli, actuaire au Ministere du Tresor, Rome (Italy),

Dr. L. V. Furlan, libre docent de statistique a l'Université de Bâle (Switzerland),

Dr. M. Greenwood, reader of medical statistics in the University of London; statistician of the Lister Institute, London (England),

Dr. A. Julin, directeur de la Statistique economique de la Belgique Ministère de l'Industrie et du Travail, Bruxelles (Belgium),

Dr. G. H. Knibbs, directeur de la Statistique de la confederation australienne, Melbourne (Australia),

Ing. L. March, directeur de la Statistique générale de la France, Paris (France), Dr. Raymond Pearl, professor of biometry and vital statistics, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland (United States).

The general editorial program may be set forth as follows:

One of the great difficulties in connection with modern statistics is that of becoming acquainted with the relevant literature; this is in fact derived from the work of very different schools and published in a variety of journals and transactions. It is necessary to consult mathematical, astronomical, technical, physical, chemical, actuarial, economic and financial, psychological, historical, legal, physiological and pathological, hygienic and medical, biological, genetic and eugenic and even purely zoological, botanical and agricultural publications.

It is true that generally such papers are merely applications of interest to specialists in the particular branch of knowledge. But this is not always the case and sometimes methods of general interest to all statisticians are to be found, or, again, we find in particular connections methodological problems enunciated and solved, the scope of hypotheses contained in certain analyses brought to light, the approximation of theoretical conclusions verified and advances made by different routes; progress of interest in all branches of statistics. Still more frequently the results of particular statistical investigations, even when they do not interest all statisticians, are of importance to those engaged in similar inquiries: thus results obtained in the field of anthropology, zoology, genetics or eugenics, hygiene, medicine, pathology, life insurance, political economy or history may be of great interest to the student of demography.

Whoever, desiring to enlarge the boundaries of statistical science as far as possible, is forced to consult the heterogeneous literature containing statistical papers must be aware of the inconvenience resulting from lack of coordination.

Valuable statistical data, carefully collected, scrupulously criticized, remain of no scientific value owing to their presentation and analysis by those unskilled in modern methods. Typographical difficulties offer obstacles to the publication of the original data in their integrity so that competent statisticians are unable to harvest the grain which the original author had not the skill to reap. Sometimes we meet with tedious, inconclusive, or even fallacious arguments where quite an elementary knowledge of statistical methods would have led to a simple and exact conclusion. Sometimes indeed we merely encounter—and this is the smallest evil—the rediscovery of an established truth or the reinvention of a familiar method, but how often do we not feel in reading the work of a writer, sagacious and profound in his own subject, that he would have greatly profited by a knowledge of other statistics published in journals quite disconnected from his specialty!

Within the limits appropriate to a review, *Metron* will endeavor to take the first step towards remedying these defects. It is addressed to those who, cultivating different soils with various implements, nevertheless are busied with statistics; that the results of their labors may become of general utility to science. It is hoped that *Metron* may be a bond of union between statistical workers in different branches, perhaps at length an organ of scientific coordination.

With this object, *Metron* will be catholic; its pages will be open to those who employ no methods beyond the scope of ordinary cultivated men as well as to those who delight in the most refined and subtle developments of mathematical science. There is indeed scope for both schools. Some problems can be solved by the older methods now part of the intellectual stock of all educated persons, others must be investigated with the help of more recondite procedures. Between these extremes are insensible gradations and both orders of inquiry interest science in general and statistical science in particular. It is hoped that both will find in *Metron* an appropriate treatment.

It can not of course be denied that, the simpler the methods employed, the easier is the process of mutual enlightenment which *Metron* is intended to facilitate, since the number of readers capable of profiting by the exposition will be larger. The editors hope therefore that questions will be dealt with as their nature permits. But this is merely the expression of a desire not a condition of publication. The editors do not desire to put any compulsion upon contributors or to gainsay those who will forego a numerous audience for the satisfaction of expressing their ideas in the most concise and accurate style.

The sole necessary condition of approval for publication is that papers shall make a contribution to the theory or practise of statistics of original value and likely to interest a greater or smaller number of students of statistics. Contributions will be inserted as articles or notes in accordance with the importance of the subject matter. Frequently statistical researches lead to fragmentary results, insufficient to form the subject of a paper or even a note, but still offering something of scientific interest or perhaps filling a lacuna in other investigations. Such results will be published under a special heading.

In addition to a bibliography of publications received, each number of the review will contain one or more analyses of statistical works or of results perhaps taken from works not exclusively statistical in character. Each such analysis will deal with a particular branch of statistics, *e. g.*, demographic, sanitary, anthropometric or economic statistics. There will also be an analysis of sources and of mathematical work bearing upon statistics (calculus of probabilities, interpolation, etc.).

Metron is an international review. As it is published in Italy and consequently a majority of the editorial staff are Italians, no doubt the Italian language will at first preponderate in its pages. But the other great international languages, French, English and German, are admitted to its pages on terms of complete equality. It rests with contributors from other countries to increase their share in its pages and to cause to disappear any such difference. It is the wish of the editors that the participation of non-Italian writers shall become larger and larger.

It is believed that many American workers, in the fields of biology, agriculture, and genetics particularly, as well as statisticians in the narrower sense, will be interested in this new journal and wish to have it in their libraries, as well as to use it as a medium of publication.

Raymond Pearl

SPECIAL ARTICLES

FOOT-ROT OF WHEAT

Early last spring attention was called to the occurrence of a foot-rot of wheat in Madison Co., Illinois. Since that time I have made a study of the disease assisted at first by Mrs. E. Young True, employed by the Illinois Natural History Survey, and later by Mr. George H. Dungan, of the Illinois Agricultural Experiment Station.

From the first it appeared probable that a certain fungus was the cause of the disease and as early as last June our notes show that this fungus was universally present and that inoculations with pure cultures gave positive results. The evidence is now so clear and conclusive that I venture to present the following facts as fully established.

1. This fungus was isolated by transfer to agar plates from diseased lesions in practically every case where the attempt was made, even when superficial leafy coverings were stripped away and the remaining surfaces disinfected with mercuric chlorid. In all several hundred such isolations were made. Reports from pathologists in other states indicate similar findings there.

2. No other species of fungus or parasite of any kind, was constantly present, or present in any large percentage of cases.

3. The diseased lesions were always penetrated and largely occupied by a fungous mycelium that agrees in general character with the fungus in question.

4. The diseased wheat stems when placed in conditions of suitable humidity become covered with spores of the fungus.

5. This fungus when inoculated in pure culture, either as spores, mycelium or infected wheat tissue, on the unwounded lower internodes of wheat seedlings in moist chambers produced a condition of disease indistinguishable from foot-rot as it occurred in the field.

6. Plants thus inoculated when placed in a moist chamber soon bore numerous spores of the fungus.

7. Wheat planted in soil in pots or benches with an inoculum consisting of this fungus, either as spores or as a pure culture on wheat, developed typical foot-rot.

8. Wheat when planted in infested soil in the greenhouse developed typical foot-rot and when placed in a moist chamber bore the same fungus found so constantly in association with the disease in the field.

9. The fungus in question is a typical *Helminthosporium* as the genus is now understood. It grows luxuriantly on wheat agar, corn meal agar and numerous other media and on autoclaved leaves or stems of various cereals. The spores, observed as grown on autoclaved wheat leaves or stems in humid air, are from 24 to 122 μ long, the majority of them falling within the limits 80–90 μ with septa or pseudo-septa varying from 0 to 13, usually about 5–10. The spores are typically thickest in the region about midway between the base and the middle point of the spore, approaching a narrow or broadly elliptical shape, tapering somewhat toward each end. They possess an outer dark wall that is thin and extremely fragile and an inner, colorless, thick wall that is frequently soft, gelatinous. Both of these characters of spore wall seem to be common in several other species of *Helminthosporium*. The spores usually, perhaps always, germinate either from one or both ends, not laterally, and are functionally one-celled.

Further discussion of the morphological and histological features and the relation of this *Helminthosporium* to other species common on cereals will be presented later.

All of the above refers solely to foot-rot as observed and studied in material originating in Madison Co., Illinois, or cultures derived from such material.

It is to be noted that this cereal disease, while of the general type of foot-rot known heretofore in Europe, Australia and elsewhere, is caused by an organism not heretofore designated as a cause of foot-rot in any of the publications on foot-rot in such countries.

The foot-rot found in Illinois, therefore, should be recognized as a disease quite distinct from all others of similar type that have been described previously. It is clear from experimental evidence that it is soil-borne and it is probable that it is also seed-borne. How serious the disease may prove to be, how dependent upon environmental conditions of climate and soil, can be told only after one or more years of additional observation.

F. L. Stevens

University of Illinois,

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

A Biochemical theory of the origin of Indianaite: W. N. Logan.

Our decreasing natural gas supply: J. A. Bownocker. A study was made of the natural gas supply from the records of four large companies in West Virginia, Pennsylvania and Ohio. It was shown that the open flow of new wells in West Virginia has decreased 79 per cent. in 10 years; in northwest Pennsylvania 70 per cent. in 7 years, and in southwest Pennsylvania 12 per cent. in 10 years. Changes in rock pressure of new wells are similar. Thus in northwest Pennsylvania there has been a decrease of 37 per cent. in 7 years, and in southwest Pennsylvania a decrease of 34 per cent. in 10 years. In the northern half of West Virginia there has been a decrease of 38 per cent. in the same period. Naturally there has been a proportional decrease in the rock pressure and open flow of all wells. In Ohio the drilling of new territory has kept the averages at a higher figure, but in spite of this the production of gas in the state is decreasing. Ohio gets 60 per cent. of her supply from West Virginia; Pennsylvania about 33 per cent.; Kentucky about 75 per cent., while Maryland and Indiana each draw on the state in a limited way. Manifestly the future supply depends largely on West Virginia. For the two years closing June 30, 1919, the production of natural gas in that state decreased 20 per cent.

Some characteristics of the Balcones fault zone in Bexar county, Texas: E. H. SELLARDS. The Balcones fault zone lies at the inner margin of the Coastal Plains of Texas, and the scarp resulting from the faults is a conspicuous topographic feature which in several counties separates the coastal plains from the high plains of the interior. The fault scarp is most pronounced in Uvalde, Medina, Bexar, Comal, Hayes and Travis counties. The formations observed to have been affected by these faults are those of the Lower and Upper Cretaceous and Eocene, while the Pleistocene formations have not been observed to be affected by faulting. Hence the age of the faults may be between Eocene and the Pleistocene. The number of faults within the fault zone as developed in Bexar county can scarcely be estimated. A few are seen at the surface; a number of others are located by well records, but with little doubt there are many more faults than have been located by either of these methods. They are normal faults with the downthrow to the south in most cases. The faulting is accompanied in some places by gentle folding, and the small oil fields of this county are found apparently upon structurally high areas produced by a combination of faulting and more or less folding. The width of the zone of faulting approximates 25 miles, and yet it remains to be determined how much farther to the south or southeast faulting in this zone may be detected.

The Ozarkian of Missouri: E. B. BRANSON.

The nature of Beatricea undulata: W. H. SHIDELER.

The possibility of a relationship between crystal types and the mode of occurrence of minerals: W. A. TARR. Along with other lines of research on the origin of crystals, the question arises as to whether the mode of occurrence shows an influence upon the type in which a given mineral crystallizes. If physical conditions influence the molecular arrangement this should be the case. A study of 128 common minerals, classified into eight zones shows that there is only a very general influence. The influence of composition appears to be more marked. The higher classes of symmetry are the most abundant in certain zones, yet physical factors do not appear to control the class of symmetry of a mineral. In large groups the physical conditions appear to be a factor but it is questioned whether the chemical factors are not of vastly more importance in these same zones.

An analysis of the process of thrust-faulting: T. T. QUIRKE. It is probable that there is so sharp a zone of division between the surficial plastico-frangible crust and the interior plastico-rigid mass that the part subject to rupture may be considered a separate member even though flow deformation may extend beneath it. Earth stresses due to the adjustment of a plastico-frangible crust to a shrinking interior affect members as wide as the continents and oceans are broad. These members fail near the ends under a stress which is rotational and unequally transmitted throughout the length of each member. The members fail after flexure somewhat in the manner of long columns. This type of rupture combined with a rotational stress makes a strong tendency to rupture at angles low at depth and high near the surface. Immediately after rupture a geologic process of abrasion comes into play. Abrasion is greatest where friction is most intense, at the steep parts of the fault plane. This movement of millions of tons of rock passing several miles along the fault plane will abrade the steep part of the plane to a lower angle and project to the surface the original low angle break. From which it follows that there may be a relation between the steepness of angle and the amount of displacement after rupture.

The mechanical interpretation of joints: WALTER H. BUCHER. On Mine Fork, Magoffin county, Ky., at the crest of an anticline in the upper third of a thick sandstone formation exposed in nearly vertical cliffs, two systems of joints are seen intersecting at an angle of approximately 120°, which is bisected by the horizontal direction. In this case, undoubtedly the joint planes, representing planes of shearing, were formed by simple tension and were arranged in such a way as to have the direction of maximum tension bisect the obtuse angle. In 1896 the French engineer Hartmann published the results of extended experimentation on the planes of shearing in metals, in which he found that the angle formed by the yield planes differs the more from 90° the harder and the more brittle the material is, and that the direction of maximum tension bisects the obtuse angle while that of minimum tension (generally negative, *i. e.*, compression) bisects the acute angle. O. Mohr, in 1900, gave a mathematical theory to account for this behavior. The author demonstrated the usefulness of this relation in interpreting the stress conditions underlying the fracturing of materials in well-known tension, compression and torsion tests. He then proceeded to apply this method to a number of joint systems taken partly from literature and partly from his own field observations, illustrating the three possible types of joint systems (1) max. tension = horizontal, min. tension = vertical (weight of overlying beds); (2) max. tension = horizontal (anticlinal bending), min. tension = horizontal and at right angles together (synclinal bending); and (3) max. tension = vertical (upward relief), min. tension = horizontal.

Notes on concretions: W. A. Tarr. Concretions found in a black shale of the Pennsylvanian in Boone county, Missouri, are believed to be syngenetic in origin. Reasons for so believing are the composition of the concretions (mainly clay and silica), the arching of the beds over them, absence of stratification lines passing through the concretions, lack of evidence of lateral crumpling, slickensides due to the consolidation of the beds around the concretion, and the volume of the concretions.

The Devonian of Ralls county, Missouri: Gilbert P. Moore.

Notes on the coal industries of northeastern France, Belgium, the Saar District and Westphalia: H. F. Crookes.

Data gathered by the writer for the War Damages Board of the American Commission to Negotiate Peace, in Paris, on the coal industry of western Europe, shows, among other things, that, of the reserves of coal, Germany now controls 28 per cent., England 49 per cent., France 7 per cent. and Belgium 4 per cent.

The acquisition by France of the Saar district does not solve that country's future requirements of coking coal for her Lorraine iron ore, because of the fact that it is impracticable to smelt the ore with Saar coke unless it is mixed with about 20 per cent. of Westphalian or equally good coke. Taken alone, Saar coke has been found to have about 67 per cent. the efficiency of Westphalian coke.

With the opening up of the Campine Basin in Belgium, France will be able to reduce her coke imports from Westphalia, but, even so, she must rely on the latter district for her principal supply of blast furnace coke.

Aside from a gain in actual coal reserves of over 16 billion tons, it is estimated that the net monetary gain by the acquisition of the German interests in coal lands, mines, equipment and coke plants in the Saar district is 411 million francs.

The dependence of the French and Belgian metallurgical industries on Westphalian coke is offset by the former's control of iron ore, for France now controls about 85 per cent. of the iron ore reserves of Europe. It has been advocated that a portion of the German indemnity be paid annually in terms of Westphalian coke. This would permit of the entire domestic coal production of both France and Belgium being diverted to industries other than metallurgic, but at best would be only a temporary arrangement. The exchange of iron ore for Westphalian coke, arbitrated by a committee from each country, might be a better solution, and is one that has been recommended.

The influence of the differential compression of sediments on the attitude of bedded rocks: Maurice G. Mehl. The diminution of the height of a column of sediment upon consolidation is brought about chiefly by the loss of water through the weight of the column. The rate of compressibility for shales is greater than for sands because of the differences in the shape of the particles. In the plate-like particles of shale there is a larger surface and hence a greater separating water film per unit volume of shale. The compressibility of sand is very slight while for shale it may be as high as 20 per cent. It follows that any difference in the total thickness of types of sediments with different rates of compressibility in adjacent columns will impart secondary dips to all beds above the irregularities. Unequal thicknesses of totals may arise through the lateral gradation of one type into another or through the actual thinning of a bed of a given type. Likewise any irregularity on an unyielding depositional surface will tend to produce different totals in the overlying columns of sediments. While the small isolated dome-like anticlines typical of the Mid-Continent oil field may have acted as localizing influences for the expression of later thrusts acting through great distances it is thought that these small structural features are chiefly the result of the differential compression of sediments.

Compression of sediments as a factor in the formation of coal basins: E. B. Branson.

On the Pennsylvanian stratigraphy in the mid-continent region: R. C. Moore.

Episodes in Rocky Mountain orogeny: C. L. Dake. West of Cody, along Greybull and Shoshone Rivers, are a series of yellow sandstones and red and gray shales with conglomerate layers. The conglomerates, which include granite pebbles, involve erosion down to the pre-Cambrian, and the beds rest with slight angular unconformity on the Cody (Niobrara and Pierre) shale. These conglomerates are themselves folded and are involved in large overthrust faults. This implies two episodes of deformation, one before and one after the laying down of these beds. The conglomerates are tentatively correlated with the Fort Union, as that formation is described by Hewett and Lupton in recent papers. These workers also recognize two episodes of disturbance, quite probably the same two noted by the writer. One they place as post-Lance and pre-Fort Union, the other as post-Fort Union and pre-Wasatch. If their correlations are correct they find both episodes of diastrophism to be post-Lance. This appears to be contrary to the idea of Knowlton and others who point very definitely to a pre-Lance (pre-Arapahoe) period of folding. We must conclude, therefore, either that the so-called Lance and Fort Union of the Big Horn Basin, as the terms are used by Hewett and Lupton, are not the equivalents of the Lance and Fort Union described by Knowlton, or else we must conclude that there are three episodes in the orogeny of the Rocky Mountains, one pre-Lance and two post-Lance.

The present status of the Pleistocene in Illinois: MORRIS M. LEIGHTON. Detailed studies on the Pleistocene in Illinois, begun in 1886 under the supervision of Professor T. C. Chamberlin, led to the publication in 1899 of Monograph XXXVIII. on "The Illinois Glacial Lobe," by Mr. Frank Leverett. Aside from certain obscure problems which were left for further study, two important questions have since arisen from changes and shifts in the classification of American drift-sheets. When the verity of the Iowan epoch was questioned, subsequent to the publication of Monograph XXXVIII. the Iowan drift in Illinois was discarded. Since then, the area has been referred to the Illinoian stage, then to a substage of the Illinoian, and still more recently a considerable portion has been suggested as being possibly Early Wisconsin. Whether the drift in northwestern Illinois is wholly or in part Illinoian, Iowan or Early Wisconsin remains to be determined by critical and comparative field-work. The Wisconsin drift deposits were divided into two major drifts in Monograph XXXVIII. but later were reduced to two subordinate stages, and more recently a suspension of the sub-stages "Earlier" and "Later" has been proposed. An early critical study of the drift of northwestern Illinois and of the basis of classification of the Wisconsin drift-sheets is contemplated.

A possible factor in the origin of dolomite: W. A. TARR. It is believed from the study of the areal and time distribution of dolomite that its origin is directly dependent upon shallow continental seas, or lakes, for the necessary concentration of magnesium salts in sufficient amounts for its formation; that the deposition took place upon the sea or lake bottom; that in such seas or lakes we have an adequate source of magnesium; and that such a mode of origin is compatible with the interbedding of dolomite with limestone.

Some glacier studies in Alaska: ROLLIN T. CHAMBERLIN. The ultimate purpose of these studies was to obtain a better understanding of the true nature of glacier motion. Some of the more immediate purposes were to demonstrate movement along definite shear planes which would indicate brittleness and rigidity of materials; and also to determine what relation there might be between the rate of shearing and the temperature, time of day, daily range of temperature, amount of water entering the ice, and variable meteorological conditions. This investigation was undertaken by means of a self-recording clock-work apparatus which was attached to two rods driven into the ice, one above the fracture plane to be investigated and the other below it. The apparatus was sensitive to shearing amounting to as little as one hundredth of an inch. Many difficulties were encountered and only indifferent success achieved. Such records as were obtained seemed to indicate that shearing was more rapid between 6 P.M. and midnight than between 6 A.M. and noon. This would not be at the time of greatest melting but lagging after it. It would be when there was the most water in the ice. A study of the "sloughing off" of Child's Glacier and especially the relation between the shearing planes and the blue bands constituted an important and critical part of the investigation.

The stratigraphy of the Chester series of southern Indiana: CLYDE A. MALOTT AND J. D. THOMPSON, JR. The following is the first attempt to give the entire detailed stratigraphy of the Chester Series of Indiana, using the names adopted by the Kentucky and Illinois surveys and by the writer in a former publication:

BUFFALO WALLOW Formation	Siberia ls. at base, 1–12 feet; overlaid by some 60 feet of sandy sh. and a thin ls.
TAR SPRINGS Formation	Massive ss., 0–75 feet, and sh., 50–125 feet; thin impure limestones in shale when ss. is absent or thin.
GLEN DEAN Limestone	Massive, often oolitic limestone; 10–45 feet.

Hardinsburg Sandstone	Hard, flaggy ss., with some sh. above and below; 25–40 feet.
Golconda Limestone	Bedded to massive ls., often oolitic; contains chert; and frequently thin sh. bands; 0–40 feet.
Indian Springs Shale	20 feet of olive sh. characteristically underlies the Golconda limestone.
Cypress Sandstone	Massive, laminated, friable, yellow ss.; 25–45 feet.
Beech Creek Limestone	Bedded to massive, compact ls.; 8–25 feet.
Elwren Sandstone	Ss. not persistent; the interval often entirely sh.; 15–60 feet. Local unconformity at the base.
Reelsville Limestone	Compact to oolitic, pyritiferous; wethers red; one ledge at north; some sh. at south; 0–12 feet.
Brandy Run Sandstone	Massive to bedded ss.; usually some sh. above and below the ss.; 10–65 feet. Local unconformity at base.
Beaver Bend Limestone	Bedded to massive, cream-colored, usually oolitic ls.; 2–20 feet.
Sample Sandstone	Usually massive and accompanied by sh.; interval frequently all sh.; 10–40 feet.
MITCHELL LIMESTONE GROUP	
Gasper Oolite Limestone	Compact to oolitic ls., 15–40 feet. Lower Gasper of K Major unconformity at base. Bottom of Chester following Weller.
Fredonia Oolite Limestone	Compact, lithographic and white, finely oolitic ls.; 60–80 feet. Major unconformity at base. Bottom of Chester following Ulrich.
St. Louis Limestone	

The correlation of coal seams by means of spore-exines: Reinhardt Thiessen. On microscopic examination of sections of different coal seams it is readily seen that each seam presents certain appearances and certain constituents that are common to all sections from the one seam but which differ in some respects from those in any other seam. The spore-exines in particular have very definite and clearly defined characteristics, such as form, size and sculpturing by means of which different kinds can easily be distinguished from one another. These spore characteristics have been so well preserved in almost all coals that the spores of one species of plants can be clearly distinguished from those of other species. In examining the spore-exines of a number of sections of one seam, it is soon found that by far the larger bulk of the spore-exines of that seam are often very largely of the same kind. In some, two kinds, while in others, three kinds of exines may form the main bulk. In comparing the predominating exines of one seam with those of another it is not difficult to see that those of one bed are different in some way from those of any other. Occasionally there will be found in a given coal seam a spore-exine that differs materially from those found in other seams. This spore-exine is a distinguishing characteristic of the coal seam in question but not in general the predominant one. As is the case in the peat forming bogs of to-day, where each bog or series of bogs contains one, two or three species of plants that predominate, so in the peat bogs of the Coal Age, each bog giving rise to a future coal seam must have contained one, two, or three, sometimes perhaps more, species of plants predominating in that bog and differing from those of bogs of any other time or perhaps locality. There are sufficient grounds for the broad statement that, as far as they have been examined, each coal seam contains one or more kinds of spore-exines that are predominant and characteristic, or if not predominant, are at least characteristic of that seam. By this means any seam may readily and easily be distinguished from any other.

Climate and geology: Stephen S. Visher. It is being increasingly realized that a knowledge of climate is very helpful to geologists. (1) In order to understand differences in weathering, erosion, transportation and deposition, climate and its differences must be understood. (2) Paleoclimatology, or the study of the climates of the geologic past is an important aspect of historical geology. Several very eminent geologists have studied ancient climates and the influence of climate and have enriched the science of geology greatly by so doing. They have urged further study of this by no means exhausted subject. Davis, Barrell, and Huntington have contributed much to an appreciation of the importance of climate in physiography and sedimentation. Schuchert has given the best summary of the climates of geologic time. Chamberlin (T. C.) was led by his study of glacial climates to formulate several hypotheses which have done much to advance geology (see "The Origin of the Earth"). The recently published work of Ellsworth Huntington concerning changes of climate is of notable interest to geologists. The data he has accumulated and the stimulating hypotheses he has advanced to interpret these data are worthy of most serious consideration. The importance of climate and the promised fruitfulness of its study has led the speaker to attempt to facilitate its study by summarizing what is known as to climate under the title "Laws of Climate." This summary will be published soon in *The Monthly Weather Review.*

A notable case of successive stream piracy in southern Indiana: CLYDE A. MALOTT. This paper deals with the Knobstone cuesta region lying between the Muscatatook and Ohio Rivers near the eastern margin of the driftless area of southern Indiana. Its purpose is to show specifically the responsibility of the geologic structure and topographic condition in drainage adjustment. Details shown how the particular lithologic units with their regional westward dip are important conditioning factors in giving rise to topographic forms. Other conditioning factors scarcely less important are the so-called time factors, such as various uplifts, rejuvenation and glaciation. The peculiarity of the streams flowing east from the Knobstone escarpment is noted. Blue River with its peculiar unchanging gradient is discussed in some detail, as it is representative of all the streams on the backslope of the cuesta. It is shown that the piracy of the Muddy Fork of Silver Creek has taken place as a result of the geologic structure and topographic condition along the Knobstone cuesta. It is not a single instance of piracy, but consists of successive piracy wherein a large number of tributaries belonging to a single system have been annexed one after another to the drainage system of the invading stream. Some 35 square miles have been stolen. The conditions are highly favorable for piracy to continue, and eventually the largest part of the Muddy Fork of Blue River will be taken over by the Muddy Fork of Silver Creek. Such piracy will continue until a balanced condition of the gradients of the two stream systems is reached. Such a condition will mark the beginning of old age of the stream systems, when stream adjustments are practically complete.

The Satsop formation and structure of the Cascade range: J. HARLEN BRETZ.

Geotectonic economy of thrust-faulting: CHARLES R. KEYES.

ROLLIN T. CHAMBERLIN,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

THE two hundred and tenth regular meeting of the society was held at Columbia University on Saturday, April 24, extending through the usual morning and afternoon sessions. The total attendance exceeded one hundred and thirty and included eighty-two members. President Frank Morley occupied the chair, yielding it to ex-President R. S. Woodward during the presentation of the papers on relativity at the afternoon session. The Council reported the election of the following persons to membership in the Society: Professor H. S. Everett, Bucknell University; Dr. J. L. Rouse, University of Michigan; Professor Nilos Sakellariou, University of Athens; Mr. H. L. Smith, University of Wisconsin; Professor Eugene Taylor, University of Wisconsin; Professor W. P. Webber, University of Pittsburgh. Thirteen applications for membership were received.

Professor L. P. Eisenhart was reelected to the Editorial Committee of the *Transactions,* for a term of three years. Professor P. F. Smith will retire from the Editorial Committee on October 1, after nine years' service as editor, and Professor G. D. Birkhoff will fill out Professor Smith's unexpired term. Professor Oswald Veblen was appointed a representative of the society in the Division of Physical Sciences of the National Research Council for a term of three years. Professor Veblen's Cambridge Colloquium lectures on Analysis Situs will be published by the society in the fall. Committees were appointed to confer with a committee of the Mathematical Association on joint plans for future meetings and to prepare nominations for officers for the annual election next December.

On the recommendation of the Council it was unanimously voted to incorporate the society under the membership corporations law of the state of New York. The new form of organization will involve hardly any changes beyond those necessary to comply with legal requirements. The board of trustees will be composed of those members of the Council who are elected by the society, the ex-officio members not being eligible as trustees. Otherwise the constitution and by-laws, which have come down from the beginnings of the society and which are a highly efficient instrument of government, well worthy of study, will remain practically as they stand.

The committee on reorganization of the society is actively engaged in preparing plans for carrying on the administrative work after the present year and enlarging the society's income. It will make specific recommendations at a later meeting. A report was received from the committee on the International Mathematical Union, and the formation of an American Section of the Union was approved. The report of the committee on bibliography, recommending the establishment of a journal of mathematical abstracts, was approved, and the committee was authorized to take steps toward securing the necessary financial support.

In the interval between the sessions over fifty members and friends took luncheon at the Faculty Club; thirty gathered there at the dinner after the meeting.

The greater part of the afternoon session was devoted to a symposium on Relativity at which the following papers were presented:

1. "The physical and philosophical significance of the principle of relativity," by Professor Leigh Page, of Yale University.

2. "Geometric aspects of the Einstein theory," by Professor L. P. Eisenhart, of Princeton University.

The regular program consisted of the following papers:

N. A. Court: "On a pencil of nodal cubics."

E. L. Post: "Introduction to a general theory of elementary propositions."

E. L. Post: "Determination of all closed systems of truth tables."

Jesse Douglas: "The dual of area and volume."

J. K. Whittemore: "Reciprocity in a problem of relative maxima and minima."

I. A. Barnett: "Linear partial differential equations with a continuous infinitude of variables."

I. A. Barnett: "Functionals invariant under one-parameter continuous groups in the space of continuous functions."

T. R. Hollcroft: "A classification of plane involutions of order four."

Tobias Dantzig: "A group of line-to-line transformations."

A. R. Schweitzer: "On the iterative properties of the abstract field."

J. F. Ritt: "On the conformal mapping of a region into a part of itself."

L. R. Ford: "A theorem relative to rational approximations to irrational complex numbers."

L. E. Dickson: "Recent progress in the theory of numbers."

G. D. Birkhoff: "Note on the ordinary linear differential equation of the second order."

Joseph Lipka: "The motion of a particle on a surface under any positional forces."

Joseph Lipka: "Note on velocity systems in a general curved space of n dimensions."

J. E. Rowe: "Testing the legitimacy of empirical equations by an analytical method."

Oswald Veblen: "Relations between certain matrices used in analysis situs."

O. D. Kellogg: "A simple proof of a closure theorem for orthogonal function sets."

C. L. E. Moore: "Rotation surfaces of constant curvature in a space of four dimensions."

H. S. Vandiver: "On Kummer's memoir of 1857 concerning Fermat's last theorem."

Nilos Sakellariou: "A note on the theory of flexion."

Abstracts of the papers will be published in the secretary's report in the July issue of the society's *Bulletin*.

The Chicago Section held a two-day meeting at Chicago on April 9–10, the program including a symposium on the Maxwell field equations and the theory of relativity. The San Francisco Section met at Stanford University on April 10.

The twenty-seventh summer meeting and ninth colloquium of the society will be held at the University of Chicago during the week of September 6–11. The colloquium will open on Wednesday, and will consist of two courses of five lectures each by Professor G. D. Birkhoff, of Harvard University, on "Dynamical systems," and Professor F. R. Moulton, of the University of Chicago, on "Certain topics in functions of infinitely many variables."

F. N. COLE,
Secretary

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The subscription price of NATURE in England is now $10.50. It has been possible to supply SCIENCE at the present rates only on account of the advertisements. But advertising contracts are usually for a year, and the increases in the cost of printing and paper during 1920 have been such that the charges for most of the advertisements in the journal are now less than the actual cost of printing them. The rates have been increased for new contracts, but with continually increasing prices they now only about meet the cost of printing, except when preferred positions are purchased.

Scientific men assist SCIENCE by ordering apparatus, supplies, etc., for themselves and their laboratories from the firms that advertise in the journal. This they can do to advantage, for the firms are the best in the United States. It is also of help when those who make purchases owing to an advertisement in SCIENCE state this fact in their correspondence. All scientific men would probably wish their books to be advertised where they are brought to the attention of those most interested, and it is of assistance when this fact is stated to publishers.

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SCIENCE

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CONTENTS

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SUGGESTIONS FOR PHYSICAL INVESTIGATIONS BEARING UPON FUNDAMENTAL PROBLEMS OF PHYSIOLOGY AND MEDICINE[1]

SINCE diseased conditions imply deranged cell-processes—leading to failure of local functioning or to defective coordination between the activities of different parts of the organism—it is clear that the problem of preventing and rectifying such derangements in man (the problem of medicine) resolves itself ultimately into the means by which cell-processes can be restored to the normal after disturbance. A scientific (as distinguished from an empirical) knowledge of how to restore normal conditions must be based on an exact knowledge of the conditions determining normal protoplasmic activity, and this knowledge presupposes a fuller insight into the fundamental physico-chemical constitution of protoplasm, since it is only through an understanding of the properties of the essential living substance that we can hope to understand how the living system acts under different conditions.

The fundamental questions are thus: what kind of a system, in the physico-chemical sense, is living protoplasm? and what are the conditions of equilibrium, *i. e.*, of normal self-maintenance, of such a system?

As a physico-chemical system protoplasm is peculiar in various respects, of which perhaps the chief are:

1. The self-maintenance of the system through its own continued chemical activity; *i. e.*, the preservation of the normal equilibrium—or continued life—depends upon the active continuance of the chemical processes

[1] Contribution to the discussion at the Conference on Biophysics held by the National Research Council, Division of Medical Sciences, at Washington, February 21, 1920.

of the protoplasmic system, *i. e.*, upon metabolism.

2. This metabolism involves a continual construction of complex specific compounds—typically compounds of high chemical potential—to replace those disintegrated (as a result or oxidation or otherwise) in the energy-yielding or otherwise destructive processes of protoplasm.

3. The rate and in part the character of both the energy-yielding and the constructive metabolism are readily influenced by changes in the external conditions: *i. e.*, protoplasm is a characteristically *irritable* system—one of unstable equilibrium.

4. The ratio of constructive to destructive metabolism may vary widely under different conditions; excess of construction over destruction involves growth; equality of the two is equilibrium, implying a stationary condition as regards size and properties; while excess of destruction leads to regression, as in starvation. Obviously regression, if sufficient, must impair functional capacity and eventually lead to death.

5. The power of *growth* is thus inherent or potential in all forms of protoplasm during life. Those pathological problems which relate to excessive or otherwise abnormal growth or proliferation (*e. g.*, the case of tumors) thus require for their scientific solution a knowledge of the physico-chemical conditions of normal growth.

It is evident, since growth is an inherent property of the living system—*i. e.*, since the continuance of the living state depends on this power of specific construction—that the problems just cited relate themselves directly to the general group of problems having reference to the essential physico-chemical constitution of protoplasm. The protoplasmic system is primarily a growing or synthesizing system, at the same time as it is a system which continually yields material and energy to the surroundings through the chemical breakdown of certain components. The chief aim of general physiology is to understand the type of physical and chemical constitution that makes possible chemical activities of this general kind.

Experiment shows that destroying the structure of protoplasm, by mechanical or other means, destroys most (though not all) of its chemical activity (including the latter's susceptibility to electrical influence), and in particular its power of specific synthesis or growth. Hence this power must depend on the special structure of the system. The chemical reactions constituting metabolism take place within a field or substratum having a special type of structure (*i. e.*, arrangement of phases); and the nature and rate of the metabolic reactions are controlled by the structural conditions present. These structural conditions are themselves produced by the growth of the system itself, or of another system having similar properties.

It must be recognized that the problem of the fundamental constitution of living protoplasm underlies all of the problems of biology—including ultimately those of medicine, as a branch of applied biology. It is therefore all-important from the practical as well as from the purely scientific standpoint that this problem should be the subject of continual and active study and investigation.

Physical Processes of Fundamental Importance in Protoplasmic Activities.—The research of the past fifteen years has made especially clear the importance of surface-processes in the activity of living matter. The behavior and properties of colloids (the substances composing most of the solid material of protoplasm) are largely determined by surface conditions (adsorption, variations of phase-boundary potentials, interfacial tensions). Electrical stimulation depends upon sudden changes in the electrical polarization of the semi-permeable surfaces of the irritable cell. Protoplasmic movement (muscular contraction, etc.) is almost certainly due in most cases to the changing surface-tension of the structural elements composing the contractile fibrils. Growth processes show various significant resemblances to structure-forming processes occurring under the influence of local electrolysis at metallic surfaces in contact with electrolyte solutions (formation of precipitation-tubules of zinc or iron ferricyanide, rust-patterns, etc.). Transmission-effects in protoplasmic systems (*i. e.*, in nerve, etc.) may be closely paralleled by processes of chemical transmission or distance-action in film-covered metallic systems, like passive iron in nitric acid or mercury in hydrogen peroxide. Many cell-processes are associated with changes in the osmotic properties or permeability of the protoplasmic surface-films or plasma-membranes. The high development of surface layers or membranes is in fact a long-recognized structural peculiarity of living matter. The prevalence of the cellular type of organization is in itself evidence of the fundamental importance of this condition.

These general facts indicate strongly that for the purpose of gaining further insight into the physico-chemical constitution of living matter a more thorough and detailed study (1) of the general properties of surfaces (their structure, tension, electrical properties, etc.), (2) of the layers of material formed at surfaces (surface-films, etc.), and (3) of phenomena dependent on surface conditions (adsorption, catalytic effects, flocking and peptization of colloids, etc.), is all-essential. Probably the purely physical or chemical investigation of these problems will best be undertaken by students trained in the methods of physics and physical chemistry. Data or principles so obtained can then be applied to biological or medical problems by those specially qualified to deal with such problems.

There is much evidence that living protoplasm is essentially *emulsion-like* in its fundamental physical constitution; and it is known that the properties of emulsions are largely determined by the presence of interfacial films and by the electrical and other conditions resident at the phase-boundaries. The general physical and chemical conditions affecting the stability and properties of emulsion-systems are thus in large part identical with those affecting the stability and properties of living protoplasm. As is well known, emulsions are mixtures of two (or more) mutually insoluble liquids, of which one is in a state of fine division and dispersed throughout the other; for stability a third substance (*e. g.*, soap), forming a surface-film between the two phases, is usually required. Recent work has shown that the properties of oil-water emulsions may be made to vary in a remarkable manner by varying the salt-content of the system, and that these changes depend upon the solubilities of the soaps formed and upon their surface-activity. Many surprisingly close parallels between the effects of different combinations of salts on emulsion-systems and on living protoplasmic systems have been demonstrated. It is well known that the presence of inorganic salts in definite proportions is essential to the normal activity of most living cells. Such results, therefore, indicate the importance of initiating and extending researches which will have as their object the determination of the relation between the soluble substances (both electrolytes and non-electrolytes) present in emulsion-systems and the general physical properties and behavior of such systems. Light may thus be thrown upon the general properties of protoplasm (mechanical properties, structure, permeability, electrical properties), in so far as these properties are determined by the emulsion-like constitution of the system.

This emulsion-structure, however, furnishes only the field or substratum in which the essential chemical reactions (or metabolism) of the living protoplasm proceed. The special nature of these chemical processes determines the special properties and behavior of the protoplasmic system. Hence the relation of the film-pervaded or emulsion-like structure of protoplasm to the special type of chemical activity exhibited by the living system should be thoroughly studied and investigated. There are many indications that the extraordinary chemical capabilities of living matter are dependent upon the extent of its surface development: *i. e.*, that the influence of protoplasm in inducing chemical reactions not found elsewhere is essentially the result of the special predominance of surface influences of a peculiar kind. And since the sensitivity of living matter to the electric current is one of its most characteristic peculiarities, it appears probable that the chemical reactions in protoplasm are largely controlled by variations in the electrical potential-differences present at the various protoplasmic phase-boundaries (the surfaces of membranes, fibrils, etc.). At present our knowledge of chemical processes occurring under electrical control is almost entirely confined to those observed at the surfaces of metallic electrodes in contact with electrolyte solutions. These are the well-known phenomena of electrolysis. Knowledge of such processes should be extended to include the case of electrolysis at other interfaces, *e. g.*, between an oil phase and a water phase. The technical difficulty here appears to be largely one of conducting the current through the non-aqueous phase. But since many of the chemical reactions in protoplasm are demonstrably under electrical control, it is clear that metallic surfaces (*i. e.*, metallic electrodes) are not necessary to the production of chemical effects by the electric current. Apparently in the living cell surfaces of other composition play the same part. There seems to be here a field of investigation which should throw much light upon the conditions of the chemical processes in protoplasm. The phenomena of polar stimulation, polar disintegration and similar effects in physiology are an obvious counterpart of the polar differences between the chemical effects of anode and cathode in electrolysis. Undoubtedly the same fundamental basis exists for the polarity in the chemical effects of the electric current in the living and in the non-living systems. The effects produced by passing currents through appropriately constituted emulsion-systems containing readily alterable (*e. g.*, oxidizable) chemical compounds might well be investigated to advantage in relation to this problem. Closely related also would be a study of the surface-films formed at the interfaces between pairs of fluids, or between fluids and solids, and the effects of electrical and other conditions upon such films.

Progress in these and related departments of physical research would undoubtedly be of great service to general physiology at the present stage of its development. Many fundamental physiological processes—growth, cell-division, muscular contraction, response to stimulation, transmission of stimuli, chemical control of metabolism, etc.—must remain imperfectly intelligible without the extension of exact knowledge in these fields. The possibilities of the control of vital processes, including the control of diseased conditions, would certainly be greatly enlarged with a more fully developed general physiology. The problems suggested above have many aspects of purely physical and chemical interest, apart from their physiological bearing; and it is to be hoped that properly equipped investigators may be found to engage in their study.

Ralph S. Lillie
Clark University,
Worcester, Mass.

THE LONGNECK SAUROPOD BAROSAURUS[1]

In 1889 Professor O. C. Marsh secured from the shales overlying the sandstones following the marine Jura, near Piedmont on the eastern "Rim" of the Black Hills, various fragmentary caudals of a huge sauropod. In these he recognized a new type which he called *Barosaurus lentus*. He had been kindly advised of the occurrence, and was accompanied by the noted collector J. B. Hatcher, but attempted no adequate excavation.

Nine years later, in the midwinter of 1898, after a friendly letter from Professor Marsh, I visited him at New Haven and discussed the subject of field work in the west for the succeeding summer. Knowing that after Hatcher left Yale several years earlier the field work on the Dinosauria had suffered, I

[1] 1890. O. C. Marsh, *Barosaurus lentus* gen. et spec. nov. in "Description of New Dinosaurian Reptiles," *Amer. Jour. Sci.*, January, page 86, Figs. 1 and 2. 1919. R. S. Lull, "The Sauropod *Dinosaur Barosaurus* Marsh—Redescription of the Type Specimens in the Peabody Museum, Yale University," *Memoirs of the Connecticut Academy of Arts and Sciences*, Vol. VI., pp. 1–42, with figures in text and 7 plates.

wished to begin with that group, through general interest in the reptilia. But two other subjects also claimed attention—the fossil cycads and the great turtles of the Pierre. The cycads I had wished to hunt for when in the Black Hills; and the studies begun with the discovery of the huge *Archelon,* the most remarkable of sea-turtles, urgently needed continuation. However, as to which subjects should take the precedence Professor Marsh was close to obdurate—they should be within my interest. This I recall pleasantly; for mayhap vertebrate paleontologists are a bit prone to use the word "direct" with a sort of obviousness. It may occur on labels in letters of inconsistent size, or in descriptions. But this was not Marsh, as I can testify. He advised with others, however meager their experience, was anxious for their best word, and valued the mental sanction of those he worked with. Only may this be called direction in the sense of singling out the roadway along which to make history. And in this sense, when it came to the fossil-bearing horizons of the west, was there ever another such a man as Marsh? He said, as I left for the field—"The Black Hills are a diamond edition of geology, prepared especially for the use of geologists by the Almighty."

Accordingly, in the latter part of August, 1898, I began the excavation for *Barosaurus.* This I carried out alone. The quarry was extended to a sixty-foot front, and ran some thirty feet back to a depth of ten feet. The first material secured was fragmentary and seemed to run out following a group of good caudals. Then a well-conserved portion of a proximal caudal, probably No. 1 was uncovered; but on interrupting the work for further prospecting for the cycads and dinosaurs, the centrum was found cut off by an ugly shear. Nearly decided that the lead had come to an end, on working down to a two-foot lower level, various dorsals, a few chevrons, rib fragments, and a sternal plate, promised a rather featureless aggregate. Much checking with extreme lightness of the vertebral structure made it necessary to hold all parts in place as uncovered. This slow task lasted into the late fall, when cold and dust storms made excavation difficult.

Finally, in the course of working forward, there came four cervicals running up to one with a centrum three feet long, at once recognized as unparalleled in the Dinosauria; though much more robust types as long are now known. It then appeared that the main group of skeletal elements, although much displaced, or only partly conserved, represented a single individual; but unluckily the long cervicals led out to a gullied surface. All possibility of further recovery was at an end. Yet the result seemed a real triumph, over which Marsh was quite elated; he held in hand novel Dinosaurian material new from the field.

And now, after twenty-two years Professor Lull, of Yale, has described this unique type in the excellent memoir of the Connecticut Academy cited. Since its discovery, Riggs has named a very striking sauropodan from Colorado, *Brachiosaurus altithorax,* from the huge humeri exceeding in size the femora; while the related *Gigantosaurus* was later found in the Tendaguru of East Africa. These are quite the largest of Dinosaurs. Also, *Diplodocus* has been redintegrated with signal success at the Carnegie Museum of Pittsburgh.

The *Barosaurus* has, as Marsh thought, some resemblance to *Diplodocus.* In that genus length of neck, dorsal shortness, and great caudal length, are correlated with lightness of vertebral structure. In *Barosaurus* the vertebral type is very similar, with shortness of the dorsum. But Professor Lull finds a strong presumption that the humerus exceeded the femur in length, as in the American and African high-shouldered sauropods; while the length of neck is extreme, with a lesser caudal length.

Fortunately *Barosaurus* (type) includes in good condition at least the proximal half of the pubis. The pubis is one of the most variable and characteristic skeletal elements throughout the Dinosauria, and Lull finds a primary resemblance to *Diplodocus* which may possibly be contested. It is true that there is in both forms a long shaft constriction. But in *Barosaurus* the ischiatic contact is not short, but long or rather deep, and concave as in *Apatosaurus*. The type is in this feature composite. In fact if a form uniting features of the greater sauropods, including the *Camarasaurus*, were sought, so far as public features go, *Barosaurus* might well be named.

Regarding a proximal femur fragment which is found to far exceed the proportions in *Diplodocus*, I may say that in no case is the femoral size absolutely determinate as large. The group of fragments from a Piedmont village "rock pile" or "fossil heap" purported to come from the *Barosaurus* quarry site. But only seven miles northerly there was an exposure of a fast disappearing Dinosaur bone bed several acres in extent. Being all outside the frost line, the material present in variety was much checked and broken. So fragments of limb bones could have been taken from this point to the "rock pile" at Piedmont, mainly, if not exclusively from the real *Barosaurus* outcrop. Or again, if the record fails, it is to be recalled that a second (though actually smaller) dinosaurian was recognized by Marsh in the material from the outer edge of the quarry, as confirmed by Lull. The point is that if a second form could so occur on the erosion or quarry front, then there might also be a third. A waterway, stream, or trend of some kind is indicated.

It is worthy of addition that in the *Barosaurus* quarry well inside the frost line, there were various fragments of charred or carbonized wood passing into silicified structure. Such material from the Morrison has not been studied. Also, various pebbles of a singular smoothness were noted at only one point close to the main group of dorsals. As the specimen was incomplete the reasonable explanation that these were stomach stones, or as later called, dinosaurian gastroliths, did not then occur to me, their true character being first recognized in examples from the Big Horn mountains.

Obviously *Barosaurus lentus* is a remarkable dinosaur from several points of view. It comes from far to the north and east of the Wyoming localities, and shows the great extent of the Como beds, as Marsh called them. The parallel with the African types adds great interest to *Barosaurus*. As a specimen it promised little of determinate value after two months quarry work, and then suddenly turned out to be, "except for the lack of limbs, one of the finest of all Yale specimens." The type remains somewhat isolated because collecting along the inner edge of the Black Hills "Rim," though never hopeless, is always much limited by the long talus slopes hiding the Morrison. This formation encloses the Hills and the Bear Lodge horseshoe-like, with the open heel on the southeast from north of Buffalo Gap to near Minnekahta. On the west side of the Hills the maximum thickness of 200 feet is reached. There, as further west in the Big Horn Rim and in the Freeze Outs, is found the association of the smaller silicified cycads with the sauropod Dinosaurs. And both in the Morrison, and in the overlying Lakota, from the lowermost strata of which comes the fine cycadeoid *Nilssonia nigracollensis*, a long contemporary cycadophytan and dicotyl record of the Comanchean is yet to be brought to light. Reconnaissance in this important field is but begun.

G. R. Wieland

Yale University

LOUIS VALENTINE PIRSSON

Professor of physical geology in the Sheffield Scientific School of Yale University for twenty-one years, after rapid promotion from the position of instructor in geology and lithology, to which he was appointed in 1892; Professor Pirsson also occupied a position of commanding importance in the administrative work of the Scientific School, as member of the governing board, and as assistant to the director, Professor Chittenden, in matters of discipline and general policy. An assistant in analytical chemistry for six years after graduation from the Scientific School, he taught for a year in the Brooklyn Polytechnic Institute, and then became interested in geology and petrography as an assistant field-worker for the U. S. Geological Survey in the Yellowstone National Park; carrying on studies in mineralogy and petrography in Professor Penfield's laboratory, and afterwards with Rosenbusch in Heidelberg and with Lacroix in Paris. For nine years he was an assistant and special expert on the U. S. Geological Survey, and since 1904 a geologist in this service.

Although a successful teacher of physical geology to undergraduate students, his special interests were in petrology, which he taught to graduate students, and to which he devoted more than half of his time and most of his thought, as may be seen in his publications. His research work was almost wholly petrological. Beginning with his observations of igneous rocks in the Yellowstone Park, he studied independently, and in conjunction with W. H. Weed, the districts of Castle Mountain, Judith river basin, the Highwood and Little Belt Mountains, and other localities in Montana; and he contributed numerous papers on the petrography of New Hampshire in the region of Squam Lake. He was joint author with Cross, Iddings and Washington of a Quantitative System of Classification of Igneous Rocks.

Professor Pirsson was especially successful in the preparation of text-books. His elementary work on "Rocks and Rock Minerals," written for a course of instruction without the use of microscopical methods of diagnosis, has been in general use for the past twelve years. Later he prepared a text-book for his undergraduate class in physical geology which is highly esteemed and widely used; the historical part of the volume having been written by Professor Schuchert. A more elementary form of the work was under consideration shortly before his death. He had begun an elementary petrography which was left unfinished, greatly to the regret of teachers of the subject.

In addition to being a careful observer and a painstaking and industrious student, he was methodical and systematic in his work, and thorough in his treatment of a subject. Moreover, he recognized the importance of emphasizing fundamental principles. He was an associate editor of the *American Journal of Science* from 1897 to the time of his death. There was a definiteness in his conceptions and in his statements that rendered his teaching effective and commanded the respect of his students. Confident in his own judgment, and tenacious of his convictions, he was at the same time considerate of the opinions of others and conscientious in his dealings with them.

By temperament cautious, he was reserved in his intercourse with strangers, but genial and outspoken in the company of friends. A man of great patience and of simple tastes, he enjoyed a quiet life in the study of nature, being especially fond of watching birds and wild animals, and of the sport of fishing; and having a photographic memory for details and a fine sense of humor, he was an entertaining story-teller, and occasionally contributed his experiences to *Forest and Stream.*

In recognition of his scientific attainments he was made a member of the National Academy of Sciences, American Philosophical Society, Geological Society of America, of which he was vice-president in 1915; fellow of the American Academy of Arts and Sciences, Connecticut Academy of Arts and Sciences, Washington Academy of Sciences, Geological Society of Washington, and an honorary member of the Geological Society of Stockholm.

Louis Pirsson was born in New York City, November 3, 1860, was prepared for college at a private school, graduated from the Sheffield Scientific School of Yale with the degree of Ph.B., in 1882, and was given the degree of A.M. by Yale University in 1902. He studied petrography in Heidelberg and Paris in 1892. In 1902 he married Eliza Trumbull Brush, of New Haven, daughter of Professor George J. Brush. His death, after prolonged illness from rheumatism, is a severe blow to the science of petrology, of which he was the foremost teacher in this country, and a sad bereavement to his colleagues with whom he maintained the friendliest relations.

J. P. Iddings

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FOURTH ANNUAL MEETING OF THE PACIFIC DIVISION

The fourth annual meeting of the Pacific Division, of the American Association for the Advancement of Science will be held at Seattle in quarters provided by the University of Washington on June 17–19, 1920.

The 1919 meeting held at Pasadena was a pronounced success, exceeding in point of interest and attendance any previous meeting, and fully justifying the wisdom of the national council in providing for a geographic division of the American Association to accommodate the large and active membership residing west of the Rocky Mountains.

Notwithstanding the long distance between centers of population on the Pacific coast, or perhaps rather on account of them, the executive committee has pursued the plan of holding the annual meetings alternately in different and widely separated sections of the Pacific Coast area, believing that although the largest attendance is not to be realized in this way, it best subserves the purposes of the organization in stimulating an active interest in science throughout the district and in promoting that cooperation among scientific men which must be effective in meeting local problems.

The Exploration of the North Pacific Ocean was discussed at the Pasadena meeting in a symposium which outlined in a general way the urgent need of launching this project and the great practical benefits which must accrue. Some of the many scientific problems involved in the undertaking were also presented by prominent specialists who took part in the symposium. Credit should be given to Dr. William E. Ritter, of the Scripps Institution for Biological Research, who fathered this symposium and whose vision of the great economic and scientific advantages to be gained by international cooperation in this enterprise now seems in process of realization. At least the attention of the National Research Council is directed to the matter and a committee has been appointed which will report on ways and means. This committee has already held one meeting and will meet again in Honolulu in August of this year. This great enterprise is felt to be of peculiar significance to the Pacific coast, and a second symposium on "The Animal and Plant Resources of the North Pacific Ocean" will be presented at the Seattle meeting. Naturally the fisheries, as constituting the most considerable present resource of the ocean, will receive major consideration in this symposium, and Seattle as the center of the fishery industry, seems the logical place in which to develop this phase of the subject. Quoting from the preliminary announcement of the Seattle meeting:

> The thorough presentation of the fisheries problems as they confront the industry to-day should prove to be a direct contribution to a better understanding of what this great project means. International in its scope, involving the vital interests of all peoples bordering on the Pacific, it perhaps offers the only solution that will meet the needs of the teeming populations of the Orient, and thus remove by peaceful, scientific means the menace of future conflict. The resources of the Pacific—by what shall they be gauged? A comparatively unknown field awaits our conquest.

Following is the arrangement of the symposium which will be held on Thursday afternoon June 17:

THE ANIMAL AND PLANT RESOURCES OF THE NORTH PACIFIC OCEAN

Marine biology in relation to the North Pacific fisheries: Dr. C. McLean Fraser, director, Biological Station, Nanaimo, British Columbia.

Relation of scientific investigations to the fisheries: Mr. W. F. Thompson, fisheries investigator, Cailfornia Fish and Game Commission.

Present condition and needs of the Alaska salmon fisheries: Dr. Hugh M. Smith, commissioner, Bureau of Fisheries, Washington, D. C.

Future of the Alaska fisheries: PROFESSOR JOHN N. COBB, director, College of Fisheries, University of Washington, Seattle, Wash.

The methods of the salmon fisheries and salmon culture in Alaska should be completely changed. How can this be done? DR. BARTON WARREN EVERMANN, director, California Academy of Sciences, San Francisco.

Ocean pasturage and ocean fisheries: MR. W. E. ALLEN, Scripps Institution of California, La Jolla.

Thursday evening, June 17, will be devoted to the address of the retiring President Dr. John C. Merrian who will speak on "The research spirit in everyday affairs of the average man." President Henry Suzzallo, of the University of Washington, will welcome the delegates and response will be made by the chairman of the executive committee Dr. Barton Warren Evermann. Following the address of the evening a public reception will be held.

Friday afternoon, June 18, a public address will be given by Professor R. W. Brock, of the University of British Columbia, speaking on "The last crusade under Allenby." Professor Brock will speak of his personal experiences with General Allenby and will relate something of the contributions of science to the winning of the campaign in Palestine.

Following are the affiliated societies which will hold meetings at Seattle under the auspices of the Pacific Division:

AMERICAN PHYSICAL SOCIETY

J. S. Ames, *President,* Johns Hopkins University.

Dr. C. Miller, *Secretary,* Case Scientific School.

E. P. Lewis, *Local Secretary for the Pacific Coast,* University of California.

AMERICAN PHYTOPATHOLOGICAL SOCIETY, PACIFIC DIVISION

F. D. Heald, *President,* Agricultural Experiment Station, Pullman, Wash.

W. T. Horne, *Secretary-treasurer,* of the University of California.

ASTRONOMICAL SOCIETY OF THE PACIFIC

J. H. Moore, *President,* Lick Observatory.

D. S. Richardson, *Secretary-Treasurer,* 2541 Hilgard Avenue, Berkeley.

CALIFORNIA SECTION AMERICAN CHEMICAL SOCIETY

Robert E. Swain, *President,* Palo Alto.

Bryant S. Drake, *Secretary-Treasurer,* 5830 Colby Street, Oakland.

COOPER ORNITHOLOGICAL CLUB

Northern Division

Curtis Wright, Jr., *President,* Oakland.

Mrs. James T. Allen, *Secretary,* Berkeley.

Southern Division

Loye Holmes Miller, *President,* State Normal School, Los Angeles.

L. E. Wyman, *Secretary,* 3927 Wisconsin Street, Los Angeles.

CORDILLERAN SECTION, GEOLOGICAL SOCIETY OF AMERICA

George D. Lauterbach, *President,* University of California.

A. F. Rogers, *Secretary,* Stanford University.

THE ECOLOGICAL SOCIETY OF AMERICA

Barrington Moore, *President,* American Museum of Natural History.

A. O. Weese, *Secretary-Treasurer,* University of Mexico.

NORTHERN INTERMOUNTAIN SECTION, AMERICAN CHEMICAL SOCIETY

Charles H. Hunt, *Secretary,* State College of Washington.

PACIFIC COAST BRANCH, PALEONTOLOGICAL SOCIETY

John C. Merriam, *President,* University of California.

Chester Stock, *Secretary-Treasurer,* University of California.

PACIFIC FISHERIES SOCIETY

C. McLean Fraser, *President,* Biological Station, Nanaimo, British Columbia.

S. H. Dado, *Secretary,* California Fish and Game Commission, San Francisco.

PACIFIC SLOPE BRANCH, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

E. M. Ehrhorn, *Chairman,* Honolulu, H. T.

E. O. Essig, *Secretary,* Berkeley.

PUGET SOUND SECTION, AMERICAN CHEMICAL SOCIETY

A. L. Knisely, *President,* C. A. Newhall Co., Seattle, Wash.

R. T. Elliott, *Secretary,* U. S. Bureau of Chemistry, Seattle, Wash.

SAN FRANCISCO SECTION, AMERICAN MATHEMATICAL SOCIETY

H. F. Blichfeldt, *Chairman,* Stanford University.

B. A. Bernstein, *Secretary,* University of California.

WESTERN SOCIETY OF NATURALISTS

J. R. Slonaker, *President,* Stanford University.

Tracy I. Storer, *Secretary-Treasurer,* Museum of Vertebrate Zoology, Berkeley.

MEETING OF PACIFIC COAST ECONOMISTS

A meeting of Pacific Coast economists will be held and a program arranged for Thursday and Friday afternoons, June 17 and 18. An effort will be made to organize a Pacific Coast Division of the American Economic Society.

SCIENTIFIC EVENTS

THE MATHEMATICAL INSTITUTE OF THE UNIVERSITY OF STRASBOURG

HELPED by the favorable exchange level, a number of students are going to study in French universities. It is important to bring to their attention that, since November, 1919, the University of Strasbourg, completely reorganized, is working in full order. Its teaching staff is more than equal in number to what it was under German rule, and its equipment, already excellent in many respects, has been greatly improved where it was deficient.

For mathematical study, students will be offered in Strasbourg the usual standard courses on analysis, mechanics, astronomy, etc., the program of which is permanent and requires the students' time for two or three years. Research courses have been arranged for candidates for the "Doctorat de l'Université de Strasbourg," and of scholars generally. French diplomas are required for registration with a view to the doctorate, but can be dispensed with on presentation of equivalent foreign diplomas, with a statement of the student's ability by one of his former professors.

The program of research courses during the academic year 1920–21 is as follows:

First Semester (November 1, 1920–February 28, 1921)

Mathematical Physics: MR. BAUER: Quantum Theory; Atomic Structure: 3 lectures a week.

Higher Analysis: MR. FRÉCHETS Theory of Chance: 2 weekly lectures; Integral Equations: 1 weekly lecture.

Second Semester (March 1, 1921–June 30, 1921)

Mathematical Physics: MR. BAUER: Statistical Applications of Quantum Theory: 3 weekly lectures.

Higher Analysis: MR. FRÉCHET: Applications of the Theory of Chance: 1 weekly lecture.—Functions of Lines: 2 weekly lectures.

Hydrodynamics: MR. VILLAT: Researches on the Motion of a Solid in a Viscous Fluid: 2 weekly lectures.

Differential Geometry: MR. PÉRÈS: Transformations of Surfaces Applicable on Quadrics: 2 weekly lectures.

Theory of Functions: MR. VALIRON: Dirichlet's Series and Facultative Series: 2 weekly lectures.

For further information apply (in French or English) to M. le Directeur de l'Institut de Mathématiques de Strasbourg, Bas-Rhin, France.

Details concerning lodgings, etc., will be supplied by the Comité de Patronage des étudiants étrangers Université, Strasbourg, Bas-Rhin, France.

Students who wish to improve their knowledge of the French language during the vacation may apply for the circular on "Summer Courses," organized by the "Faculté des Lettres de Strasbourg."

THE FOREST PRODUCTS LABORATORY DECENNIAL CELEBRATION

THE Forest Products Laboratory was organized by the U. S. Forest Service in 1909 and formally opened in June, 1910. It is conducted in coöperation with the University of Wisconsin.

During the ten years of its existence the efforts of the laboratory have been devoted to the development of improved methods and processes for the better utilization of forest products of all kinds, and to the direct assistance of the industries concerned. Among the major lines of endeavor are the following:

Pulp and paper,
Hardwood and softwood distillation,
Preservation of wood,
Decay and decay prevention,
Mechanical properties of wood,
Glues for wood,
Kiln drying and air seasoning,
Grading structural timbers,
Grading lumber,
Laminated construction,
Chemistry of wood,
Boxing, crating, packing,
Needle and leaf oils,
Ethyl alcohol from wood waste,
Wood finishes,
Aircraft parts,
Veneers and plywood,
Steam bending,
Identification of wood,
Microscopy of wood.

During the war direct assistance was rendered the War and Navy Departments and various other branches of the government in the solution of many important problems, particularly in connection with aircraft, gun-stocks, artillery wheels, escort wagons and the boxing and crating of arms and stores for overseas shipment. It was necessary, throughout this period, to abandon all work on the regular peacetime program.

A good many men acquainted with the work of the laboratory have expressed the thought that the laboratory and the service rendered by it should receive some mark of recognition or appreciation from the industries which it serves. In response to this thought, the decennial celebration has been planned, and a general committee organized to carry out the detailed arrangements.

The present plans call for a two-day program, including addresses by men prominent in science, industry and commerce; inspection of the laboratory; a banquet; and various other forms of instruction and entertainment. It is proposed to make a permanent record of the decennial in the form of a souvenir publication to contain all of the addresses and other relevant matter, including the names of those who can permit a permanent record of their cooperative contributions to be made.

ENGINEERING INVESTIGATIONS OF THE U. S. GEOLOGICAL SURVEY

A CORRESPONDENT writes:

In these days of economizing in government appropriations it is refreshing to note some of the remarks on the floor of the House by Representative Good, of Iowa, chairman of the Sundry Civil Appropriations Committee and Representative Byrns, of Tennessee, ranking minority member of that committee, in which they urged additions to appropriations. Their arguments were in defense of an item of $125,000 providing for an engineering investigation by the U. S. Geological Survey of the super-power project for the eastern United States. Mr. Byrns stated: "This proposition is one that looks forward to the conservation of our resources and, as has been stated, the time is at hand when something must be done looking to the conservation of our fuel supply because those in authority state that at present the known supply of oil will be exhausted within a very few years at the present rate of consumption." He further characterized this Geological Survey investigation as one that should be made "by government experts in order that if the investigation discloses that such a plan is practicable, those who are asked to make these investments will have confidence in the accuracy and impartiality of the report." Chairman Good in reporting the Sundry Civil bill had already made special reference to the super-power item in the bill as unique but as believed vitally important and he stated that such a survey would represent "Government initiative and co-operation which will result in the savings to the country of hundreds of millions of dollars annually. It will result in a great saving in the direct cost of fuel. It will furnish a reserve source of power for transportation and utility companies, which will be of large value in time of labor disputes and public emergencies. The principle can be applied broadly. Its benefits will accrue to towns and villages and to the farms of the country." Chairman Good also stated that this provision best illustrated the policy of including in the appropriation bill items providing for the future. He said "Government can not stand still. It must advance. It must provide for healthy growth of every useful governmental activity." In concluding the debate on this item which was followed by a favorable vote, Chairman Good remarked: "We may smile at this proposition. We may laugh it out of Congress, just as we did by ridicule the proposition of Mr. Langley in regard to the aeroplane."

To those who are interested in scientific and engineering investigations under government auspices such expressions by leaders in Congress are encouraging. It is also worthy of note that neither Mr. Good nor Mr. Byrns represent sections of the country that would primarily and immediately be affected by the proposed investigation; they seem to represent the country as a whole.

AWARD OF THE WILLARD GIBBS MEDAL

The presentation of the Willard Gibbs medal to Dr. Frederick G. Cottrell, director of the United States Bureau of Mines, from the Chicago Section of the American Chemical Society, took place on May 21. This medal was founded by William A. Converse, of Chicago, and is conferred "In recognition and encouragement of eminent research in theoretical and applied chemistry."

At a meeting, which took place in the City Club, Lawrence V. Redman, chairman, addressed the section on The Willard Gibbs medal. The presentation was made by Dr. Willis R. Whitney, director of the Research Laboratories of the General Electric Company, and the Willard Gibbs address on "International scientific relations," was given by Dr. Cottrell.

While a professor at the University of California from 1902 to 1911, Dr. Cottrell devised a process for removing fumes from the waste gases of a sulphuric acid plant at a copper smelter. There had been numerous complaints that the noxious vapors were imperilling the health of the surrounding population, destroying animal life, and injuring vegetation. The process devised by Dr. Cottrell consisted of placing chains at the bottom of the flues. These chains were charged with currents of electricity, the effect of which was to cause the particles to fall and thus prevent their escaping into the air.

Dr. Cottrell patented the device but turned over his rights to a non-dividend-paying organization, formed for that purpose and known as "The Research Corporation." A charge for the use of the process is made and the net profits are devoted to the promotion of scientific research.

THE RETIREMENT OF PROFESSOR FAIRCHILD OF THE UNIVERSITY OF ROCHESTER

Professor Herman Le Roy Fairchild, head of the department of geology and curator of the geological museum at the University of Rochester, reached his seventieth birthday on April 29 and will retire from active service at the close of the present academic year. As a tribute to his contribution to science and his service to the university, undergraduates and members of the faculty joined in paying homage to him. Gifts from his classes and from the faculty expressed the esteem in which Professor Fairchild is held by the undergraduates and his associates on the teaching staff. His entry into the chapel in Anderson Hall on April 29 was the signal for an outburst of applause and cheering, which was renewed on the presentation of the faculty gift.

President Rush Rhees and Professor John R. Slater, head of the department of English, were the speakers. Pointing to Professor Fairchild's successful career as an indication that "a prophet is not without honor in his own country, even if he is a weather prophet," Professor Slater lauded his contribution in the field of science and scholarship, and after reading an original poem written for the occasion presented the faculty gift.

Professor Fairchild received the bachelor of sciences degree from Cornell University in 1874, and the honorary doctorate of science from the University of Pittsburgh in 1910. He was professor of natural science in Wyoming Seminary, at Kingston, Pa., from 1874 to 1876, and from there he went to New York city as a lecturer on natural science and on geology in Cooper Union. He was recording secretary of the New York Academy of Sciences from 1885 to 1888, going to the University of Rochester in that year. He served as president of the Rochester Academy of Science from 1889 to 1891, secretary of Geological Society of America from 1890 to 1906, and president of the society in 1912. He was chairman of a section of geology of the American Association for the Advancement of Science in 1898 and is a member of its executive committee. Professor Fairchild is an authority in glacial and dynamic geology.

SCIENTIFIC NOTES AND NEWS

Professor John C. Merriam, of the University of California, was elected president of the Carnegie Institution of Washington on May 25, to succeed Dr. R. S. Woodward, who will retire at his own request at the end of the year, after sixteen years of service. Dr. Merriam is professor of paleontology and dean at the University of California. He was last year acting chairman of the National Research Council.

At the annual meeting of the American Academy of Arts and Sciences held on May 12, it was voted upon the recommendation of the Rumford Committee to award the Rumford Premium to Dr. Irving Langmuir, of the General Electric Co., for his researches in thermionic and allied phenomena.

At a stated meeting of the Franklin Institute on May 19 the Franklin Medals were presented to Sir Auckland Geddes, British ambassador for the Honorable Sir Charles A. Parsons, Newcastle-on-Tyne and to His Excellency, Mr. A. W. F. Ekengren, minister of Sweden for Professor Svante August Arrhenius, of the Nobel Institute, Stockholm. Papers were read on "Some Reminiscenses of Early Days of Turbine Development," by Sir Charles A. Parsons and on "The World's Energy Supply," by Professor Arrhenius.

The Société de Pathologie Exotique has elected the following members from the United States: Dr. S. Flexner, Rockefeller Institute, associate member, already corresponding member; Dr. B. H. Ransom, U. S. Bureau of Animal Industry, corresponding member.

Professor Hiram Bingham has been decorated by the French government with the Ordre de l'Etoile Noire, grade of officer, for his services in France during the war. Dr. Bingham was recently elected an alternate-at-large to the Republican National Convention to be held in Chicago in June.

Professor A. D. Wilson, director of the division of agricultural extension of the college of agriculture of the University of Minnesota, has declined the post of assistant secretary of agriculture, tendered him by the Secretary of Agriculture, E. T. Meredith.

At its meeting on May 12 the Rumford Committee of the American Academy of Arts and Sciences voted an appropriation of $200 additional to former appropriations to Professor Norton A. Kent, of Boston University, in aid of his research on spectral lines.

Charles W. Trigg, incumbent of the Coffee Fellowship at the Mellon Institute of Industrial Research, while still retaining his former connection, has moved to Detroit, Michigan, to assume charge of the chemical department of the donors, the King Coffee Products Corporation.

General W. C. Gorgas has left for England accompanied by Brigadier-General Robert E. Noble. They will proceed to Wset Africa to study what is alleged to be an outbreak of yellow fever in that district.

Dr. Louise Pearce, of the Rockefeller Institute for Medical Research, has sailed for England and Belgium *en route* to the Belgian Congo for the purpose of studying the chemotherapy of African sleeping sickness.

Mr. Frank C. Baker, curator of the Museum of Natural History of the University of Illinois, will spend the months of July and August in making a survey of the molluscan fauna of Winnebago Lake, Wisconsin, in the interests of the Wisconsin Geological and Natural History Survey. Material will also be obtained for the exhibits and research collections of the Illinois University Museum. Winnebago Lake is similar in origin to the large Oneida Lake in New York, which Mr. Baker surveyed several years ago for the College of Forestry at Syracuse University, and a comparison of the faunas of the two bodies of water is expected to add to our knowledge concerning the life of shallow lakes.

Governor Smith of New York, has announced the appointment of five commissioners of the Enfield Falls Reservation, the property recently conveyed to the state by Mr. and Mrs. Robert H. Treman, of Ithaca. They are Robert H. Treman, giver of the reservation; Liberty Hyde Bailey, of Ithaca, former dean of the New York State College of Agriculture; Mayor Edwin C. Stewart, of Ithaca; George A. Blauvelt, former state senator, and William E. Leffingswell, of Watkins, former assemblyman.

The council of the British Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1919–20: Telford gold medals and Telford premiums to Mr. David Lyell, Mr. J. K. Robertson, and Major-General Sir Girard M. Heath; a George Stephenson gold medal and a Telford premium to Mr. Maurice F. Wilson; a Watt gold medal and a Telford premium to Mr. P. M. Crosthwaite; and Telford premiums to Major E. O. Henrici, Sir Francis J. E. Spring, Mr. F. O. Stanford, Mr. J. Mitchell, Mr. J. W. Sandeman, and Dr. A. R. Fulton.

Dr. Colin G. Fink, of New York, recently lectured before the graduate students in chemistry of Yale University on "The Organic Chemistry of Metal Carbides" and on "Contact Catalysis."

Under the auspices of the Southwestern Division of the American Association for the Advancement of Science, Mrs. M. D. Sullivan gave a lecture, entitled "Scientific Research and the Library," at the Carnegie Public Library of El Paso, Texas, on May 20 and on May 27, Professor Daniel Hull, assistant superintendent of the El Paso High School, gave a lecture on "The Einstein Theory of Relativity," at the Chamber of Commerce.

Dr. E. B. Rosa, chief physicist of the Bureau of Standards delivered an address on May 20 before the Washington Academy of Sciences on "The Economic Value of Scientific Research by the Government."

The Linacre lecture of the University of Cambridge was delivered on May 6, by Dr. Henry Head on "Aphasia and Kindred Disorders of the Speech."

Dr. John Nelson Stockwell, of Cleveland, known for his contributions to mathematical astronomy, at one time professor in the Case School of Applied Science, died on May 18, aged eighty-eight years.

George Gilbert Pond, dean of the School of Natural Science of Pennsylvania State College, died at Hartford. He was born in Holliston, in March 1861. For five years he was instructor in chemistry at Amherst and then became a professor in the same department. He left Amherst to accept the appointment with the Pennsylvania State College.

Dr. H. P. Barrows, who resigned recently as professor of agricultural education at the Oregon Agricultural College and as state supervisor of agricultural education under the Smith-Hughes act to accept the position of federal regional agent for agricultural education with headquarters at San Francisco, died at San Francisco, on May 3.

Deaths of scientific men are recorded in *Nature* as follows: John Alexander McClelland, professor of experimental physics in University College, Dublin, and known for his researches on secondary radio-activity; T. G. Bartholomew, the head of the cartographical firm which has been known since 1899 as the Edinburgh Geographical Institute; Rudolph Messel, president of the Society of Chemical Industry and past vice-president of the Chemical Society, London; L. T. O'Shea, professor of applied chemistry in the University of Sheffield and honorary secretary of the British Institution of Mining Engineers, and A. K. Huntington, emeritus professor of metallurgy at King's College, London.

The Civil Service Commission announces an examination for supervising metallurgist. A vacancy in the Bureau of Mines, Department of the Interior, for service in the field, at $4,000 to $5,000 a year, will be filled from this examination.

THE U. S. Civil Service Commission announces an examination for assistant for fishery food laboratory. A vacancy in the Bureau of Fisheries, Department of Commerce, Washington, D. C., at $2,000 to $2,400 a year, and vacancies in positions requiring similar qualifications, will be filled from this examination. The duties of appointees will be to make analyses of fishery products, including canned products, oils, fish scrap, fish meal, etc., and to aid in the technology of development of methods of preservation and utilization of fishery products in the laboratory and in the field. Competitors will not be required to report for examination at any place, but will be rated on education, experience and a thesis.

THE Ellen Richards Research prize offered by an association of American college women, hitherto known as the Naples Table Association, is available for the year 1921. This is the tenth prize offered. The prize has been awarded four times, twice to American women and twice to English women. The competition is open to any woman in the world who presents a thesis written in English. The thesis must represent new observations and new conclusions based upon laboratory research.

THE Indiana Academy of Science held its annual spring meeting at the McCormack's Creek Gorge State Park near Spencer, Ind., on May 13 and 14. At the business meeting on the thirteenth the academy voted to direct the officers to prepare a suitable clause amending the constitution of the academy, so that affiliation with the American Association for the Advancement of Science would be possible. Final action on this matter will, in all probability, be taken at the regular winter meeting next December. The academy members dined together in the dining rooms of the Christian Church at Spencer on the evening of the thirteenth and early the next morning proceeded by automobile to the State Park, where, under the leadership of Professor Malott, of Indiana University, who has made a special study of the region, the members explored the Flatwoods district and the gorge of McCormack's creek, which drains it. Professors Mottier and Scott, of Indiana University, led the botanists and zoologists on the trip.

DURING the past year the following papers have been presented before the Society of the Sigma Xi at the University of California under the presidency of Professor Herbert M. Evans:

September 27, *Research behind the battle line:* J. H. HILDEBRAND.

October 29, *The processes of social phenomena:* A. L. KROEBER.

November 20, *A study of anger and pugnacity:* G. M. STRATTON.

December 9, *Low temperature research:* W. H. RODEBUSH.

January 28, *Hookworm and military efficiency:* C. A. KOFOID.

February 18, *The effect of alkali on plants:* D. R. HOAGLAND.

March 3, *On the construction of a geological scale for the Great Basin of North America:* J. C. MERRIAM.

March 24, *Physiological studies on aviators:* J. L. WHITNEY.

April 21, *Recent research in the organic compounds of nitrogen:* T. D. STEWART.

May 5, *Some aspects of the development of the anatomical sciences in America:* H. H. EVANS.

CREATION of a Canadian Bureau of Scientific Research, at an initial cost of $600,000 for the site and construction and equipment of the building, and $50,000 for the first year's salaries and upkeep, has been endorsed. The leader of the Government and of the Opposition both supported it. The standardization of all measures used in Canada of length, volume, weight, etc., of all forms of energy and of scientific apparatus used in industry and the public services will be one of the main functions of the Bureau of Research.

THE *Journal* of the American Medical Association quotes from the *Progresos de la Clínica* of Madrid giving the royal decree establishing the Instituto Cajal as a center for scientific research in different branches of biology, and to prepare students to carry on research in other countries. The institute is also to offer facilities to a limited number of foreign research workers, especially those from Latin America, and will invite foreign professors to lecture on their specialties. The new institution will include the laboratories already installed in 1901 for biologic research and the laboratories maintained for research on experimental physiology, neuropathology and histology. A new building is planned and the whole will form a part of the National Institute of Sciences.

In order to stimulate more general research along the lines of better preparation and packing of foods and beverages, and to increase our knowledge of such changes induced by preparation or storage of such products, the Glass Container Association of America, Dr. A. W. Bitting, director of research, 3344 Michigan Avenue, Chicago, Ill., will make seven awards in value from $50 to $150 for theses submitted prior to June 10, 1921. A thesis may cover any phase of the subject of foods or beverages—technological, bacteriological, or chemical. It may treat of any legitimate method of preparation, as sterilization by heat, pasteurization, salting, drying, smoking, pickling, sugaring, etc., the product to be packed in glass. The thesis may be bibliographical with abstracts, or may be a translation from work along the lines indicated. Any student working for a degree in any college or university is eligible to compete.

The proceedings of the Paris Congress of Physiology under the presidency of Professor Charles Richet, will begin on Friday, July 16, and will end on the following Tuesday. The last congress was held at Groningen in September, 1913, and it was then decided that the next should be held in Paris. The subscription (35 francs) should be sent to M. Lucien Bull, l'Institut Marey, Avenue Victor-Hugo, Boulogne-sur-Seine (Seine).

UNIVERSITY AND EDUCATIONAL NEWS

In recognition of the great and increasing need for competent specialists in the medical sciences, a new course leading to the degree of doctor of medical sciences (D.M.S.) has been established at the Harvard Medical School. The first two years' work of this course is substantially identical with that of the regular medical students and this general training in the medical sciences is followed by a minimum of two years of concentration work in one of the laboratory departments. The qualifications and character of work required of those admitted to the concentration course are essentially the same as for Ph.D. students. The granting of the D.M.S. degree will be based on the same standard.

It has been planned for some time to found a university at Cologne. *The Journal* of the American Medical Association reports that the necessary formalities were complied with last year, and the new university has recently come into being very quietly. The various colleges and institutes have thus been collected into a state university which offers a chance to relieve the overcrowding of the university at Bonn. The new university starts with 2,000 students and over forty instructors.

Professor Cecil H. Peabody, head of the department of naval architecture, the Massachusetts Institute of Technology, has resigned after thirty-seven years. Dr. Peabody has been in charge of the marine engineering course since its formation in 1883. Professor J. R. Jack will succeed Professor Peabody.

Dr. William E. Ford, of Yale University, has been promoted to a professorship of mineralogy and has been made a member of the governing board of the Sheffield Scientific School.

Dr. H. E. Wells, formerly professor of chemistry at Washington and Jefferson College and captain in the Chemical Warfare Service, U. S. A., has been appointed professor of chemistry at Smith College.

Dr. J. P. Musselman, of Washington University, St. Louis, has been appointed associate in mathematics at the Johns Hopkins University. Dr. Musselman is the national president of the Gamma Alpha Graduate Scientific Fraternity.

DISCUSSION AND CORRESPONDENCE

"PETROLIFEROUS PROVINCES"

In a discussion of Petroliferous Provinces in a recent number of *Mining and Metallurgy*,[1] Dr. Charles Schuchert has quoted from an article on "Some Factors in the Geographic Distribution of Petroleum"[2] by the present writer, and has drawn certain conclusions and made certain inferences which are decidedly at variance with the ideas the author intended to convey. In order that some of the apparently ambiguous statements in the article on Geographic Distribution should not be generally misconstrued, it is desired to call attention to certain points which the reviewer has apparently overlooked.

Dr. Schuchert says:

> Since the previous paragraph was written there appeared the suggestive paper by Mehl, already cited, in which he points out that all the major oil fields of the world are situated between 20° and 50° north latitude. Further, that there are no major oil areas within the tropics or in the southern hemisphere. As the known major oil fields lie between the present isotherms of 40° and 70° F., he thinks that this distribution "does suggest a distinctly zonal distribution of petroleum in which temperature may have been an important factor." The question that here arises is, Is this suggestion of present climatic conditions also true for the times when the oil was deposited in the strata in which it is now found, remembering that the oil fields were not made recently but are the accumulations of hydrocarbons of the seas of geologic ages? The answer is not at all in harmony with Mehl's suggestion, for we are living in an exceptional time of stressed climates and marked zonal conditions, while the mean temperature conditions during the geologic ages were warm and equable throughout most of the world, and this is even more true of the temperature of oceans than of the lands.

The paragraph that called forth this comment follows:

> Attention is further called to the general correspondence between the position of the twentieth and fiftieth parallels in both hemispheres with the average annual isotherms of 70° and 40° respectively. Although these parallels are, in reality, nothing more than imaginary lines of geographic references, *each does, in much probability, mark the average position of some isotherm as it has shifted in past geologic times.* While the disposition of maximum accumulations as here bounded does not indicate a definite temperature zone within which petroleum has been formed, it does suggest a distinctly zonal distribution of petroleum in which temperature may have been an important factor.

There follows a few paragraphs further on:

> Very often the rapid decay of organisms is pointed to as illustrating the manner in which petroleum is formed. In certain parts of the Mediterranean Sea, for instance, the accumulation and decay of organic detritus is so rapid that the lower levels of the water are filled with scattered globules of oil. *Instead of illustrating how petroleum is formed, however, it points to the effective manner in which fatty matter is ordinarily separated out from accumulating sediments. Certainly, the globules which are escaping into the water offer no suggestion of being retrapped and converted into petroleum.* It is only that part of the organic matter which is converted into oil so slowly that the accumulating sediments form a sufficient thickness and suitable succession to retain it against the tendency of the associated waters to drive it off, that may become petroleum.

So much has been added to our knowledge of the climates of past geological ages by the work of Dr. Schuchert and others that it does not seem appropriate, in an article not intended primarily for the beginning student in geology, to call attention to the fact that the present average annual isotherms are not necessarily coincident with the same isotherms throughout past geologic periods. Furthermore, it would appear that one might logically take for granted a general knowledge of the principles underlying temperature zones and the nature of their boundary lines as follows:

1. The sinuosity of isotherms is determined largely by the extent of the land masses and their configuration.

[1] *Bull. Amer. Inst. Mining and Metallurgical Engineers*, No. 155, pp. 3058–3070, November, 1919.

[2] *Bull. Scientific Laboratories, Dennison Univ.*, Vol. XIX., pp. 55–63, June, 1919.

2. In general, the more widespread the oceans the less sinuous the isotherms.

3. During periods of more nearly universal oceans, the closer the parallelism between isotherms and parallels.

It would appear that the logical conclusions to be drawn from the two immediately preceding quotations, providing we may take for granted a knowledge of the general conditions of past climates, are as follows:

1. The belt between the parallels 20° and 50° north latitude was, during the periods when the petroleum of the zone was forming, some definite temperature zone the boundaries of which, the average annual isotherms, were essentially coincident with the parallels.

2. The temperatures of this zone very likely fluctuated within a single period and showed more or less marked differences from period to period.

3. The average of the fluctuating temperatures for this zone was not necessarily the same as that of this belt for the present time, viz., 40°–70° F.

4. The only reference to the formation of petroleum in this zone at present day temperatures (the Mediterranean Sea) *does not* illustrate the manner in which petroleum is formed.

The obvious inference of these conclusions is that could we determine the exact temperature conditions under which petroleum is formed there would be available another means of testing the temperatures of the various areas in which the petroleum was formed, during the periods when it was forming. In other words, some estimate could be made of the average temperature of the "petroleum zone"—that belt bounded by the parallels 20° and 50° north latitude—during the "petroleum periods."

There is one more point on which the present writer's view was, perhaps, not adequately stated, although his intention would seem to be clear. The following is from Dr. Schuchert's criticism:

> . . . The writer also knows that hydrocarbons have accumulated in large amounts in seas within the tropics, yet seemingly the amount is far the greatest in what is now the north temperate zone. That this zone has the greatest amount of petroleum is apparently due wholly to the greater land masses here, along with the necessary storage strata accompanied by the proper amount of deformation.
>
> Even if Mehl's suggestion were correct, and we should accordingly think of next exploiting the temperature region of the southern hemisphere, we must not overlook the fact that the northern hemisphere is a land hemisphere, while the southern one is a water hemisphere, and therefore has greatly reduced continents.

To quote from the article on "Geographic Distribution":

> Regardless of the lack of thorough prospecting, however, there is reason to believe that of the three zones, the equatorial belt between the twentieth parallels and adjacent belts in the northern and southern hemispheres extending north and south to the fiftieth parallels, the northern belt will, when investigations are carried to completion, be found the more productive. For instance, one may safely assert that, all other factors being equal, the amount of petroleum underlying a given area is directly proportional to the size of that area. It is evident that in the area of exposed lands neither the southern nor the equatorial belts compare favorably with the northern zone.

And again, in summarizing:

> If we may grant, then, that within a limited zone, the equatorial belt, conditions have been unfavorable for the formation of accumulations of petroleum, on the average, it is logical to seek a belt in the southern hemisphere suitable for such deposits, to correspond with the belt in the northern hemisphere. *Were the temperature factors alone to be considered, there is little doubt but that much might be expected from the southern zone. It has already been pointed out, however, that the area of exposed land within this zone is relatively small and of this a very large proportion consists of Pre-Cambrian or igneous rocks. Apparently little more is to be expected from the southern belt than from the equatorial zone.*

As the writer stated in the article quoted by Dr. Schuchert, it was hoped "that the speculations would call forth a discussion of the principles involved and possibly stimulate investigations in the several branches of science interested." He was much surprised to learn that these principles had been so stated as to convey a meaning quite different from that intended. It is hoped that these notes concerning the writer's statements that have been criticized will throw a somewhat different light on their interpretation.

MAURICE G. MEHL
UNIVERSITY OF MISSOURI

AN IMPROVED METHOD OF HOLDING LARGE SPECIMENS FOR DISSECTION

MR. JOHN M. LONG[1] recently published a scheme for holding large specimens open while dissecting them in which he uses "trays of galvanized iron with four or more loops of metal soldered on the sides to which ordinary heavy rubber bands are attached. To these rubber bands are tied small fishhooks which have had their barbs filed off. These hooks are to be fastened to any part of the anatomy so as to hold the specimen firmly, or to pull certain parts to the desired position." As these rubber bands with the sharp fishhooks attached are permanently tied to the sides of the trays, there is some danger and inconvenience in handling the latter. This difficulty can be overcome and the whole scheme improved upon by fastening small, blunt hooks to the rubber bands at the opposite ends from the fishhooks, thus making them so that they can be easily removed from the trays. It is also a good idea to file the points of the fishhooks down somewhat so that they are not so dangerous to handle, and yet they can be easily thrust through the skin or flesh of the specimen to be held.

HORACE GUNTHORP
WASHBURN COLLEGE,
TOPEKA, KANS.

[1] SCIENCE, Vol. XLIX., pp. 120–121.

SCIENTIFIC BOOKS

South. The Story of Shackleton's Last Expedition, 1914–1917. By SIR ERNEST SHACKLETON, C.V.O. With 88 illustrations and diagrams. The Macmillan Company, New York, 1920. $6.00.

It has been well said that peace has its victories as great as those of war. Too much praise can not be given the men who for country alone, or for the whole world, have struggled and suffered, bled or died. But peace, not war, is the normal phase of our life, and its unwarlike victories—material, mental and spiritual—most deeply affect us. For this reason the world delights to read this straightforward tale of Shackleton, wherein are embodied high adventure, unique experiences and thrilling situations with displays of courage and persistence, of fidelity and solidarity—qualities which ennoble mankind.

The scientific work in view was the most comprehensive and ambitious ever attempted by a polar expedition. In extent and importance it approached, if it did not surpass, the International Polar Conference program of 1881–1884. Geographically the vast ice-clad continent of Antarctica was to be crossed from Weddell Sea to Ross Sea, and its glacier-lined, unknown coasts charted by cruises in unvisited waters of the Antarctic Ocean. Scientifically were to be studied the fauna of the sea, the hydrography of the ocean, the geology of the land, the meteorology of the air, and the mysteries of magnetism. The primary base, under Shackleton personally, was to be established near Vachsel Bay, Luitpold Land, discovered in Weddell Sea by Filchner in 1912.

It is of special interest that this south-polar area, through the comprehensive policy and timely application of England's colonial methods, is a part of her empire. By proclamation of July, 1908, this region was declared to be British territory which was defined as "Situated in the South Atlantic Ocean to the south of the 50th parallel of south latitude and lying between 20 degrees and 80 degrees west longitude."

The second party—to enter Ross Sea—will be later considered. Sailing from Plymouth, August 8, 1914, after the Admiralty had declined the offer for war purposes of his ship *Endurance*, Shackleton made his final arrangements at Grytvikin, South Georgia whence he steamed south on December 5. His ship was fitted for every contingency, and his crew of 28 were men selected from nearly 5,000 volunteers, eager for polar adventure.

Two days later the ship entered the pack which was found very far north, and proved to be increasingly unfavorable. Five hundred bergs were passed in a single day, and the *Endurance* sailed over the projecting foot of a berg 150 feet high. After steaming over 700 miles through the pack Coats Land, discovered by Bruce in the *Scotia,* 1904, was sighted from 72° 20′ S. on January 10, 1915. This land was skirted its entire length, from 72° 34′ S., 16° 40′ W., to about 74° 04′ S. 22° 48′ W. Beyond this coast Shackleton discovered new land, which he named Caird Coast, which he followed about 200 miles to its junction with Leopold Coast of Filchner, 1912. The extreme northerly point of Caird Coast is in about 73° 20′ S., 26° W. and the southern point in 76° 30′ S., 28° W.

Shackleton thus describes it: "It is fronted by an undulating barrier, which terminates usually in cliffs ranging from 10 to 300 feet in height, but in a very few places sweeps down level with the sea. At the southern end of Caird Coast the ice-sheet, undulating over the hidden and imprisoned land, is bursting down a steep slope in tremendous glaciers bristling with ridges of ice and seamed by thousands of crevasses. Along the whole length of the coast we have seen no bare land or rock. Not as much as a solitary nunatak has appeared."

On January 18, 1915, the *Endurance* was beset in the pack, in 76° 34′ S., 31° 30′ W., never to be released. Thus ended the chance of landing and of crossing Antarctica. This besetment occurred in midsummer, when unusually low temperatures of zero and below were observed.

Held fast the ship drifted with the main ice-pack and reached an extreme southing of 77° S. 35° W. The drift was first to the west and then to the north-by-west attaining April 9, 1916, 62° S., 54° W. Crushed by the ice the *Endurance* sank November 21, 1916, in 69° S., 53° W. when the crew took to the ice. They were then 346 miles from Paulet Island, the nearest place of safety, which two separate attempts to reach, by travel over the ice-floes, proved impossible of attainment. They were forced to depend on the northerly drift of the main pack for safety. Their drift life of four and a half months was marked by vicissitudes and miseries inseparable from storms, with tent-shelter only, and lack of heat. Food was also insufficient, their daily ration for a while being below ten ounces of food, and despite continuous hunting they finally were forced to eat their dogs. Storms were frequent and one blizzard caused intense suffering with temperatures of 21 to 34 degrees below zero. Dredging, soundings, weather observations, hunting and games were carried on in such manner as to preserve the morale of the men.

There had been a northerly drift of about 1,500 miles, making good a northing of 573 miles before the *Endurance* sank. This drift continued until the end of the antarctic summer, in March, found them outside of the antarctic circle and in sight of Joinville Island, with the close ice-pack so disintegrated as to make travel thereto impossible, either by boat or by sledge. On April 7, 1916, after the breaking up of floes had several times threatened the loss of boats and party they sighted Elephant Island. Launching their three boats under conditions of great and continuing danger they were day after day obliged to take refuge from closing ice on the nearest floe or berg of size. Almost as by miracle they reached and landed on glacier-covered Elephant Island, where a narrow fringe of tide-swept beach was the only visible land. Fortunately penguins and seal were present in such numbers as to save them from immediate starvation. With coming winter there was such danger of the party perishing that Shackleton with five men sought relief from South Georgia, over 800 miles distant. This journey, across the most tempestous storm-swept southern ocean in approaching winter, and the crossing of South Georgia by land, are among the most thrilling experiences in polar history. Tortured by thirst, benumbed by cold, water-soaked whether on duty or in their sleeping bags, their skill as navigators was all that enabled them to make the journey, while they were exhausted by the necessity of bailing the boat continuously for days, to keep her from swamping under pouring sprays and whelming waves.

Four relief expeditions were necessary under Shackleton before the party on Elephant Island were rescued. Through the energy and direction of Frank Wild, the marooned party of 22 men lived through four and a half months of winter in huts with stone walls, and boat-covered, as had been done by the Greely Arctic Expedition at Cape Sabibe in the winter of 1883–1884.

At Elephant Island the food supply was limited almost to a starvation point, though their regular food was supplemented by penguins, seals, seaweed and sea-limpets. While the Weddell Sea scientific observations have not been published some items of interest are given in this narrative. In 77° S. 34° W. the magnetic variation was found to be six degrees west; auroras were rare. Meteorologically clear sky increased steadily from 7 per cent. in January to 45.7 in July; it decreased to below 30 from September to November and nearly to zero in December. Temperatures were fairly high, the minimum for the year being 35 degrees below zero in July. Generally southerly winds brought clear weather with low temperatures, while the reverse conditions obtained with northerly winds. The ice-drift, due partly to currents but more largely to winds of Weddell Sea, is contrary to the movements of the hands of a watch. Doubtless it conforms almost entirely to a course nearly parallel to the general contours of the land masses of Antarctica. Geographically the only direct contribution is the connection of Coats Land and Luitpold Land, which determines the continuity of the continent of Antarctica from 6 to 43 degrees west longitude, and from 72.5 to 78 degrees south latitude. The North Greenland of Morrell disappeared long since from charts, but the reviewer's belief, in his Hand-Book of Polar Discoveries, that Morrell's longitudes were to blame would throw this land some 12 degrees west to Palmer or Graham Land. Astronomical observations proved that Shackleton's chronometer longitudes were one degree in error. Again he throws Foyn coast two degrees to the west of its reported position, and states that his observations place Sanders Island three miles east and five miles north of its charted position. These corrections indicate clearly the liability of explorers, unless highly skilled, to material errors when making observations under abnormal and difficult conditions. Hydrographically Weddell Sea is very deep, averaging in the large over 2,000 fathoms. Shackleton mentions three soundings of 2,400, 2,810 and 2,819 fathoms. He mentions the shoaling of the sea as he drifted "north either to east or west, from 77° S., and the fact suggested that the contour lines ran east and west roughly." The reviewer thinks that this indicates the existence of a continental shelf, off land trending westerly along the 77th parallel, and changing to north-northwest between longitudes 55° and 60° west.

The summary of Lieutenant Clark on the whaling industry of the Dependencies of the Falkland Islands is of special interest. The total value of the fisheries, in pounds sterling, were: 1913, 1,252,342; 1914, 1,300,978; 1915, 1,333,401 and in 1916, 1,774,570. In 1916 11,860 whales were captured in this area. The industry is now dependent on large fin and blue whales, humpbacks having been largely reduced in numbers.

The Ross Sea story is one of heroic effort not unmixed with disaster. The *Aurora*, Captain Mackintosh, left Hobart in December, 1914, and reached Cape Evans January 16, 1915, and after preliminary movements went into winter-quarters. While Mackintosh was absent, and all stores for the expedition not yet landed, the *Aurora* was forced by a violent blizzard into the pack on May 6, 1915, and drifting north was not able to clear the pack until March 14, 1916, in 62° 28′ S., 158° W. The marooned party, ten men only, by heroic effort, succeeded in establishing, as planned, a supply depot for the party which was expected to cross Antarctica from Weddell Sea. This depot was laid down at the base of Mt.

Hope, at the foot of the Beardmore, Glacier, in 83° 30′ S. These field parties in 160 days traveled 1,561 miles, of which distance 830 miles were made in laying down from Hunt Point the depot at Mt. Hope. Scurvy attacked the main party in the field and one man, Spencer Smith, died the day before their return journey was completed. Later Captain Mackintosh and Hayward perished in a blizzard during a short journey—probably from disruption of the ice-pack. Shackleton went at once to the rescue of this party, sailing in the *Aurora,* which was commanded by the veteran polar captain, Davis, in December, 1916. The voyage was short and the marooned men were brought safely to Hobart.

The illustrations are of unusual value, conveying as they do a clearer and more accurate view of polar scenes and lands, and especially as to Caird Coast and Elephant Island. The set illustrating various types of ice are important, and should become standard.

The narrative is marked by its appreciation of the members of the two expeditions, and from it one is confirmed in the realization that Shackleton is a leader of men of unusual ability and force. Considerate of his subordinates, he never spared himself, and under a less able leader the Weddell Sea party would have perished.

A. W. Greely

SPECIAL ARTICLES

THE ASH OF DUNE PLANTS

Sand, the final residue after weather and water have worked their will on the silicate rocks, is possibly the poorest substratum in a chemical sense for the growth of plants. Under the action of glaciers and running water followed or accompanied by the hydrolyzing action of water in the presence of carbon dioxide and lastly subjected to the monotonous attrition of particle against particle acutated by wave motion, nothing is left of the original rock masses except partially rounded particles of quartz accompanied by grains of the more resistant silicate minerals and magnetic oxide of iron (Fe_3O_4). The finely divided silt and clay produced during the formation of the sand by wave abrasion and containing the most valuable mineral constituents for plant growth, consisting as they do of particles approaching colloidal dimensions, remain easily in suspension and are carried away by very slight water currents to be deposited far apart from the sand in quiet places. That which remains with the sand after deposition on beach or shore is carried away by the wind and redeposited at a distance, so that beach, shore or dune sand contains a minimal quantity of clay—not enough in a handful to cloud a tumbler of water.

In ordinary sand the silica content varies from approximately 92 to 98 per cent. A part of this exists free as quartz and a part in combination in silicate minerals which have resisted decomposition. The following analyses from Clarke[1] show the composition of sands from various sources.

	A	*B*	*C*	*D*	*E*	*F*
SiO_2	77.78	90.74	82.13	89.99	55.03	91.39
Al_2O_3	9.95	5.16	9.04	7.36	14.12	5.44
Fe_2O_3	2.55	1.14	2.94	.72	10.15	.89
FeO	.21	.08	......	.13	.....	.16
MnO	.....	Trace	......	Trace	.....	Trace
CaO	.71	.69	1.28	.46	6.88	Trace
MgO	.17	Trace	.84	Trace	6.38	Trace
K_2O	2.50	1.19	1.93	.33	1.66	1.19
Na_2O	1.82	.26	.95	.33	.87	.70
P_2O_5	.....	......	.20	......	.....	......
Ignition	2.74	1.30	1.01	.60	4.55	.65
	98.43	100.56	100.01	100.43	99.64	100.42

A, B. Glacial sands.
C. Average of five river sands.
D. Sea sand.
E. Sea sand derived from subsilicic igneous rocks.
F. Blown sand.

In spite of its chemical poverty and its inadequacy as a soil for the support of nearly all agricultural plants, sand, nevertheless, has certain physical advantages which are of importance and valuable to such vegetation as

[1] "The Data of Geochemistry," by F. W. Clarke, Bull. 616, U. S. Geological Survey.

can maintain life on low mineral rations; (1) on account of its porosity it is always well drained; (2) it is likewise well aerated; (3) it allows free lateral and vertical movement of ground water; (4) on account of its low capillary absorption of water it has a very low wilting limit;[2] in other words, it

	Water per 100 of Dry Soil When Plants Wilt	Hygroscopic Water
Coarse sand	1.5	1.15
Sandy garden soil	4.6	3.00
Fine sand, with humus.	6.2	3.98
Sandy loam	7.8	5.74
Chalky loam	9.8	5.20
Peat	49.7	42.30

gives up its water readily to plants and even though it contains little, that little is available for the growth of vegetation; (5) it offers little obstruction to the growth and extension of roots, when compared with stiffer soils such as clay loams and clay.

Probably its greatest physical disadvantage is its tendency to drift with the wind with the resultant root-uncovering or top-burying action. However, this is not a serious menace to typical dune vegetation for the great root systems of most dune plants permit uncovering in some degree while even a continuous "hilling-up" of most of them during their growth appears to work no harm.

The dune region of Northern Indiana along the south shore of Lake Michigan, with which the writer is most familiar, has been the subject of numerous botanical as well as general investigations, and has attracted much interest recently since the proposal has been made to establish a National Park there. Cowles in a series of interesting papers[3] has discussed the plant ecology of the region and Shelford[4] the animal ecology.

[2] A. D. Hall, "The Soil," p .85.

[3] "Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan," *Bot. Gaz.*, 27, pp. 95, 167, 281, 361 (1899). Also "Plant Societies of Chicago and Vicinity," Bull. 2. Geog. Soc. of Chicago.

[4] "Animal Communities in Temperate America," Bull. No. 5. Geog. Soc. of Chicago.

The variety of plants in the district between Gary and Michigan City and extending about 1 or 1½ miles back from the lake shore is very great. The storm beach, to the upper limit of storm waves and driftwood (the region of the "singing sands") practically devoid of vegetation, is usually about 40 to 100 feet wide, but naturally varies with the season and wind intensity. There may be a few quick growing annuals such as sea kale (*Cakile americana*), bugseed (*Corispermum hyssopifolium*), etc., in this belt, especially during a few weeks of summer calm. Between the storm beach and the fixed dunes lies the belt of young dunes in the making, and here grow both annuals and perennials. The sand cherry (*Prunus pumila*) is here, perhaps of all the most characteristic shrub, but along the same stretch grow red osier dogwood (*Cornus stolonifera*), cotton woods (*Populus deltoides*), low willows (*Salix glaucophylla, Salix adenophylla*), artemesia (*Artemesia caudata*), Pitcher's thistle (*Cirsium Pitcheri*), the grasses, *Calamovilfa longifolia* (abundant) and *Ammophila arenaria* (less abundant. *Andropogon scoparius* (*littoralis*) does not grow as a rule near the storm beach but higher up on the fixed or partially fixed dunes.

Back of the storm beach and the embryonic dunes rise the permanent or wooded dunes, well fixed by vegetation, except where blowouts have cut through and started the sands to drifting once more. In some places the fixed dunes rise abruptly from the rather narrow storm beach, and in others low, moving or semi-fixed dunes run back from the shore for long distances. But the first example is typical.

Usually in the region discussed the shore consists of the fine sand described with relatively little shingle, but after a succession of severe storms as during the past two years, the amount of shingle increases until the shore is covered with it for a width of ten to forty feet. Undoubtedly this assists in holding the sand and preventing its drifting.

The sand of the northern Indiana dune region is considerably finer than that of some others, for example Cape Cod, and in fact the entire Atlantic coast, drifts easier with the wind and is less stable unless indeed it is stabilized by growing vegetation. A rough sieve analysis gives the following proximate physical composition, the percentages shown being the amounts passing or retained on sieves of the indicated mesh.

PHYSICAL ANALYSIS LAKE MICHIGAN SAND

	Shore Sand	Dune Sand
Finer than 100 mesh ..	3.3	3.4
Finer than 80 mesh....	9.4	11.3
Finer than 60 mesh....	49.2	46.3
Coarser than 60 mesh..	50.8	53.7

When examined chemically the sand shows no remarkable peculiarity with the possible exception of a rather high percentage of calcium which may be accounted for by the fact that the native rock of the region is limestone and the gravel of the boulder clay of the west shore of the lake is composed largely of the same rock. Analyses of the shore sand and of the dune sand give results which are practically identical. The following analyses were made in 1911.[5]

CHEMICAL ANALYSIS OF SHORES AND DUNE SAND

	Shore Sand	Dune Sand
Loss on ignition	1.00	0.90
Silica	92.00	91.90
Iron and Al. oxides...	3.24	4.30
Calcium oxide	1.36	1.36
Magnesium oxide	0.56	0.72
Sodium oxide	0.47	0.63
Potassium oxide	0.85	1.00

Another analysis of sand from a blowout was made in 1918 and gave the following results:

ANALYSIS OF SAND FROM BLOWOUT

Silica (SiO_2)	90.28
Iron oxide (Fe_2O_3)	1.03
Aluminum oxide (Al_2O_3)	3.55
Calcium oxide (CaO)	1.57
Magnesium oxide (MgO)	0.73
Sodium oxide (Na_2O)	2.22
Potassium oxide (K_2O)	1.05
Phosphoric anhydride (P_2O_5) trace, less than	0.01%

[5] Analyses by L. S. Paddock.

Approximately 90 to 92 per cent. of the sand is silica but it should be remembered that the remaining 8 to 10 per cent. consisting of calcium, magnesium, iron, aluminium, sodium, potassium, etc., is contained in undecomposed silicate minerals. Under the hand lens, while the clear white, yellow or red sand quartz grains greatly predominate, there is present also, in characteristic fashion, a considerable proportion of bright-colored and dark particles, red, brown, green and black feldspar, mica, hornblende, magnetite, etc., making up, let us say, approximately 25 per cent. of the total. From these particles the dune plants must in the main derive their supply of soluble inorganic substances necessary for nutrition. It should be noted that these rock particles are practically in their unaltered condition, any decomposed or finely disintegrated portions having been mostly dissolved or washed away by the waves or blown away by the wind. However, when the sand is agitated with water there is always present a very small quantity of colloidal particles or clay which is undoubtedly important for the growth of plants. The amount, however, is so slight that it scarcely fails to leave the water clear and could be entirely disregarded for the purpose of the argument.

The integration of chemical infinitesimals by the living organism is not an isolated or unique phenomenon, particularly in the vegetable world. It is nevertheless a matter of the greatest interest, whether it consists in the elaboration of complex carbon compounds from the carbon dioxide of the atmosphere, wherein this substance occurs at a dilution of about 3 parts in 10,000, or the concentration of potassium salts by the giant kelps of the Pacific (*Macrocystis, Pelagophycus, Nereocystis,* etc.) from sea water which contains about 4 parts potassium per 10,000 or only about 1/30 the amount of sodium present; but in the two instances cited, the raw material is brought to the plant in suitable quantity and form of combination, if in a condition of great dilution, from the enormous reservoirs of air and ocean. In the case of dune plants the root systems must go after their mineral food supply and search the sand grains for it. Not only this, they must convert the needed portions of insoluble silicates into soluble compounds suitable for absorption and metabolism. This they are well equipped to do; for whatever other characteristics various species of dune plants may have and howsoever greatly they differ from one another, they are alike in possessing extraordinary root systems. This does not mean that all the root sytems belong to one type or class but that all are of relatively large dimensions and well adapted to exploring for their food supply or failing this to storing up a supply by slow accumulations through the year for a brief season of active growth or short blooming period—for example, the birdfoot violet (*Viola pedata*). The distances which some of the longer roots travel, horizontally, parallel with the surface, or in a downward direction, are astonishing and all but unbelievable unless one has traced such roots by pulling them out; distances to be measured in units of yards or rods rather than feet or inches. Even quick-growing annuals like sea kale (*Cakile americana*) will send out horizontal root branches in length many times the height of the plant—a plant ten inches high may have horizontal root branches ten feet long.

For the determination of ash constituents, seven typical species were selected. The sand cherry (*Prunus pumila*), artemesia (*Artemesia caudata*), black oak (*Quercus coccinea tinctoria*), the three grasses, *Calamovilfa, Ammophila* and *Andropogon,* and the scouring rush (*Equisetum hyemale* var. *intermedium*).

The sand cherry sample consisted of stems and a few leaves, the artemesia of stems, leaves and seeds, the oak of a section of trunk, the grasses of stems, leaves and seeds, and the scouring rush of stems. These were first carefully burned on clean iron pans to a blackish or gray ash, then taken to the laboratory and the ashing completed at a moderate red heat in muffles. The analyses follow:[6]

ANALYSIS OF ASH FROM ARTEMESIA AND PRUNUS

	Artemisia	Prunus
Silica	12.12	1.50
Iron oxide (Fe_2O_3)	1.74	0.71
Aluminum oxide (Al_2O_3)	0.42	0.02
Calcium oxide (CaO)	35.47	44.13
Magnesium oxide (MgO)	6.41	4.25
Phosphoric anhydride (P_2O_5)	3.95	3.25
Carbon dioxide (CO_2)	21.40	35.48
Mangano-manganic oxide (Mn_3O_4)	0.12	0.06
Chlorine present as chlorides	1.75	0.26
Sulphuric anhydride (SO_3)	6.00	0.79
Sodium oxide (Na_2O)	0.52	0.40
Potassium oxide (K_2O)	11.61	10.94

ANALYSIS OF ASH FROM QUERCUS AND COMMERCIAL SAWDUST

	Quercus	Sawdust
Silica	32.38	12.84
Iron oxide	1.50	2.55
Aluminum oxide	0.70	3.05
Mangano manganic oxide (Mn_3O_4)	0.24	0.72
Phosphoric anhydride	0.91	1.40
Sulphuric anhydride	3.33	2.09
Carbon dioxide	18.04	22.40
Chlorine present as chlorides	trace	trace
Calcium oxide	28.86	36.00
Magnesium oxide	3.42	4.13
Potassium oxide	9.51	13.39
Sodium oxide	0.82	1.26

ANALYSIS OF ASH FROM FOUR DUNE PLANTS

	Equisetum	*Calamovilfa* Ash	*Andropogon* Ash	*Ammophila* Ash
Silica	49.44	58.74	65.40	48.56
Iron oxide	1.04	1.61	2.52	2.85
Aluminum oxide	2.26	1.69	2.57	3.02
Calcium oxide	13.36	11.61	10.19	19.00
Magnesium oxide	3.67	3.72	3.21	4.29
Potassium oxide	6.01	10.70	6.68	6.32
Sodium oxide	10.37	4.52	4.00	8.18
*Chlorine	3.83	1.83	2.57	1.10
Sulphuric anhydride	8.97	4.58	1.55	4.95
Phosphoric anhydride	2.55	2.04	2.04	2.05
*Oxygen equivalent	0.86	0.40	0.55	0.25

For comparison with the black oak ash, an analysis was made of the ash on a sample of ordinary commercial oak sawdust, source and

[6] I am indebted to Messrs. L. S. Paddock and W. B. Cochrane for the analytical work on the ash of the various dune plants.

soil unknown This sawdust would represent a mixture of samples from numerous trees and possibly represent several species grown on ordinary forest soils.

From these analyses several interesting conclusions are to be drawn. The dune plants have obtained and concentrated in their tissues, the same mineral constituents commonly found in plants growing on good soils, and these have been accumulated in approximately the same relative proportions. It is natural to suppose that the concentrations of the various substances in the soil would have some influence on the composition of the ash. If a soil contain a relatively large amount of potassium or phosphorus, or calcium or silicon, one might expect that these elements would be contained in the plant ash in relatively large proportion. While this influence of total quantity present in the soil is of some effect, it is not determinative. The plant takes what it needs. Contrast *Prunus* with *Artemisia, Quercus* or the three grasses or the scouring rush and note the astonishingly low silica content of *Prunus* ash compared to any of the others and the relatively high calcium. It is astonishing indeed to find a negligible quantity of silica and an extremely large proportion of calcium in the ash of a plant grown on such a highly silicious soil.

Consider those elements derived from the soil which are assumed to function in the essential metabolism of the plant, iron, manganese, calcium, magnesium, potassium, phosphorus, sulphur. From most inadequate and insufficient sources the dune plants have obtained their requirements of these necessary elements. On such a soil as beach sand, the ordinary plants of agriculture would wilt and starve. It would probably not be possible to successfully grow any sort of plant which in addition to maintaining itself normally, stores up abundantly large quantities of organic compounds suitable for human food in roots, leaves, fruits or grains. Plants of this sort would probably not reach maturity or grow at all. Certainly they would not develop into a food-producing crop, but the characteristic dune plants are at least sufficient unto themselves, carry through their life cycle successfully and win from a most refractory soil their necessary mineral sustenance. Prunus refuses silicon and gathers in large supplies of calcium whereas the grasses and the scouring rush store up large quantities of the former and are satisfied with one fourth to one third as much calcium as Prunus requires.

Those other elements, aluminium, silicon, sodium and chlorine, consistently present in plants, but apparently not essential to growth (as determined by pot and water cultures) are yet present in the ash of dune plants, although, with the exception of silica, in small proportion. Must we conclude that these elements although not essential to growth, are nevertheless not harmful, and that they are absorbed by a selective apparatus which while highly efficient is not absolute in its action, since the physiological requirements of the plant are satisfied short of positive rejection of harmless non-essentials? Or, on the other hand, are some or all of these elements, while not necessary for the normal metabolism of the plant, at least desirable in some unknown way in connection with osmotic pressures?

The older chemists puzzled much over the meaning of plant ash composition and not without reason. However regrettable the fact is, we are forced to admit that to-day we know little more in regard to the fundamental requirements of plants as regards mineral substances and the ability to obtain them from various soils and under various conditions than they did. In Liebig[7] are some hundreds of analyses in the old chemical notation unclassified save as to species and with the components in every conceivable proportion. The names of the analysts are appended but this throws little light on the subject as some of them are known to fame, others all but lost in oblivion, and as the methods of analysis used by the various investigators are not given, the degree of accuracy attained in the various cases remains unknown. Undoubtedly the

[7] "Die Chemie in ihrer Anwendung auf Agricultur und Physiologie."

methods used were less perfect than those in use to-day but even assuming that the analyses are reasonably accurate, the varying proportions and the various ingredients in the case of different species and different analyses are such that it is impossible to discern any rule or law governing their absorption by the plant. It is evident that certain mineral constituents are necessary for the plant's growth, but the minimum amount required of individual elements or the relative amounts of various elements apparently depend on a number of variables, such as species and race of plant, the soil, the season, the rainfall, the state of cultivation, etc., to such an extent that it is doubtful whether or not any sort of rule governing these proportions can ever be formulated. About all we can say is that certain elements are necessary for the normal growth of the plant and either the plant obtains these at the proper time or it suffers injury or death.

Small wonder that the older chemists failed to find the rule and all credit to them that they did ascertain the main fact.

Considering plants of all sorts, and all parts of plants, silicon is the greatest variable of all. It is invariably present but only in small amount, even to a fraction of one per cent. in fruits and edible grass seeds (grain), whereas in the stalks of the same plants it may constitute as much as seventy-five per cent. of the ash. In the light of these facts, it has been looked upon by some authors as a material of construction (the first and most natural thought) rather than as a physiologically functioning substance. This view receives some confirmation from those obvious cases in which silica serves as a structural support, as in the scouring rush and diatoms. There can be no doubt that plants acquired the silica habit early in their evolutionary history and it yet may be found to function physiologically, osmotically or structurally. It is difficult to think of an active, surviving, plant organism absorbing and storing up such a substance or any substance which has and can have no real and positive use in its life cycle. Unless silicon functions in some way in plant metabolism or serves as a building material, it is most difficult to explain the high relative portion of this element in the grasses and scouring rush, the moderate amounts in Artemesia and the almost negligible quantity present in Prunus.

It is interesting to visualize the activities of the growing root tip as it projects itself among the sand grains, moving under the reactions of the various tropisms in such wise that the weal of the growing plant is conserved; turning as necessity arises first in one direction, then in the other, but on the whole maintaining its direction, since there are no serious obstructions in the dune soil; wedging its way molelike underground, expanding, holding fast; neglecting grains of silica, lying close to potash silicates, absorbing chance molecules of calcium bicarbonate and phosphates, furnishing the chemical means if need be, of bringing the insoluble substance it requires into solution; keeping the cell pumps going to furnish the water supply to the plant in time of rain or drought; a very center of ceaseless, slow, sure activity, in which all the forces of nature seem to be at work to maintain a useless bitter plant.

W. D. Richardson

Chicago, Ill.

THE UTAH ACADEMY OF SCIENCES

The thirteenth annual convention of the Utah Academy of Sciences was held in the physics lecture room of the University of Utah at Salt Lake City on April 2 and 3, 1920.

At the business meeting at the close of the session, April 3, the following members were elected to fellowship in the Academy: O. W. Israelson, Utah Agricultural College, Logan; T. B. Brighton, University of Utah, Salt Lake City, and R. A. Hart, Springville.

The following were elected to membership: Dr. E. L. Quinn, University of Utah; Dr. E. E. Ericksen, University of Utah; Orin A. Ogilvie, University of Utah; Wm. Z. Terry, Ogden; Geo. P. Unseld, Salt Lake City, and Albert S. Hutchins, Springville.

The constitution was amended raising the annual dues to two dollars, effective for the present year.

A resolution, urging the United States Senate and House Committees on Civil Service, to an early adoption of the report of the Congressional Commission on the reclassification of government employees was unanimously adopted.

The following officers were elected for the ensuing year:

President, Carl F. Korstian, U. S. Forestry Service, Ogden.

First Vice-president, Dr. Frank L. West, Utah Agricultural College, Logan.

Second Vice-president, Hyrum Schneider, University of Utah, Salt Lake City.

Councillors, Dr. M. C. Merrill, Utah Agricultural College, Logan; Carl F. Eyring, Brigham Young University, Provo, and H. R. Hagan, Salt Lake City.

At the Friday evening session, the program consisted of a symposium on the subject of "The constitution of matter" and consisted of the following papers:

The theory of the constitution of matter: DR. ORIN TUGMAN, University of Utah, president of the academy.

The oil drop method of measuring the electric charge: CARL F. EYRING, Brigham Young University.

The electron theory of the conduction of electricity: DR. FRANK L. WEST, Utah Agricultural College.

The theory of valencies: DR. W. D. BONNER, University of Utah.

The relativity theory: E. W. PEHRSON, University of Utah.

The Einstein theory: GEO. P. UNSELD, West High School, Salt Lake City.

Matter from the point of view of a personalistic philosophy: W. H. CHAMBERLAIN, University of Utah.

The program for the Saturday morning session was as follows:

Capacities of soils for irrigation water: O. W. ISRAELSON, Utah Agricultural College.

The breeding of canning tomatoes: DR. M. C. MERRILL AND TRACY ABELL, Utah Agricultural College.

The value of farm manure for Utah soils: DR. F. S. HARRIS, Utah Agricultural College.

Research work of the experiment station of the Bureau of Mines: THOMAS VARLEY, U. S. Bureau of Mines, University of Utah.

Hydrometallurgy as applied to the mineral industry: CLARENCE A. WRIGHT, U. S. Bureau of Mines, University of Utah.

Oil shales and their economic importance: MARTIN J. GAVIN, U. S. Bureau of Mines, University of Utah.

Pyrometallurgy and its future possibilities: JOHN C. MORGAN, U. S. Bureau of Mines, University of Utah.

Chemistry and its relation to metallurgy: EDWARD P. BARRETT, U. S. Bureau of Mines, University of Utah.

Complementary luncheon to the members of the academy by the University of Utah at the dining hall. At the luncheon, an address was given by President John A. Widtsoe, University of Utah.

At the afternoon session the following papers were read:

A capillary transmission constant and methods of measuring it: WILLARD GARDNER, Utah Agricultural College.

Mid-tertiary deformation of western North America: HYRUM SCHNEIDER, University of Utah.

Electrical conductivity of thin metal films: DR. ORIN TUGMAN, University of Utah.

Is disinfection a reaction of the first order? DR. L. F. SHACKELL, University of Utah.

Some problems in daylight illumination: C. ARTHUR SMITH, East High School, Salt Lake City.

Equilibrium conditions in the system calcium sulphate-manganous sulphate-water: A. G. KLINE AND DR. T. B. BRIGHTON, University of Utah.

Standardization from constant boiling hydrochloric acid: J. T. BONNER AND DR. T. B. BRIGHTON, University of Utah.

Comparison of the action of potassium cyanide and sodium cyanide on alkyl halides: W. D. KLINE AND DR. W. D. BONNER.

The determination of arsenic as lead arsenate: A. E. ANDERSON AND DR. T. B. BRIGHTON, University of Utah.

C. ARTHUR SMITH,
Corresponding Secretary

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE EFFECT OF THE WAR ON THE CHIEF FACTORS OF POPULATION CHANGE[1]

THERE have recently appeared some figures[2] regarding the "mouvement de la population" in France, Prussia and Bavaria which appear to deserve somewhat more careful analysis than they have received. These figures are derived from official sources and are conveniently collected in the place to which I have made reference.

There are three factors fundamentally concerned in producing changes in the absolute size of the population in a given fixed area (country, province, etc.). These are:

1. The birth-rate,
2. The death-rate,
3. The net immigration rate.

Of these factors the two first are, generally speaking, of the greatest biological interest. This is particularly true of such political units as France, Prussia and Bavaria, where in normal times net immigration makes no significant contribution to the population. Under war conditions permanent immigration to these units was *nil* and may therefore be safely neglected in the following discussion.

The relation of birth-rate and death-rate changes to population changes is a simple one and may be put this way. If in a given time unit the percentage

$$\frac{100 \text{ Deaths}}{\text{Births}}$$

has a value less than 100, it means that the births exceed the deaths, and that the population is increasing within the specified time

[1] Papers from the department of biometry and vital statistics, School of Hygiene and Public Health, Johns Hopkins University, No. 14. This paper recently formed the basis of an evening's discussion at the writer's seminar.

[2] *Jour. Soc. Stat. Paris*, Soixantième Année, pp. 356–361, December, 1919.

unit. If, on the other hand, the percentage is greater than 100 it means that the deaths are more frequent than the births, and that the population is decreasing, again within the specified time unit. The ratio expressed in (i) may be conveniently designated as the vital index of a population.

were of the births for (*a*) the 77 non-invaded departments of France; (*b*) Prussia; and (*c*) Bavaria; and (*d*) England and Wales, from 1913 to 1918 by years, with the results shown in Table I. The English data were obtained from the quarterly returns (No. 284) of the registrar-general.

TABLE I

Percentage of Deaths to Births

Year	77 Non-invaded Departments of France	Prussia	Bavaria	England and Wales
1913	97 per cent.	——	58 per cent.	57 per cent.
1914	110 " "	66 per cent.	74 " "	59 " "
1915	169 " "	101 " "	98 " "	69 " "
1916	193 " "	117 " "	131 " "	65 " "
1917	179 " "	140 " "	127 " "	75 " "
1918	198 " "	132[3] " "	146 " "	92 " "

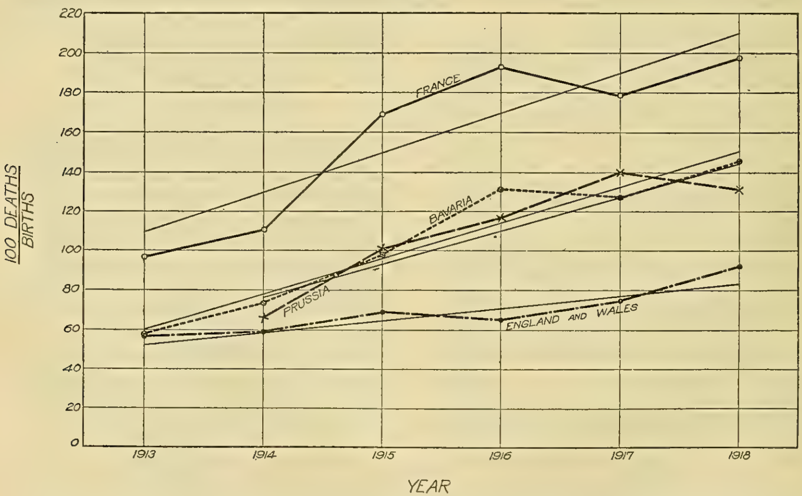

Fig. 1. Showing the change in the percentage, which deaths were of births in each of the years 1913 to 1918 in France (non-invaded departments) (————), Prussia (——), Bavaria (- - - -) and England and Wales (—-—-).

From the raw data of births and deaths given in the source referred to above I have calculated the percentage which the deaths

[3] This percentage is based upon returns for the first three fourths of the year only.

These percentages are shown graphically in Fig. 1, together with straight lines fitted to each, by the method of least squares. The equations to the straight lines, where y denotes death/birth ratio, and x time, are:

France, $y = 84.0669 + 21.0285\ x$. Origin at 1912. (ii)

Prussia, $y = 59.9 + 17.1\ x$. Origin at 1913, (iii)

Bavaria, $y = 42.4668 + 18.0571\ x$. Origin at 1912. (iv)

England and Wales, $y = 45.9335 + 6.2571\ x$. Origin at 1912. (v)

From this diagram and the data of Table I. we note.

1. In the year prior to the beginning of the war the death-birth ratio of France was at nearly twice as high a level as in any of the other countries dealt with. This fact was of course well known. With a very low birth-rate and a death-rate of the same general order of magnitude as that prevailing in other European countries the French death-birth ratio could not be anything but extremely high.

2. In all the countries here dealt with the death-birth ratio in general rises throughout the war period. This means that the proportion of deaths to births increased as long as the war continued. In France it was slightly more than double in 1918 what it was in 1913. The same was in general true of Prussia and Bavaria. These states started from a very different base in 1913, and the relative rise was even greater.

3. In England and Wales, while the death-birth ratio increased throughout the war period, the rate of this increase was markedly slower than in any of the other countries dealt with.

4. A straight line is not a particularly good fit to the French curve, but it has been used in order to demonstrate more clearly the general trend. In 1915 and 1916 the French percentage rose markedly above the straight line. These were perhaps the years when the forces of war impinged most heavily upon the French.

5. It is noteworthy that despite the epidemic of influenza in 1918, unprecedented in its severity so far as this disease is concerned, none of the curves shows any sharp or marked rise in that year. The curve for England and Wales comes nearest to showing an effect of the epidemic, but even then the rise in 1918 is not so marked as one might have expected.

6. The straight lines for France, Prussia and Bavaria are nearly parallel, or in other words have slopes of about the same order of magnitude (cf., the values of b which determine the slope in the straight line equations). The slope of the line for England and Wales is very different from that of the other three.

These facts raise many interesting points for discussion. The people of Prussia and Bavaria suffered progressive deprivations in respect of food and other comforts of life throughout the war. The sufferings of the French people in these respects were undoubtedly less severe than those of the Germans. All, however, lived for several years on an inadequate diet. This fact alone unquestionably contributed to an ever-increasing death-rate, particularly at the two ends of the life cycle. This same dietary factor undoubtedly also played a considerable part in producing the steady fall in the birth-rate. Here, however, the psychological factor also had a large rôle, and this introduces a point of great interest. Psychologically, the civilian French population and the civilian German population were on a different footing. In the one case, until well into 1918, the attitude was that of the potential conqueror, fighting as an invader in the other's territory. In the other case a war of defense against invasion and further destruction of the home land was being fought. Yet the net effect on the vital indices of the population was, as is shown by the essential parallelism of the straight lines, substantially the same in the one case as in the other. In any other game than war the psychological attitude of offender produces far different results from that of defender. Here the essential and out standing fact is that the net biological outcome of the complex interplay of forces resulting from war was almost identically the same in France and Germany.

Another interesting point is that while France started in 1913 with a death-birth ratio 40 per cent higher than that of the German states—she having at that time an approximate equality of births and deaths—nevertheless the biological changes induced by the war, as expressed in this ratio, were the same for the one as for the others. We are evidently dealing here with deep-seated and fundamental phenomena of racial biology. The biological reactions of French and Germans in respect of a most fundamental phenomenon, the death-birth ratio, were essentially the same, though they started from such different pre-war bases.

The case of England is obviously entirely different. Starting from about the same base as the German states England's biological reaction to war was much less pronounced. There are many explanations, such as better food conditions, different race psychology from any of the other belligerents, etc., which might be brought forward. There appears at the moment no way of accurately evaluating any of these possible explanations. We must perforce rest with the setting forth of the facts. It is worth noting, however, that though England's vital index changed less in degree than that of the other countries, its movement was the same in kind.

There are two other points which one would like to have information upon. The first is: What will be the course of these death-birth ratio curves in the years following 1918? Will they come back to the pre-war level, and if so, how soon? For England and Wales alone is it now possible to get an indication on this point. For the year 1919 the relation $\frac{100 \text{ Deaths}}{\text{Births}}$ had the value 73 per cent. This represents a marked drop, though it does not bring the curve back to the pre-war level. The appearance of official statistics which will make possible the further plotting of the curves of Fig. 1 will be awaited with great interest. In the second place, one would like to know what the appearance of the curve for the United States would be. Unfortunately, we have for the Registration Area of births data only for the years 1915, 1916, and 1917 now available. So few years appear inadequate to set against the longer series for the other countries.

Raymond Pearl
The Johns Hopkins University

COLORED PHOTOGRAPHS OF PLANT DISEASE SPECIMENS

In the preparation of a handbook of the diseases of vegetables by the U. S. Bureau of Plant Industry for the Food Products Inspection Service of the U. S. Bureau of Markets, it has been found practicable to make colored illustrations by the aid of a firm of commercial photographers.[1]

The specimens of diseased vegetables were collected by the writers to a large extent in the Chicago markets and freight yards. In addition numerous field excursions were made into the region surrounding Chicago for the purpose of securing specimens. To date, over two hundred illustrations have been completed, a number of which were exhibited at the Baltimore and St. Louis meetings and aroused a very general and real interest on the part of the botanists. So many questions were asked concerning the process by which the illustrations were prepared that the writers are using this means of making the answers as generally known as possible.

A vertical camera was used and the specimens were arranged on a ground-glass background which eliminates shadows. Occasionally a black velvet background was used, and leaves usually were laid on wet blotting paper to prevent curling. In making the exposures, artificial light was seldom used. Most of the subjects have been reproduced in natural size on 8 by 10 inch negatives. The camera was equipped with Cooke Process Lenses, Series 5, of 16 or 18 inches focal length, or with a Goerz Dogmar lens of 12 inches focal length. Color filters, usually the K2 yellow or the green, and occasionally the red, were used in about 75 per cent. of the exposures. About two-thirds of the exposures were made on Seed's Panchromatic plates and the remainder on Polychrome or Standard Orthonon plates. The legends are etched in the gelatin of the negative. The majority of the subjects have been photographed in duplicate to insure against loss of the record by breakage.

Prints are made either on Defender or Kresko printing-out paper or on Defender or

[1] Webster Bros., Chicago, Illinois.

Azo developing paper, preferably the latter in each case. The coloring is secured by painting directly upon the dry prints with transparent dyes. The detail of the image is supplied by the lines of the print itself. Water-soluble aniline dyes in the colors yellow, orange, red, brown, blue and royal blue are commonly used. The original plate is colored with the specimens before the artist and, while it has been necessary to supervise closely the color work on this print, a surprising degree of skill and accuracy has been developed by some of the operatives. Since most truck crop disease specimens are highly perishable and change considerably during the time elapsing between exposure of the negative and the completion of prints, even though held in a refrigerator, it has been found advantageous to register the exact colors on some other print of proper color value at the time of exposure, or if possible to collect fresh specimens of a similar character.

Inasmuch as the print is to serve as a background for the color, the kind of paper chosen and the intensity of the image depend upon the color effects desired. For example, the printing-out paper is desirable for most yellows, browns, and reds, while for purples, blacks, and dark greens the developing paper is preferable. However, the printing-out paper serves very well for the majority of greens and has been more extensively used.

After the dyes are mixed and diluted to secure the desired shade, the gelatin surface of the print is prepared for coloring (probably softened and swelled) by wiping with a cloth moistened with alcohol, ammonium hydroxide, or more commonly saliva, and the dye is applied with a brush in rather liberal amounts of which the excess is removed by means of a blotter. The quality of the color is determined by the proportions of the dye mixture and the type of paper used for the print; the intensity of color is determined by the dilution of the dye, the intensity of the photographic image, and the length of time the excess dye is allowed to remain on the print before blotting. In case of error the color can be removed with ammonium hydroxide. In some instances a very small amount of this substance added to the dye causes the latter to spread and adhere more satisfactorily. Details in white or background color, such as holes in a leaf, can be conserved by coating with a paste or enamel which is insoluble in ordinary solvents and is removed with benzine after the coloring is completed. Details in black, such as the blackened veins in cabbage black rot, can best be shown by the image on Azo paper. After the coloring is completed, the prints are run through a mordant bath to fix the colors. Combinations of acetic acid, formalin, and other mordant reagents constitute this bath, the exact composition of which depends in part upon the colors to be fixed. The gelatin surface must be thoroughly wetted by the solution. The prints are then rinsed in a water bath, placed face downward on squeegee boards, spónged, and passed through rollers to remove the excess water. The prints are mounted while wet on muslin or Japanese paper with a cardboard flap and allowed to dry on the squeegee board.

While these colored photographs are ultimately to be used for lithographs, it has been found feasible to reproduce about ninety sets of fifty duplicates each for immediate use by hand coloring of duplicate prints, the original colored print being used as a guide. However, this process is too laborious and unreliable for large scale production and the colors will not endure indefinite exposure to light. Colored lantern slides of a very gratifying quality have also been made.

This process of color reproduction could well be utilized in other branches of science and there appears to be no reason why it could not be perfected and employed by educational and research institutions. The results of this method of scientific illustration are far superior to uncolored reproductions and are, it is believed, an improvement over other types of color reproduction because of the accuracy of detail afforded by the photographic image. Such illustrations should find wide use in technical publications and especially in charts, stereopticon slides, and extension bulletins.

Max W. Gardner,
Geo. K. K. Link

WILLIAM DIXON WEAVER

Dr. William D. Weaver, for a number of years editor of the *Electrical World,* a man of the true scientific spirit, a friend of education and scholarship, a devotee of literature, an upholder of the finer things of life, and one of the most delightful of companions, died at his home in Charlottesville, Va., on November 2, 1919.

Dr. Weaver was born on August 30, 1857, at Greensburg, Pa. After a year spent in preliminary study at the University of Kentucky, he entered the United States Naval Academy, from which he graduated as cadet engineer in 1880. Only a few months ago Dr. Weaver received the honorary degree of LL.D. from the University of Kentucky. After graduation the young officer served in the Navy for twelve years except for one year's leave of absence in 1884, during which he studied electricity and conducted some investigations in the electrical laboratory of the Sorbonne, Paris, and the School of Electrical Engineering, London. In 1883 he was a member of the U. S. S. *Yantic* expedition sent to the relief of Lieutenant Greely, the Arctic explorer. When he resigned from the Navy in 1892 he held the relative rank of ensign.

Mr. Weaver's life work was that of an editorial exponent of the science, art and industry of electricity. After resigning from the Navy he spent a year in the business of manufacturing electrical appliances, and he became editor of the *Electrical World* in 1893. In 1896 the *American Electrician* was established, and this magazine, a monthly, with Mr. Weaver as editor, became notably successful. Mr. Weaver accomplished the difficult task of making a magazine that was useful and interesting to the "practical" man and at the same time of high technical standing. His gifts as a technical journalist were indeed of a high order. In 1906 the *American Electrician* was absorbed by the *Electrical World,* and Mr. Weaver retaining his connection with that paper until May, 1912, when he retired, removing to Charlottesville, Va.

Of a modest, retiring nature, Mr. Weaver did a great deal for electrical advancement, although often he remained in the background, cooperating with others whose names appeared in connection with the particular task in hand. He became an associate of the American Institute of Electrical Engineers in 1887 and became successively a member and a fellow of the society. For six years Mr. Weaver served as manager of the institute, and it is probable that he could have been elected president had he not refused to entertain the honor. On May 16, 1919, as the result of the work of a group of friends and admirers, a bronze tablet was unveiled at the headquarters of the American Institute of Electrical Engineers in recognition of Mr. Weaver's services. It bears a bas-relief portrait and this inscription:

> This tablet is dedicated to William Dixon Weaver, engineer, journalist, scholar, to record his influence in the development and promotion of the art and science of electrical engineering.

In 1900 Mr. Weaver was appointed by the United States government as an official delegate to the International Electrical Congress at Paris, but, upon his suggestion, the appointment was transferred to Dr. A. E. Kennelly, of Harvard University. He had much to do with the St. Louis (1904) International Electrical Congress, of which he was treasurer and business manager. With Dr. Kennelly, who was general secretary, he supervised the publication of the *Transactions* of that congress in three large volumes, published in 1905.

An excellent judge of engineering literature, Mr. Weaver was for several years chairman of the Library Committee of the American Institute of Electrical Engineers. In 1901 Dr. S. S. Wheeler purchased the Latimer Clark collection of electrical books and pamphlets and presented it to the institute. Thereafter, as a labor of love, Mr. Weaver edited the Catalogue of the Wheeler Gift of Books, Pamphlets and Periodicals in the Library of the American Institute of Electrical Engineers. This catalogue raisonné, in which the late Brother Potamian collaborated with Mr. Weaver was published in two handsome volumes in 1909 and stands as a monument to Mr. Weaver's learning and taste.

It is believed that Mr. Weaver was the first to lay before the late Andrew Carnegie a plan for a home for the engineering societies in New York City which later resulted in the Engineering Societies' Building and the Engineers' Club.

A French scholar and an admirer of French achievements in science and much in French literature, Mr. Weaver was a collector for many years of books, pamphlets and pictures relating to the French Revolution. It is said that few private collections in the United States of books relating to the French Revolution were more complete than his. At one time he wrote about Paris:

> I feel more at home in that city than in any other in the world, on account probably of my first impressions of the real world having been received there.

But Lieutenant Weaver was nevertheless a thorough American. During the Spanish-American war of 1898 he served as volunteer chief engineer on the U. S. S. *Glacier*. In 1915, after his retirement, he was asked to become a member of the Naval Advisory Board, but declined on account of his health.

After taking up his home in Charlottesville Mr. Weaver became at once at home in the scholastic atmosphere of the University of Virginia. It is reported that he was offered a place on the faculty of this university a few years ago. Some time before his death Mr. Weaver gave nearly his entire collection of technical books to the University of Virginia.

An independent thinker, Mr. Weaver was tenacious in adhering to his opinions, although quiet and pleasant in manner and not vociferous in advancing his views. He felt strongly that cultural studies should not be neglected in technical education, and deplored a purely materialistic attitude in schools of engineering.

Mr. Weaver was one of the founders of the Illuminating Engineering Society and also of the American Electrochemical Society. He served for three years as manager of each. He had also much to do with the formation of the Commission on Resuscitation from Electric Shock. He was a member of the Société Internationale des Electriciens and had been honored by the French government as an officer de l'Instruction Publique.

With an acute distaste for public appearances, Mr. Weaver found his greatest pleasure in his home and library. His home life was ideal. In 1900 he married Miss Mildred Niebuhr and the union was blessed with six children. He had been a sufferer from heart trouble and passed away in his sleep.

William E. Keily

STATE GRANTS FOR SCIENTIFIC INVESTIGATIONS IN ENGLAND

A joint deputation from the British Medical Association and the British Science Guild waited upon the Right Hon. A. J. Balfour, Lord President of the Council, at the offices of the Privy Council on March 2, to place before him certain considerations with regard to state awards for scientific research.

According to the report in *The British Medical Journal* Sir Watson Cheyne said that the object of the deputation was to bring forward the question of state awards for scientific work after such work had been done. Scientific workers were assisted by scholarships and so forth while doing their work, but after it was done there was at present no provision for them, although, excited by the interest of their investigation, they had often neglected to make any provision for themselves. Moreover, it was the tradition that a scientific man should immediately publish his discoveries, making no attempt to conceal any knowledge in order to secure personal advantage.

Sir Clifford Allbutt, president of the British Medical Association, referred in particular to the conditions under which medical men worked. Those conditions were governed by the very high-standard of ethics maintained in the profession. No medical man could have honor in the profession if he descended to any kind of direct or indirect advertisement. No medical man was permitted to take out a patent. The large hospitals no doubt gave a field to the clinical worker which might offer considerable indirect reward, but that did not apply to the research worker, who was rather hidden behind his work. He knew men of very high academic attainments working enthusiastically at research who were declining lucrative appointments in order that they might finish —which they never did, of course—their experimental investigations. It was from such disinterested research—not utilitarian nor aimed at sensational or immediate results—that the greatest benefits accrued to mankind. He himself was chairman for some years of the Scientific Relief Committee of the Royal Society. Mr. Balfour would perhaps be surprised if he were to tell him privately the names of the very distinguished scientists who, or whose representatives, came forward to ask for grants in order to tide over a time of great difficulty. It was desirable to attract a great many more potential workers. The field of comparative pathology, for example, lay untilled; at present it offered no reward, direct or indirect. It would be said that the Treasury must be careful about expenditure, but he feared that the expenditure under this head would not be very great. He was afraid that the highest kind of intellectual research was rather scarce, and consequently the demands for grants would not be so heavy as might be anticipated.

Sir Richard Gregory said that in medicine the great experimental work was rarely done by the successful practitioner or consultant. It was carried out in the research laboratories by men who occupied posts carrying only moderate salaries. There was the further consideration that the highest type of worker —the genius—in medicine or any other department of science was precisely the man who was not amenable to control—the free worker who followed up a clue in some department of knowledge to the willing sacrifice of himself. There should be a fund of some kind for making suitable awards, to be considered as payment for results achieved, and not as grants for favors to come. The scientific worker (he added), unlike the worker in literature or art, could not dispose of his achievement to the public for profit.

Mr. Balfour said that he had always been an advocate—even a vehement advocate—of two things which, until quite recent years, the British public had been very slow to realize: the one, that the material progress of mankind depended upon the applications of science, and the other, that there must be pure science before these could be applied. While that was still worth saying even now on the public platform, it was a commonplace to everybody sitting around that table. They were all agreed that the state—which, after all, represented the people of the country and could not be in advance of them by more than a certain amount at any given time—had been backward in the past in its support of science. The only difference among them, if there was any difference, was as to the way in which the stimulus could best be given to those brains in the country best qualified to further scientific research and the subsequent industrial research based upon it. The view of the deputation, as he understood, was that when a man whose opportunities and genius permitted him to work at research had turned out some brilliant discovery the state should give him a reward.

Everybody must feel that the straits to which many distinguished men of science were reduced after devoting their whole lives to research without any desire for pecuniary reward were rather pathetic, and in many cases discreditable. For his own part he thought it most desirable that some remedy should be found. But he wondered how many such people would get the reward under the scheme which in rough outline had been laid before him that day. He thought the truth was that in the case of the very great discoveries, while it was often possible to go back to the individual who started the train which led to the great result, he himself had not directly produced that result. Faraday did not discover the telephone or wireless telegraphy or a practical method of electric lighting; what Faraday did was to make all those things possible, to lay the scientific basis of them. It was not easy to see how the reward was always or even commonly to be got into the right pocket. The amazing progress which medical science had recently made in stamping out certain forms of zymotic disease was, indeed, a wonderful triumph; but it was very hard to pick out the individuals to whom that triumph was due. If he might put himself in the unfortunate position of a Prime Minister, the difficulty of saying that A. should have the money which was available, or that B. should have it, would be very great, even though he took the best advice obtainable. There would be certain dramatic cases in which the whole public would be behind the Prime Minister in apportioning a particular reward, and yet when the historian came to look back upon the long labors which had made the triumph possible, might not he have to say that the genius to whose intuition and inspiration the achievement was really due had died unrewarded? Did anybody think that Maxwell, for instance, would ever have come in for any share of this parliamentary grant, seeing that his discoveries were such as very few were capable of comprehending in the form in which he gave them to the world? Yet his discoveries lay at the root of much of the subsequent progress in physical science. Sir Clifford Allbutt had pointed out that this was not asking very much from the taxpayer, because the number of people who would actually get the reward was so small. But, looked at from the point of view of the encouragement of research, that meant that a young man, going into research, and surveying the possibilities of reward, would find he had the chance only of one in ten thousand. He might contribute himself as a colloborator to the great discovery for which somebody else, quite properly, got the chief credit. The collaborator, on this plan, got nothing, yet without the collaboration of people not in the first rank could progress be made? Germany had never excelled this country—he would like to use a stronger phrase, but he would be nationally modest—in the production of those geniuses who started original discovery; but it had surpassed this country in the organization of men not of the front rank whom it had brought together in cooperation towards a common end. He did not see how the investigations of a body of cooperative workers could be stimulated by rewarding a few isolated individuals. At any rate, he saw difficulties. Was there not more to be said for some attempt to stimulate research by improving the position of the researchers while they were doing their work? He was told the other day that there were people carrying on research work at Cambridge for a smaller remuneration that the town council of Cambridge paid to its unskilled employees. This showed that there was still a great deal to be done in the way of aiding research while it was proceeding. He agreed entirely with Sir Richard Gregory that while the state might aid research it would only destroy research if it were resolved to control it. The best men would not be controlled. The state was incapable of forming a judgment on the merits of an abstruse physical of physiological inquiry. That must be left to the genius of the men themselves. But he hoped it did not follow that it was quite impossible to combine with that independence of the worker some better reward for the work he was doing. He was afraid, however, that if the Treasury were represented at that assembly, it would say it preferred the original scheme laid before him by Sir Watson Cheyne. The framing of any such ideal scheme would require a great deal of thought.

In conclusion, Mr. Balfour said that while he had spoken for himself alone, he was also there in some sense as representing the Prime Minister, and he would like to add that there was no man living who had shown a greater sympathy with scientific development than Mr. Lloyd George, who had been responsible for some of the greatest advances which had been made in the direction of state aid for scientific and medical research. When he reported to him what had passed that day, they might be sure the Prime Minister would give it the most sympathetic consideration. He was far from laying it down that the state should not on occasion imitate our forefathers in the case of Jenner and offer a pecuniary reward to some great man of science whose services had been exceptional and whose achievements were obviously his own. But he would not wish that to be a part of the regular system of dealing with discovery in this country. He hoped that what the government had already done would be found to be far greater in its ultimate results than perhaps the public at large, or even men of science, as yet had realized. He feared that they had not been supported as they might have been by men of great wealth in this country. There had been admirable exceptions, but either we had fewer millionaires than the Americans or we were less lucky in them, for there was no doubt that private individuals across the Atlantic had contributed on a scale which did justice to their generosity and was likly to produce great results for the whole world. Probably it was out of the question to hope completely to emulate them, but he did not despair that among the wealthy men in this country some might be found, in addition to those who had already shown themselves generous benefactors, who would do much to aid and stimulate that research into the laws of nature and that application of those laws upon which our main hopes for the amelioration of the lot of the human race must depend.

SCIENTIFIC EVENTS

THE MANUFACTURE OF SYNTHETIC AMMONIA IN ENGLAND[1]

The Ministry of Munitions announces that Lord Inverforth has arranged for the sale of H. M. Nitrate Factory of Billingham-on-Tees to Messrs. Brunner, Mond, and Co., Ltd. The purchasers will form a company to take over the factory, and will be responsible for all outstanding liabilities of the ministry in connection with the project. This factory, the erection of which was commenced early in 1918 by the Department of Explosives Supply, was designed for the manufacture of synthetic ammonia and for the production of 60,000 to 70,000 tons of ammonium nitrate annually.

During 1916 the Nitrogen Products Committee had established a laboratory in premises placed at its disposal in the new Ramsay building of University College, London, and the Committee's research staff, under the direction of Dr. J. A. Harker, was engaged in an experimental investigation of a number of problems relating to nitrogen fixation. Although it was not anticipated that there would be any shortage of supplies of ammonia, yet it was deemed desirable, in view of the special ability of the synthetic ammonia process for the needs of this country, that an experimental study of it should be made forthwith, so that the required information should be available if necessary.

After a year's experimental work, the progress made was considered so encouraging that the Committee decided to establish a moderate-sized technical trial unit, and funds for the purpose were allocated by the treasury. It was hoped, by means of this plant, that a study of the chemical engineering problems could follow upon that already made of the pure chemistry of the reactions involved, but the committee did not suggest the establishment of the process as a war measure upon an industrial scale. In 1917, however, the Explosives Supply Department considered that the position reached in the experiments justified it in recommending the erection of a large works, in substitution for the committee's cyanamide project, and a site at Billingham, some 260 acres in extent, was ultimately chosen for this purpose. But a number of difficulties supervened, and construction was slow, and at the time of the armistice only a few permanent buildings and a number of temporary structures had been erected, though a large amount of plant had been ordered.

The purchasers of the factory now undertake

[1] From *Nature*.

to complete the scheme by providing the additional buildings and plant required for the synthesis of ammonia and its oxidation to nitric acid and nitrates suitable for the manufacture of explosives and fertilizers. It is understood that the company has acquired a large amount of additional land and that it intends to develop the project on a very large scale. The factory has been re-designed on a peace as distinct from its former war basis, and in many particulars the new plant will represent a substantial advance, both in the ammonia and nitric acid sections, on anything previously used in Germany.

SPANISH EDITION OF THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION

AT the meeting in New Orleans the board of trustee's presented the following report:

The first year of the Spanish edition of *The Journal* has been reasonably satisfactory. Its publication was undertaken with some hesitancy because it meant a venture in an entirely new field. Other periodicals had been published in this country in the Spanish language for circulation in South and Central America, but their publication was undertaken for commercial reasons. Our Spanish edition entered the field solely as a scientific periodical for educative and scientific purposes, and it has been received with approbation. The field was a difficult one to work in the first place because there was not available any physician's directory, or any even fairly reliable list of physicians of standing. However, a list of such physicians has been gradually assembled so that now there is a fairly reliable one at the association headquarters. Included in this list are the physicians of Central and South America and the Philippine Islands.

Another difficulty has been the mailing facilities; these have been anything but satisfactory. Under normal conditions it takes a long time for a communication to reach the South American countries, with the exception of those bordering on the Gulf of Mexico.

At the end of the year the subscription list comprised 2,908 names. To those who appreciate the difficulties and know the conditions that prevailed at the beginning, this must be regarded as quite satisfactory. Roughly, this circulation is as follows: The largest number of subscribers naturally are in Mexico—539; in Cuba next, 530; Argentina, 270; Brazil, 194 (in Brazil Portuguese is the language in general use, therefore it is rather remarkable that this number has been secured there); Chile, 179; Spain, 142; Peru, 101. The rest of the circulation is in Bolivia, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Nicaragua, Paraguay, Salvador, Santo Domingo, Uruguay, Venezuela, Panama and Porto Rico.

It is not to be expected that this journal could be published without a loss for the first few years. As will be remembered, the venture was undertaken at the request of the International Health Board of the Rockefeller Foundation, which agreed to pay half the loss. It should be explained in this connection that the number of copies of each issue printed was 4,500 to 5,500, and that the excess above those subscribed for was sent out as sample copies. Hereafter, of course, there will be fewer sample copies distributed; consequently a less expense with an increased income. During the months of January, February and March the circulation has been steadily increasing. The actual loss to the association to date has been less than $10,000, which amount promises to be returned with more than gratifying results within the first five-year period of its publication.

GRANTS FOR RESEARCH MADE BY THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Committee on Grants of the association held a meeting in April, and distributed grants amounting to forty-five hundred dollars as given below. The next meeting of the committee will be in connection with the annual meeting of the assocation in December, when grants for the year 1920 will be made. Applications or suggestions in regard to grants may be made to any member of the committee, and should be received before December 1. The present membership is: Henry Crew, chairman; W. B. Cannon, R. T. Chamberlin, G. N. Lewis, George T. Moore, G. H. Parker, Robert M. Yerkes, and Joel Stebbins, secretary.

Following are the grants for 1919:

MATHEMATICS

Three hundred dollars to Professor Solomon Lefschetz, of Kansas University, to assist in the publication of his memoir on algebraic surfaces, which was awarded the Bordin prize of the Paris Academy of Sciences.

One hundred dollars to Dr. Olive C. Hazlett, of Mount Holyoke College, in support of her work on the theory of hypercomplex numbers and invariants.

PHYSICS

Two hundred dollars to Professor A. A. Knowlton, of Reed College, in aid of a determination of the relation between chemical composition and magnetic properties in Heusler alloys. The particular problem is to find the precise proportions in which the elements must be mixed in order to get the maximum value of magnetic intensity at saturation.

One hundred dollars to Professor John C. Shedd, of Occidental College, in aid of a further study of snow crystals, similar to that which he has already published.

ASTRONOMY

Six hundred dollars to Professor Philip Fox, of Dearborn Observatory, Northwestern University, in support of his work on the photographic determination of stellar parallaxes. This is a renewal of the grant made for the same purpose in 1917, but the use of which was interrupted by the war.

One hundred dollars to Professor Anne S. Young, of Mount Holyoke College, for the determination of the positions and proper motions of stars from photographic plates already taken. The work is being done in cooperation with the Yerkes and McCormick Observatories.

GEOLOGY

Two hundred and fifty dollars to M. Ferdinand Canu, of Versailles, France, to carry forward toward completion the very significant studies upon the classification of bryozoa in which he is collaborating with Dr. R. S. Bassler at the U. S. National Museum.

Two hundred and fifty dollars to Mr. Frank B. Taylor, of Fort Wayne, Indiana, for a field study of the moraines of recession in the St. Lawrence Valley.

ZOOLOGY

Two hundred and fifty dollars to Professor S. I. Kornhauser, of Denison University, for a continuation of his work on the sexual characteristics of the membracid insect *Thelia bimaculata*. The first part of this work was published in September, 1919, in the *Journal of Morphology*.

Two hundred dollars to Dr. P. W. Whiting, of St. Stephen's College, for breeding outfit and temperature apparatus to be used for genetic and cytological researches on *Ephestia* and *Hadrobracon*.

BOTANY

Five hundred dollars to the editorial board of *Botanical Abstracts* for editorial and office expenses in connection with the preparation of manuscripts. The general interests of botany, in both its national and international aspects, would seem to be best served at this time by aiding this abstract journal for another year.

Five hundred dollars to Dr. I. W. Bailey, of the Bussey Institution, Harvard University, for aid in investigations upon: (1) Myrmecophytism; particularly certain supposed symbiotic relations between ants and higher plants. (2) Relations between ants and fungi, particularly ants as disseminators of disease. (3) Cytology of the cambium. The entomological work involved will be done in collaboration with Professor W. M. Wheeler, and the headquarters for the summer will be at the British Guiana Tropical Research Station of the New York Zoological Society.

ANTHROPOLOGY, PSYCHOLOGY AND EDUCATION

One hundred dollars to Mr. S. D. Robbins, of the Harvard Psychological Laboratory, for measurements of blood pressure of a trephined stammerer.

Two hundred dollars to Professor Daniel W. La-Rue, Stroudsburg State Normal School, Pennsylvania, in support of experimental work on a phonetic alphabet.

Two hundred dollars to Professor Margaret F. Washburn, Vassar College, for a study of emotional characteristics of certain racial groups in New York City.

Two hundred dollars to Professor Joseph Peterson, George Peabody College for Teachers, Tennessee, in support of a study of the qualitative differences in the mentality of whites and negroes.

Two hundred dollars to Professor A. A. Schaeffer, University of Tennessee, in support of an experimental study of orientation and the direction of movement of animals, and particularly of the "spiral path" in man.

PHYSIOLOGY AND MEDICINE

One hundred dollars to Professor Theodore Hough, University of Virginia, in support of his studies with Dr. J. A. Waddell on blood changes after severe hemorrhages.

One hundred and fifty dollars to Professor Carl J. Wiggers, Western Reserve University, in support of his investigations of the cardiac function by optical registration.

Joel Stebbins,
Secretary

SCIENTIFIC NOTES AND NEWS

Fellows elected at the annual meeting of the American Academy of Arts and Sciences include Cecil Kent Drinker, Harlow Shapley, William Underwood and Clark Wissler. Maurice Caullery and Jacques Solomon Hadamard were elected foreign honorary members.

At the annual meeting of the Association of American Physicians held in Atlantic City, N. J., May 4 and 5, Dr. William S, Thayer, Baltimore, was elected president; Dr. Herbert C. Moffitt, San Francisco, vice president; Dr. Thomas McCrae, Philadelphia, secretary; Dr. Thomas R. Boggs, Baltimore, recorder, and Dr. Joseph A. Capps, Chicago, treasurer.

Dr. Reid Hunt, of Harvard University, was elected president of the United States Pharmacopeial convention, on May 12, to succeed Dr. Harvey W. Wiley.

Colonel Marston Taylor Bogert, professor of chemistry in Columbia University, has been elected president of the American Section of the Société de Chemie Industrielle of France.

Dr. Stanley H. Osborne, formerly epidemiologist of the Massachusetts State Department of Health, has been appointed director of the Division of Preventable Diseases in the Connecticut State Department of Health.

We learn from Nature that at the annual general meeting of the Marine Biological Association, held in London on April 28, Sir E. Ray Lankester was reelected president and Sir Arthur Shipley chairman of the council. The Right Hon. Sir Arthur Griffith Boscawen was added to the list of vice-presidents, and Messrs. T. H. Riches and Julian S. Huxley became members of the council.

Sir Henry A. Miers, vice-chancellor of the Victoria University of Manchester, formerly professor of mineralogy at Oxford, has been reelected president of the Manchester Literary and Philosophical Society for the session 1920–21.

Mr. Wilfred H. Parker has been appointed director of the British National Institute of Agricultural Botany. The institute, including the Official Seed-testing Station for England and Wales will be housed in quarters in course of erection at Cambridge.

Dr. E. S. Moore, professor of geology and mineralogy and dean of the School of Mines of the Pennsylvania State College, has been appointed a member of the committee on sedimentation of the National Research Council. He will represent the colleges and universities in the eastern states in an organization for the stimulation of research work on sedimentation.

Professor W. W. Rowlee, of Cornell University, has been engaged to make a further investigation of balsa wood in Central America. Sailing to Costa Rica immediately after Commencement, he will resume the work which he began on his first trip in 1918–19. He will be accompanied by Instructor Harvey E. Stork.

Professor L. C. Glenn has recently been on leave of absence from Vanderbilt University investigating for the U. S. Department of Justice the physiographic and geologic problems involved in the disputed jurisdiction between Texas and Oklahoma in the Red River valley part of the Burkburnett oil field. He plans to spend a part of the coming summer there in further studies of the river's changes in that region.

W. L. Whitehead, recently of the geological department of the Massachusetts Institute of Technology, has gone to South America to carry on geologic exploration in Bolivia, Argentina and Chile.

It is noted in *Nature* that the Royal Academy's exhibition this year includes a presentation portrait of Sir Clifford Allbutt painted by Sir William Orpen. The picture hangs in the first gallery and bears the inscription: "Sir Clifford Allbutt, K.C.B., M.D., F.R.S., Regius Professor of Physics in the University of Cambridge; President of the British Medical Association. Presented to him by his Profession, 1920." A proof of the mezzotint engraving of the portrait is exhibited in the room devoted to engravings, drawings and etchings.

The John Calvin McNair lectures at the University of North Carolina were delivered this year by Professor Edwin G. Conklin, of Princeton, who spoke on the subject of "Human Evolution in Retrospect and Prospect."

The University of North Carolina chapter of Sigma Xi was installed May 26 by Professor C. E. McClung, of the University of Pennsylvania, president of Sigma Xi. The charter members of the North Carolina chapter are Drs. James M. Bell and Joseph Hyde Pratt, initiated at Cornell and Yale respectively, and Drs. F. P. Venable, H. V. Wilson, W. D. MacNider, A. S. Wheeler, W. C. Coker and William Cain, all members of the faculty.

The meeting of the University of Pennsylvania Chapter of the Society of the Sigma Xi on May 26 was held at the Flower Observatory, Highland Park. Addresses were made by Professor Eric Doolittle on "Star Clusters and Star Nebulæ" and by Professor Horace C. Richards on the "Einstein Theory of Relativity." Preceding the addresses, supper was served on the lawn to one hundred and fifty members and guests. Officers elected for 1920–21, are M. J. Babb, president; O. L. Shinn, vice president; H. C. Barker, secretary; H. S. Colton, treasurer.

Professor George B. Mangold recently spoke before the Anthropological Society of St. Louis on "Ethnic Types in America." On May 5, Dr. W. W. Graves gave a lecture on the "Scaphoid Scapula."

The Croonian lecture of the Royal Society will be delivered by Professor William Bateson on June 17 upon the subject of "Genetic Segregation."

Sir Arthur Newsholme, who has returned to England, has in press a volume of American addresses on Public Health and Insurance, which will be published by the Johns Hopkins University Press.

According to the English correspondent of the *Journal* of the American Medical Association, Sir William Osler left an estate of the gross value of $80,000 with a net personality of $53,000. He left his medical and scientific library (as cataloged) to the McGill University, Montreal, and all other property to his wife. At her death or earlier, if she should wish it, his residence, 13 Norham Gardens, Oxford, is to be given to the dean, canons and governing body of Christ Church as the residence of the regius professor of medicine.

We learn from *Nature* that a committee of fellows of the Royal Society and members of the University of Cambridge has been formed for the purpose of collecting funds for a memorial to be erected in Westminster Abbey to the late Lord Rayleigh in recognition of his eminent services to scence. Lord Rayleigh was both president of the Royal Society and Chancellor of the University, and an appeal has been issued by the society and the university. It is thought, however, that there may be some men of science unconnected with either of these bodies who may wish to show their appreciation of Lord Rayleigh's work. Donations may be sent to the hon. treasurers of the fund, Sir Richard Glazebrook and Sir Arthur Schuster, at 63 Grange Road, Cambridge.

Marvin Hendrix Stacy, professor of civil engineering and dean at the University of North Carolina, has died at the age of thirty-seven years.

Frederick Kolpin Ravn, professor of plant pathology in the Royal Agricultural College of Denmark, Copenhagen, died from blood poisoning on May 24, in East Orange, N. J., aged forty-seven years.

Dr. Alexander Ferguson, professor of pathology in the School of Medicine, Cairo, has died at the age of forty-nine years.

Captain Ettrick William Creak, F.R.S., known for his work on the compass and on magnetism, died on April 3, at the age of eight-five years.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. T. Harrison Hughes has given £50,000 and the Cunard Steamship Co., £10,000 to the

University of Liverpool as a contribution to the appeal for funds.

TEN members are reported by the *Journal* of the American Association to have resigned from the faculty of the Marquette University School of Medicine on account of a disagreement between them and the president over several ethical questions, one of which is that of sacrificing an unborn infant when necessary to save the life of the mother.

PROFESSOR J. H. CLO, of Tulane University, has accepted the position of professor and head of the department of physics at the University of Pittsburgh.

DR. HIRAM BYRD, now of the University of Mississippi, has accepted an invitation to become head of a new department of hygiene to be established at the University of Alabama.

LEO F. PIERCE, professor of chemistry at Washburn College, has resigned to work for a doctor's degree at Tulane University.

DR. CHARLES LOUIS MIX has accepted the position of head of the department of medicine of Loyola University School of Medicine.

DISCUSSION AND CORRESPONDENCE

RENEWAL OF OUR RELATIONS WITH THE SCIENTIFIC MEN OF EUROPE

TO THE EDITOR OF SCIENCE: A flood of publications is now coming in from all parts of Europe, especially from the long pent-up workers of France, of Austria, and of Germany, as well as in lesser degree from those of Great Britain and the Scandinavian countries. The German and French publications are as elegant in form and appearance as of old. The Austrian publications show very stringent conditions.

Arrangements are being made for coming scientific congresses and meetings. Certainly so far as science is related to human progress and welfare, it was never more widely needed all over Europe or all over the world than at the present moment. Certainly no one would shut off a British discovery, which would double the productive value of wheat, from the people of the ancient Central Empires. Certainly also any discovery made by savants of the Central Empires, which would mitigate human suffering or extend our knowledge, should be immediately transmitted to the people of the former Allied Powers. I, for one, am in favor of renewing scientific relations with the people of all countries of the world irrespective of whether they have been fighting with or against me in the great war for civilization. On this subject we have recently received very wise counsel from an entirely neutral party, Svante Arrhenius and his confrères. I may also quote from a letter of January 12, 1920, received from Arrhenius:

> I was very glad to receive your kind letter of December 3. I am in the highest degree thankful to you for your decision to keep up the perfect internationality of the Eugenics Congress. Now France and England have peace with Germany, and in old times it was always written in the peace treaties that the contracting parties should live on the best footing for the time to come. . . . Before the war the situation in Europe was one cause of the expensive armaments such that every German believed a (short) war would be much cheaper than the steadily increasing military expenses.
>
> In Austria the common expression was, "Lieber ein Ende mit Elend, als ein Elend ohne Ende." Now they have in reality the "Ende mit Elend." People are starving to death, many thousands every day. The children are infected with tuberculosis. The professors have their salaries of 12,000 kronen, which is now about 100 dollars, a year. The institutions are not heated. Series of experiments, which have taken many years, must be given up. The better classes are giving their clothes and their family relics for getting some foodstuffs from the peasants, who do not take the valueless paper money. The coal mines, which belonged to the companies in Vienna, have been given to the peasants of the state of Bohemia, which is according to letters from a Bohemian patriot under a bolshevist government, enriching itself and its friends through bribery. No coals are sent to Vienna, which is beset by starvation and cold. What have these old agreeable people in Vienna committed that they should be extirpated. . . .

From one of the most eminent men in Vienna, in fact, one of the most brilliant men in his subject in Europe, a colleague has received the following:

I perceive from your letter that my friend Dollo, whom I had informed of the critical conditions here with us, turned for aid to my friend Osborn. In fact, the past winter in Vienna was literally frightful. Your people have done a great deal for our children and in this way have aided materially in reducing the number of cases of sickness due to privation and hunger. The circumstance that Austria is reduced by the peace treaty to a relatively small country, and especially that it is limited to the mountain territories, which could not previously raise their own food supplies, and under the present bad conditions are still less able to provide for themselves, has shaped the situation since the end of the war for a catastrophe, as we are surrounded all about by new states which in part are unwilling to help us, as with Czecho-slovakia and Hungary and Jugoslavia, and in part are unable to help because they themselves are in want, as with Germany. . . . Up to the present time destitution has attained terrible dimensions with us, and people have been dying like flies. The middle classes especially have been most heavily affected by these conditions as they were in no position to pass over to other classes the enormous increase in prices occasioned by the destitution, as the business and labor classes were enabled to do. We can only hope that as soon as political conditions will permit, Austria, now so much reduced in size and productivity in consequence of its geographical limitations that it will scarcely in the future be self-supporting, may be able to shape up some possibility for a continued existence. . . . (April 4, 1920.)

Despite these circumstances the writer of the above letter has succeeded in publishing a monumental work, printed on paper of the poorest quality, which must be used by all American students.

I have taken the liberty of quoting from these personal letters from two men in the very front rank in Europe, in order to present the actual situation to some of my colleagues who are still in doubt as to what their attitude should be. We geologists can not cut off communication with a country which has produced Edouard Suess. We paleontologists welcome the works of Othenio Abel.

As regards others, with whom personal relations are less close, I have decided neither to forgive nor to forget nor to extenuate, but *to carry on*. In brief, I find that it is my duty to renew scientific relations with all the specialists of Europe who are engaged in my lines of work, regardless of past or present geographic boundaries. Needless to say, I am now renewing personal relations with my former friends and colleagues, whatever their nationality.

Henry Fairfield Osborn

American Museum,
New York,
May 12, 1920

THE METEOR OF NOVEMBER 26, 1919

To the Editor of Science: From the Climatological Data, Michigan Section for November, 1919, issued from the Grand Rapids, Michigan Weather Bureau Office under the heading of "Remarks of Observers" on page 132, the following has been taken:

> Newberry—A large and brilliant meteor was observed at about 8 P.M. of the 26th; it looked to be about 38 inches in diameter. It was first seen in the southwest—rather low but considerably above the horizon—with its course southeastward and downward. At a point about 9° west of south, and near the horizon, it appeared to be bursting like a rocket as it sank from view.

This probably is an observation of the same meteor which was noticed in southern Michigan and supposed to have fallen into Lake Michigan near its southern end. This observation is 300 miles or more north of the previously supposed position of the meteor's descent.

William Kelly

Vulcan, Mich.

FORMULÆ FOR DATES

In my formulæ for finding the day of the week of any date (Science, May 21, 1920, p. 513) the explanation of the method of finding the value of the symbol L is not sufficiently clear for dates in centennial years. The following modification is therefore offered: L is the number of leapdays (not counting the one in a centennial year, if any) preceding the date and subsequent to the beginning of the centennial year having the same first two digits as the year of the date in question.

Further study also reveals the fact that the formula for Old Style dates requires modification for dates in January and February of centennial years. This modification may best be made by starring the figure 5 of the formula and inserting the following footnote: *Use 4 instead of 5 for dates in January and February in centennial years.

W. J. SPILLMAN

THE LIBRARY OF THE LATE PROFESSOR ZUNTZ

TO THE EDITOR OF SCIENCE: A letter received from a friend in Berlin a few days ago brings information of the death of Professor N. Zuntz. The very great services of Professor Zuntz, extending over a long life time, devoted to the advancement of physiology and nutrition, his broad-mindedness and kindly character render his death at this time, when renewal of scientific associations severed by the war is so important, peculiarly sad.

The information comes also that, for the support of his widow who is a hopeless invalid, funds are needed. To this end it is desired to sell the large library which Professor Zuntz had collected. It includes complete sets of practically all of the journals in his field of work. By disposing of the library direct to some purchaser, or purchasers, in this country the advantage of the rate of exchange would accrue to the widow instead of to some book dealer.

I shall be glad to supply the address and such further information as I have to any one interested in the purchase of this library.

YANDELL HENDERSON

DEPARTMENT OF PHYSIOLOGY,
YALE UNIVERSITY

QUOTATIONS

WORK OF THE MAYO BROTHERS

A FRIEND of Christian civilization and a supporter of the present social order rejoices to visit such a shrine of philanthropy as can be found at Rochester, Minnesota. To that obscure and remote town came from England a good many years ago a physician and surgeon named Dr. W. W. Mayo. He had been brought up in an atmosphere of scientific progress and had studied with the English physicist, Dalton. He settled down to a general practise in Rochester and attained eminence in his profession. He had two sons, William and Charles, who followed his profession and developed the highest known skill in surgery, acquiring a reputation that brought people from the country around to seek relief at their hands. They soon discovered that their income was quite beyond their own need, and they conceived in their breadth of vision the opportunity of philanthropic progressive work for relief of their stricken fellowmen. They turned half of their income over to a business friend, with the request that he invest it and increase it; and thus in the days of rapid increase in values this fund became $2,000,000. Meantime their reputation grew, the demand for their service and for the enlargement and development of their plant greatly widened. They adopted the principle that no one needing surgical aid and coming to Rochester should be turned away without receiving it; that the rich and the moderately circumstanced should me made to pay in proportion to their means, and that the man without anything should receive aid for nothing. The amount received from the wealthy they apportioned with a view of creating a foundation for their clinic, which should continually enlarge its usefulness. Rochester is now a town of 14,000. It now has constantly 4,000 to 6,000 transient residents who are there for treatment. There are 900 beds all told in the various hospitals, and something more than 300 are being added. Sixty-thousand cases of all kinds are received and treated a year. The iron rule is that the poorest shall receive as careful and as good treatment as the wealthiest. The result has been that the name of the Mayos and Rochester has spread to the uttermost quarters of the world, and to-day a most cosmopolitan group greets the visitor in all the buildings in which this great philanthropy is carried on. As one notes the crowds of people that gather from 7 in the morning until late in the evening exery day to await their turn for examinaton, diagnosis and treatment, he thinks that he has come to the shrine of a saint.—William Howard Taft in the Philadelphia *Public Ledger.*

THE JOURNAL OF MAMMALOGY

On April 3, 1919, the American Society of Mammalogists was founded at Washington, D. C. One of the principal objects of this society was the publication of a journal of mammalogy and on November 28 the first number of this journal appeared, from the press of Williams and Wilkins Company, Baltimore.

The arrival of the journal must have been a matter of gratification to the many students, scientific workers and others who are interested in the subject of mammalian life, for the need of such a publication has long been felt. In its aims this journal is broad, including within its scope morphology, evclution, paleontology, taxonomy, life histories and habits, in fact "every phase of technical and popular mammalogy." It is the announced purpose to make the journal indispensable to all active workers in mammalogy and of value "to every person interested in mammals, be he systematist, paleontologist, anatomist, museum or zoological garden man, big game hunter, or just plain naturalist."

In its make-up the journal seems in the opinion of the reviewer to be both substantial and attractive. The type is well chosen, the paper of good quality and the photographic reproductions contained give evidence that the illustrative features will be well handled. The front of its gray-green cover presents as decoration a pen drawing by Ernest Thompson Seton of the prong-horn antelope—symbol of something distinctively American. Below this is the table of contents and a glance at the list of contributors reveals the names of many well-known authorities in the field of mammalogy.

The first number consists of 51 pages, of which about 37 are devoted to major articles, 5 to general notes and about the same number to recent literature and 2 pages to editorial comment. On the closing pages are found the by-laws and rules of the society adopted at the time of its founding. The second number, which appeared promptly, includes pages 53 to 110.

An idea of the contents of the journal may best be conveyed by mention of a few representative titles. Among the major articles, of technical character are "Criteria for the recognition of species and genera," "Preliminary notes on African Carnivora," "Notes on the fox squirrels of the southeastern United States," "Names of some South American mammals," "A new fossil rodent from the Oligocene of South Dakota," "Identity of the bean mouse of Lewis and Clark." Among articles dealing with distribution, habits and other phases of life-history may be mentioned "Bats from Mt. Whitney, California," "The mammals of Southeastern Washington," "Migrations of the gray-squirrel," "An apparent effect of winter inactivity upon the distribution of mammals," "For a methodic study of life-histories."

Under General Notes, a department of the journal which promises to be one of unusual interest, are found among others, "An easy method of cleaning skulls," "Red bat and spotted porpoise off the Carolinas," "The Florida spotted skunk as an acrobat," "Rodent mountaineers," "Does the cuterebra ever emasculate its host?" "The coyote not afraid of water," "The flying squirrel as a bird killer," "Technical names of two *Colobus* monkeys."

In addition to reviews of recent literature each number contains a long list of titles of recent mammalogical publications, domestic and foreign, while in the correspondence and editorial departments appear some very readable letters and comments on topics of current interest to mammalogists.

In a magazine of the scope of the *Journal of Mammalogy* it seems inevitable that articles of certain types will at times predominate over other kinds and it is perhaps too much to expect that every number shall have equal interest for all of its readers. It is a matter beyond the control of the management but one of which it is fully mindful and the editor very properly points out that if the magazine is to be a well-balanced one those members who are particularly interested in certain special phases of mammalian life must be largely responsible for furnishing the materials relating to their respective fields. In the opinion of the reviewer the management is to be congratulated upon the manner in which the journal has been launched. That the magazine will be indispensable to the active worker in the domain of mammalogy is a matter of course, but it seems also eminently worthy of a place in the libraries of all our schools and colleges where biological subjects are taught, for a sufficient number of articles of non-technical nature are assured to furnish highly profitable reading of a kind that can not help but be an incentive to a wider and more intelligent interest in mammalian life.

CHARLES E. JOHNSON
DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF KANSAS

SPECIAL ARTICLES

FLUORESCENCE, DISSOCIATION AND IONIZATION IN IODINE VAPOR

I. FLUORESCENCE AND IONIZATION

EARLY attempts to account for fluorescence as due to radiation produced by the return to the parent molecules of electrons which were photoelectrically emitted by the exciting light have been unsuccessful, since the fluorescence of gases and vapors is not generally accompanied by ionization. Consequently, the recent viewpoint is that the primary effect of the exciting light is to cause one or more electrons of a molecule to take positions or conditions of abnormally large potential energy, without being necessarily removed from the parent molecule. This additional energy is absorbed from the exciting light, and is reemitted as radiation when the electrons return to their initial stable configurations. This fluorescent radiation may be of the same, of longer, or of shorter wave-length than the exciting light according as the return is accomplished in a single step, in several steps, or in a single step following the absorption of additional radiant energy.

We have obtained experimental evidence of the correctness of this viewpoint from measurements of the minimum energy required to ionize an iodine molecule in the normal state as compared with that required to ionize a fluorescing molecule. This energy is expressed, as usual, in terms of the minimum ionizing potential, which is found to be close to 10 volts for the normal molecule and 7.5 volts for the fluorescing molecule, excited by the green mercury line (whose wave-length is the same as that of the green absorption band of iodine, and which excites strong fluorescence). The difference, 2.5 volts, corresponds to the quantum of energy of the frequency of the exciting light by the quantum relation $eV = h\nu$. This offers direct evidence, therefore, of the existence of molecules whose electrons possess abnormal potential energy as a result of the exciting light. The existence of such unstable, and therefore active, molecules has particular bearing on the explanation of photochemical reactions, and suggests the process of chemical action recently proposed by Perrin.

II. DISSOCIATION AND IONIZATION

Two types of ionization were discovered in iodine vapour, a very weak ionization at 8.5 volts, attributed to the ionization of atoms present because of the hot filament which served as the source of the bombarding electrons, and a very intense ionization at 10 volts, attributed to the ionization of the molecules. This was tested by carrying out ionization experiments in a pyrex glass tube which could be highly heated in an electric furnace so that various degrees of dissociation of the iodine vapor could be obtained. The results thus obtained were consistent with the above assumptions that the ionizing potential of the iodine atom is 8.5 volts and that of the iodine molecule is 10 volts.

The interesting feature of this result is that the difference, 1.5 volts, corresponds exactly to V in the relation $eV = W$, where W is the heat of dissociation of iodine reckoned for a single molecule. In other words, the ionization of an iodine molecule may consist in its dissociation and the ionization of one of the parts by the same electron impact.

This kind of a process has been suggested to estimate the heat of dissociation of hydrogen from ionization data, but the present work is the first, as far as we are aware, to give direct evidence as to which ionization effect is due to the atom and which to the molecule. It is probable that this method may be of value in determining heats of dissociation which are too high to be found by ordinary methods.

K. T. Compton,
H. D. Smyth

Princeton University,
May 18, 1920

THE AMERICAN PHILOSOPHICAL SOCIETY

At the 1920 general meeting of the American Philosophical Society, held on April 22, 23 and 24, in Philadelphia, the following comprehensive program was followed.

April 22, 2 o'clock

William B. Scott, D.Sc., LL.D., president, in the chair

Beach protection works: Lewis M. Haupt, Philadelphia.

Geographic aspects of the Adriatic problem: Douglas W. Johnson, professor of physiography at Columbia University. (Introduced by Professor W. M. Davis.)

The reefs of Tutuila, Samoa, in their relation to coral reef theories: Alfred G. Mayor, director of the department of marine biology, Carnegie Institution of Washington.

A distribution of land and water on the earth: Harry Fielding Reid, C.E., Ph.D., professor of dynamic geology and geography, Johns Hopkins University. The conception of the land of the earth as being a deeply dissected and loosely joined together mass, with its center about half way between the equator and the poles, explains nearly all the characteristics of the distribution of land and water, such as: the antipodal relation, the concentration of land about the north pole and of water about the south pole, etc.

Thyroxin: E. C. Kendall, Ph.D., of the Mayo Clinic, assistant professor of chemistry of the University of Minnesota. (Introduced by Dr. Philip B. Hawk.)

The dualistic conception of the processes of life: Samuel J. Meltzer, M.D., LL.D., head of department of physiology, Rockefeller Institute for Medical Research, New York. Animal life manifests itself by an uninterrupted stream of various forms of activities. But each of the activities is discontinuous, it is interrupted by a longer or shorter resting phase. Most physiologists look at life processes from a monistic point of view. In their opinion only action needs a cause; the reduction in action or the resting phase needs no special interpretation; they are simply due to a reduction in the extent of the cause or to its entire absence. However, seventy-five years ago, it was discovered by the brothers Weber that stimulation of the peripheral end of a vagus nerve stops the beating of the heart which remains resting in an increased state of diastole. Here a special cause, a stimulation of a nerve going to a muscle, causes a resting phase in the heart muscle. This action was termed inhibition. In the three quarters of a century since this discovery was made, numerous instances of inhibition in the various processes of animal life were discovered. From all the facts as they are known now, it must be assumed that there is in the animal life probably not a single function in which the phenomenon of inhibition is not an important factor. The part played by inhibition is on one hand to remove obstacles to an efficient action, and on the other hand to permit the living tissues to perform in the resting phase anabolic processes, that is, to build up the tissues or to replenish the material expended during the action phase. The dualistic conception of the life processes may be presented as follows. Irritability is a characteristic property of all living tissues. Irritability means the property of the tissues to react with a change in each state to a proper stimulus. The change may consist in an excitation, an increase of activity, or an inhibition, a decrease in activity. Each and every state of life of the plain tissues or of the complex functions is a resultant from the combination of the two antagonistic factors, excitation and inhibition. In a state of utmost rest the factor of inhibition prevails greatly; but there is still a remnant of the factor of the excitation which permits the tissues or the functions to remain in a state of tonus, of dormant life. On the other hand, in a state of extreme excitation there is still a remnant of the factor of inhibition which prevents the excitation from completely destroying the life of the involved tissues.

The relation of the bacillus influenza: Francis G. Blake, M.D., associate in medicine, Hospital of the Rockefeller Institute for Medical Research, New York. (Introduced by Dr. A. C. Abbot.) Following Pfeiffer's discovery of *Bacillus influenzæ* in 1892 this organism was rather generally accepted as the probable cause of influenza, and of a characteristic type of bronchopneumonia which complicates influenza. Pfeiffer and others failed to support this possible etiological relationship by animal inoculation experiments. During the recent pandemic the causal relationship of *B. influenzæ* to the primary influenza has been seriously questioned and in general the organism has been relegated to the position of a secondary invader responsible for a variable proportion of bronchopneumonias complicating influenza. Because *B. influenzæ* is constantly present in the respiratory tract in uncomplicated influenza and in a characteristic type of bronchopneumonia following influenza, it seemed desirable to determine by animal experiments whether influenza and this type of bronchopneumonia could be produced by inoculation with pure cultures of *Bacillus influenzæ*. Twelve monkeys were inoculated on the mucous membranes of the nose and mouth with the successful production of an acute self limited respiratory disease closely resembling influenza. This disease was complicated in five cases by sinusitis, in three by bronchopneumonia. The pathology of the pneumonia was identical with the pathology of the pneumonia ascribed to pure infection of the lungs with *B. influenzæ* in man. Ten monkeys were inoculated in the trachea with pure cultures of *B. influenzæ* in man. Ten monkeys were inoculated in the trachea with pure cultures of *B. influenzæ* with the production of the same type of bronchopneumonia in seven cases. These experiments establish the etiological relationship of *Bacillus influenzæ* to the type of bronchopneumonia with which the organism has been found constantly associated in man. They also prove that *Bacillus influenzæ* can initiate an infection of the upper respiratory tract and produce a disease that closely resembles influenza, and that is complicated by the same complications as influenza. They do not prove that *Bacillus influenzæ* is the primary cause, however, since it is impossible to determine whether the disease produced in monkeys with *B. influenzæ* was actually identical with pandemic influenza.

X-rays of the brain after injection of air into the ventricles of the brain and into the spinal canal: W. E. Dandy, M.D., associate in surgery, Johns Hopkins Hospital. (Introduced by Dr. Keen.)

Celt and Slav: J. Dyneley Prince, Ph.D., professor of Slavonic languages, Columbia University. Slavs and Celts are strikingly similar to each other in habits of mind and expression although far removed geographically. The Russians, Poles, Czecho-Slovaks, Serbo-Croatians and Bulgarians all speaking Slavonic idioms, although racially very various have certain marked traits in common which they all share with the Celts; viz., the Irish, Scottish and Manks Gaels and the Armorican Bretons of France, and the Welsh still Celtic speaking, and the Cornish, whose Celtic language is now extinct. The similarity between Slavs and Celts is twofold, viz., temperamental discontent and morbid joy in sorrow. As a concomitant of this discontent goes the spirit of quest after the unattainable, which is manifest in both Slavonic and Celtic trends of thought. Success plays almost no part as an element of heroism in Slavonic literature and comparatively a small rôle in Celtic. Both Celt and Slav are not satisfied with the present world, and care more for sympathy than for accomplishment. In Russia, especially, the public sympathy has been with the unsuccessful rather than with the successful hero. Morbid pleasure in failure, delight in a "lost cause," love of the appurtenances of death are all common and underlying Slavonic and Celtic traits. These characteristics are instructive as accounting for the "political impossibility" of the easternmost and westernmost branches of Indo-European language-influence. The sun of common sense has never risen on either the Slav or the Celt and it is doubtful whether the Slavs can exist very long without the guiding hand of strangers. The charm of the Celt and Slav is great and durable, but it is charm and not character, feeling and sentiment rather than thought and reasoning, which dominate the east and west of Europe alike.

A new theory of Polynesian origins: Roland B. Dixon, Ph.D., professor of anthropology, Harvard University. (Introduced by Dr. W. C. Farabee.) The question of the racial origins of the Polynesian peoples has long attracted the attention of anthropologists. Previous studies have dealt mainly with small portions of the area, and have not satisfactorily correlated the various factors characterizing physical types, nor the Polynesian types with those of the rest of Oceanica. The present study seeks to secure more satisfactory results by including the whole of Oceanica and eastern Asia in its scope. Following a method differing from those previously employed, a number of fundamental physical types are defined, and their distribution and that of their derivatives traced.

One of these fundamental types unexpectedly proves to be Negrito; the other two most important ones being Negroid and Malayoid. The Negrito and Negroid types being marginal in their distribution, are probably the older.

The Zoroastrian doctrine of the freedom of the will: A. V. Williams Jackson, professor of Indo-Iranian languages, Columbia University. The purpose of this paper was to show the signficance of the doctrine of the freedom of the will in the dualistic creed of Zoroaster more than two thousand five hundred years ago. The warring kingdoms of good and evil, light and darkness, personified as Ormazd and Ahriman, the ancient Persian god and devil, are in perpetual conflict, according to Zoroaster's philosophic teachings. While these two antagonistic principles, which struggle for the soul of man, are primeval and coeval, they are not coeternal, because Ormazd will triumph in the end and Ahriman will be annihilated. Man will help in bringing about the victory. Man is Ormazd's creature and belongs by birthright to the kingdom of good. He is created, however, a free agent, with the power of will to choose right or wrong. By the universal choice of right he will contribute his share towards the ultimate triumph of the hosts of heaven over the legions of hell at the final judgment day, and will win salvation for his soul. It was Zoroaster's mission in the world to guide man to make the right choice. Passages from the ancient Avestan and Pahlavi texts relating to the subject were translated, and emphasis was laid upon the interest which this old Zoroastrian doctrine in regard to the freedom of the will has for students of philosophy and religion.

The Hittite civilization: Morris Jastrow, Jr., Ph.D., LL.D., professor of Semitic languages, University of Pennsylvania. During the last four decades the discoveries and excavations in northern Asia Minor have brought the Hittite problem into the foreground of Oriental archeology. The notices about the Hittite groups found in the Old Testament and in the inscriptions of Egypt and Assyria have been supplemented by an abundance of material now at the disposal of scholars, though this can not be fully utilized until the large quantity of inscriptions in the Hittite characters have been satisfactorily deciphered. Even without this decipherment the monuments themselves tell us much of the important part played by the Hittites during the second millenium before this era in the ancient East. They seem to have been composed of a conglomeration of various ethnic elements and about 1500 B.C. a strong Hittite empire was located in northern Asia Minor which was powerful enough to threaten both Egypt, on the one side, and Babylonia and Assyria, on the other. These Hittites moving along the historical highway across Asia Minor left their rock monuments and their fortresses as traces of the power and civilization which they developed. Their contact with Assyria appears to have been particularly close and it is not impossible that the earliest rulers were actually Hittites. We find that at one time they extended far into Palestine. The "sons of Heth" associated in tradition with Abraham are Hittites and there were Hittite generals in the army of the Jewish kings. The introduction of cuneiform writing among the Hittites to replace their more cumbersome script is in itself an important indication of the close contact with Babylonian-Assyrian civilization as it also furnishes a definite basis upon which the decipherment of the Hittite language becomes a definite possibility.

The decipherment of the Hittite languages: Maurice Bloomfield, L.H.D., LL.D., professor of Sanskrit and comparative philology, Johns Hopkins University.

The beginning of the fourth gospel: Paul Haupt, Ph.D., LL.D., professor of Semitic languages, Johns Hopkins University. John i. 1, should be translated: In the beginning was Reason. Greek "logos" denotes both "word" and "reason." Logic is the science of reasoning. According to the Stoics, Reason (Greek Logos) was the active principle in the formation of the universe. We find stoic phraseology not only in the New Testament, but also in the Old Testament. The most valuable lessons of Stoicism were preserved in Christianity.

Arthur W. Goodspeed

(To be continued)

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THE FUTURE OF THE STATE ACADEMY OF SCIENCE[1]

In Science of December 5, 1919, Mr. D. D. Whitney presents certain data and conclusions on State Academies of Science. Omitting mention of a number of large academies centering in cities his figures show that membership varies from 25 to 350; that annual dues run from 50 cents to $10; that annual receipts from state or private sources vary from none to $1,500, 9 out of the 18 enjoying such receipts; that 4 out of 18 pay their officers salaries, from $75 to $1,000; and that the annual publications by 12 out of the 18 academies contain 50 to 600 pages.

In these academies Mr. Whitney finds great variation as to interest and vitality, comments from the officers being "dead" in three cases, "apathetic" in others, and "very lively" in a few. Assigning grades to indicate the various degrees of health and vitality, we may say that of the eighteen academies considered, two would be graded A or "superior"; one B, or "good"; eight C, "passing"; four D, "poor but passing"; and three E, "failure." This result seems to follow the probability curve fairly well, and should perhaps cause us to look upon the situation with some complaisance. It might be unreasonable to expect all of the group to come up to the highest standard of excellence.

Our own academy is reported as having 96 members, no annual state appropriation, no salaries for officers, no annual publication, and as manifesting an interest "fairly lively." This ranks us as of about C grade, passing but without distinction. Our growth, however from 46 charter members in 1914 to 110 members in 1920, indicates a persistent vitality, and the classification of our membership, 25 per cent. of our resident members being un-

[1] President's address before the Kentucky Academy of Science, Lexington, May 8, 1920.

connected with educational institutions, shows that we are to a small extent at least "unifying the scientific interests of the State."

Mr. Whitney takes a somewhat somber view of the future of the state academies. He points out the fact that only a small percentage of the scientific men and women of the states are affiliated with the academies, explaining the fact by the existence of larger societies for specialists which appeal more strongly than the local academies with this lack of differentiation. However, he mentions two advantages of the state academy; the opportunities for social intercourse and good fellowship which tend to encourage scientific effort in smaller colleges and normal schools; and the provisions for the publication of articles that would not be accepted by the larger and more important periodicals. To these we should add the practise of bringing to the annual meeting some outstanding scientist who otherwise might not come before our membership.

This article suggested to the writer that it might be well to ask the secretaries of these academies certain questions with a view to determining if possible a little more definitely whether there is a field and a future for the state academy, and in particular for the Kentucky Academy. Accordingly a series of questions was proposed, the first of which was whether, in view of the large number of national and regional scientific societies there is any need for a state academy. Mentioning the replies from state academies only the vote stood: Yes, 9; No, 2. These two negative votes were, curiously, one from a very active academy centering in a large city, and one from a state academy reported by Mr. Whitney as showing lively interest at the annual meeting but apathetic the remainder of the year. We may say however that most of those reporting, whether lively or moribund, wish still to live and claim for themselves a *raison d'etre*.

The second question asked was "What are your reasons?" First let us notice the reasons of those who vote against the state academy. We are told that the academies are not needed because a state does not seem to be a convenient unit for scientific organization; because the interest in the academies is very small; because the publications are mediocre, no one being willing to publish their good articles in the *Proceedings* for fear that they will never be seen; because the social value is the only real value and that is not sufficient justification for the work entailed; and because the professional men and every one else have their own societies in which they are much more interested.

But the affirmative argues that the academies have a field and are needed, because their meetings are so near home that scientists of the state can get together; because a large number of the members are young people who are not yet, and in many cases never will be, ripe for membership in the national societies, but who can be greatly stimulated by the academy activities; because the society brings together scientists of varied interests, there being too much subdivision and segregation in the scientific field at present; because they bring men not connected with educational institutions in touch with scientific matters; because they give opportunity for papers of local interest which would not find place on the programs of national societies; because they foster state pride and interest in state welfare; because they bring to bear a certain amount of influence for the betterment of the state; because, except in the field of chemistry, they are about the only local scientific societies that emphasize research rather than education; because they exercise a tonic effect in the life of the state and foster a proper appreciation of the value of science; and because they supply a needed element of organization in the scientific field which the national societies do not afford.

With the feeling that, valuable as is the annual meeting of the academy, there should be some larger service possible in the interests of science and the state, a third question was asked for information regarding other activities. Of the eleven academies being quoted, four did nothing beyond the annual meeting, excepting in some instances, the publication of the annual proceedings. Other answers were that the secretary sends out letters to find out what is going on in the way of science advancement; that an annual expenditure of $250 is made in grants for the encouragement of research on the part of members; that a library and exchanges are kept up; that various sections hold meetings throughout the year; that a second meeting of the academy is held; that an out-door "excursion meeting" is held, usually for two days, when members ride, tramp, camp, do field-work and get better acquainted; and that a number of committees are working on various problems of value to the state. This last comes from Illinois, where the academy has a committee on the Ecological Survey of the State, organized now for ten years; a Committee on Science Education; a Committee on Legislation as affecting Scientific Interests; and a Committee on Conservation of Wild Life in the State.

Omitting other questions asked of the academies the last should be mentioned, namely, "What new forms of scientific service might the Academy undertake?" Here we run against the very general handicap of lack of funds. Many things might be done if only the necessary money were available. The need is felt of more money for publication, more money for research funds, more money for surveys. But a number of other suggestions are made. The academy might become more influential as an adviser in connection with legislation affecting the natural resources of the state. The work of science should be more closely correlated with the industries of the state. More effort should be spent on the problems of development of the natural resources of the state on a firm scientific basis. The members should be stimulated to study and report on many subjects of state or local interest. Local chapters should be formed. State surveys in botany and zoology and geology should be organized and allotted to various members. High-school teachers should be brought in to the academy for the sake of better science in the high schools. Science clubs should be organized in the high schools, these clubs to be affiliated with the State Academy.

These ideas should prove exceedingly suggestive to us in Kentucky. No state in the union offers a richer opportunity for the efforts of an energetic and progressive Academy of Science. It would be a reflection upon your intelligence to argue the point that the war just closed has proved the value and the need of science. Scientific achievements threatened civilization with destruction, and science was an essential in the salvation of the world from barbarism. No civilized nation will henceforth be so criminal as to neglect the deliberate, systematic, organized effort to develop science in the interests of national defense and domestic welfare. This essential importance of science was recognized by scientists long before the war, if it was not by the general public. But scientists themselves apparently had not realized the necessity for organization and cooperation in scientific effort as well as in government and in industry. This perhaps is the outstanding fact before our minds to-day. We saw the forces of science hurriedly and effectively classified and grouped and directed under the leadership of the National Research Council during the war. In peace we are now seeing the same idea carried out in the organization of International Associations, in the present-day program of the National Research Council, which contemplates the permanent coordination of the scientific work of the nation, and in the enlarged program of the American Association for the Advancement of Science. Both the Council and the Association propose to reach down and touch local scientific interests through the state academies.

In this fact we find an immediate and conclusive reason for the continuance of our State Academy. No organization can be complete without its subordinate units, nor can the scientific interests of the nation be completely fostered and directed without state and local groups. In the army must be brigades and regiments and battalions and companies and squads. The state academy furnishes the necessary subdivision for the effective marshalling of the nation's scientists.

This being agreed to, it follows logically that the state academy should proceed to organize local chapters for the completion of the system. The greatest need now is not more national societies but a more thorough-going organization of state and local scientific forces. We have already seen that in Illinois an effort is being made to stimulate the formation of science clubs in the high schools and to interest high school teachers in the work of the academy. Our Academy has a goodly percentage of its members among scientists not connected with educational institutions. What is needed is that this membership be greatly extended and organized into chapters so that every large industry and even the smaller establishments will be brought into touch with the academy and through it coordinated with the national organizations. The academy will thus include in its fold both those who love science for its own sake and for the extension of knowledge and also those who are using science for the furtherance of industry and the material advancement of man.

But the academy finds justification apart from its usefulness as a subdivision in the great national organization in that it can serve its own state in many distinct directions. Many lines of possible service have already been suggested in the summaries of the questionnaires, but it will be worth our while to think a little farther concerning some of them. Isolation is one of the most serious handicaps to research, although it can doubtless be shown by examples how certain great constructive geniuses have lived their lives in seclusion and by the sheer power of intellect brought to light important additions to human knowledge. Many have found the needed contact in correspondence and publications. But for the average scientist whose number is legion and whose aggregate contribribution to progress is large, the stimulus of human association, and the spur of close contact with kindred minds are indispensable. We can not depend entirely upon the large universities nor upon the large industrial establishments for our scientific life. There will always be able men in the smaller colleges and schools and in the smaller establishments who must have opportunity for contact and mutual inspiration and suggestion to enable them to produce their maximum effort and stand as missionaries in the cause at home. The academy must supply to all scientific workers in the state this desirable contact and mutual helpfulness.

Selfishness and secretiveness and suspicion in research, individualism must now give way to coperation for the sake of the advancement of knowledge and of social and industrial progress in the state. Scientists have much to learn in this respect from statesmen and business men. Men do not greatly increase their wealth by hoarding; they do not make most in small private businesses; they do not win wars by "sniping," they do not destroy threatening social iniquities by individual blamelessness. Efficient machinery directs and multiplies power, increases speed.

The academy should come to be a source from which any man in the state who needs help along scientific lines may draw what he needs. If for instance a worker in some small or large industry of the state feels the need of consultation or advice he should come to look upon the academy as the proper organization to which to apply. The academy through its officers or special committees should be in a position to answer his questions or to direct him to those of its members best fitted to render aid. An instance to the point is that of a research chemist in a large drug manufactory who was enabled to complete a three year research which had failed of reaching a definite result, by means of a hint from a university worker. In our own state many such cases of helpfulness will arise if we can bring our academy to the point where it will be regarded as the natural place to which to come for information as to facts and men.

The organizers of the academy six years ago had in mind the possible usefulness of the academy as an adviser in legislative matters affecting scientific interests when provision was made in the constitution for a standing legislative committee. This committee was appointed for a number of years, but gradually sank into "innocuous desuetude" through lack of effort or of opportunity for rendering service. The question now arises whether the present, when all things are being made over, when all institutions and societies are feeling the new impulses furnished by the war, is not the proper time for a rejuvenation of this committee. It is safe to say that the academy in the past has not at all impressed itself upon the attention of our legislatures nor our citizenship and that outstanding usefulness will come to such a committee only after years of steady growth in the size and activity of the academy. The time to begin however is now, and the way to gather to itself influence and authority as an expert adviser is to begin first with a thorough study of local scientific problems and to put before the public in speech and print definite facts and recommendations. No other opportunity for extension of academy activity and service seems more fertile in possible good than this. Not even the State University, which stands before the public in a peculiar sense as the guardian of state scientific and industrial interests, can appeal to all elements in the state as a disinterested and representative source of expert advice as can the Kentucky Academy. There is distinct need for such a force in the life of the state and the academy must not prove false to her mission nor neglect her manifest opportunity by failure to assume the responsibility of leadership.

Many problems face us in Kentucky that will need the keen interest and intelligent cooperation of the especially qualified membership of the academy. In this last legislature there arose a rather minor question the handing of which well illustrates how valuable can be the man who knows. A bill was proposed which placed a bounty on hawks and owls, the idea being that without exception all such birds are pests, killing quail and chickens with ruthlessness and dispatch. The bad science back of such a bill was discussed in one of our societies at the university and word was sent to the committee considering the bill that the bill threatened injustice to a large class of desirable bird citizens. As a consequence two members of the Legislature paid a visit to one of our professors for the purpose of getting information, and were quickly convinced that only the Cooper's hawk is depraved while all the others are useful in that they kill rats and other undesirables. This incident calls attention both to the value of expert testimony and to the prevailing lack of scientfic treatment of problems affecting many people and widespread social and industrial interests. In our hap-hazard, hasty, self-confident, irresponsible law-making, certainly some organization should stand out before the public as a source of sane reliable and unbiased scientific information.

There is great need for scientific direction and propaganda for the preservation of bird life, for the proper appreciation of their economic importance. Only last Tuesday one of our professors stated before the Audubon Society that the bird population of the state and nation had been reduced approximately 50 per cent. in the last 15 years; and that the causes were, next to cats, the destruction of our woods and forests. And yet, he said, birds are the greatest weapon of the farmers against crop-ravaging insects.

There is pressing need that wise research and public education be devoted to the problems of forestry. Many problems of forestry must be solved if the forests are to continue adequate and the supply of lumber be on hand for succeeding generations of men. The mineral resources of the state present problems that must be the concern of all properly qualified scientists of the state. The preservation and development of our water-power resources demand intelligent survey-work, persistent public education and authoritative advice to our legislatures. The growing of tobacco has reached such proportions in the state as to affect the well-being of large numbers of citizens. It is not the part of wisdom to banish all study of the growing and marketing of tobacco because of a dislike for the weed and disapproval of its use; but rather for all so qualified to unite in a program of research and education that will conduce to the improvement of the human elements involved. The preservation and promotion of human health is a matter of "vital" concern to every citizen, and there is abundant need and opportunity for a representative state scientific society to exert its strength toward the conservation of vital resources.

It is not being urged that the academy should attempt to take over the work of the experiment station or of the private laboratory. That of course would be ridiculous. Rather, the academy should be a medium through which men in various parts of the state and in various educational and industrial plants may be associated in the furtherance of needed scientific endeavor. Such a medium will bring all men in touch with problems of research in which they may be fitted by training and location to take a part in problems too large and complex and requiring too many phases of scientific treatment for one man to handle. We may well imagine for instance that officials of the National Research Council, wishing to find qualified men in certain parts of Kentucky to carry on locally a certain part of some large piece of research will come to the Kentucky Academy for information and advice as to men. Such an organization should be in a position through its officers and committees to speak with authority and conviction upon all matters of scientific importance in the state, bringing to bear upon public opinion the weight of disinterested scientific unity. Certainly such an active and influential academy would stimuate research in Kentucky and the whole South, render valuable aid in assignment of problems and the placing of men, and guide public opinion into the proper understanding of local scientific matters.

Our study has led us to feel a firmer faith in the mission of our Kentucky Academy. From her modest past she may yet arise to grand proportions of influence and usefulness. To that end let us adopt a program commensurate with the spirit of the times.

First, let us cooperate heartily with the national bodies seeking to organize the scientific forces of the country.

Second, let us actively seek to extend our membership to every educational and industrial plant in the state, and to every scientist, and exert a scientific leadership throughout the state.

Third, let us promote the organization of science clubs in our secondary schools and of research clubs in various centers.

Fourth, let us bring our influence to bear upon the problem of better science teaching in the high schools.

Fifth, let us appeal to the next Legislature for liberal publication funds, and to the public for research funds to be used in support of local scientists.

Sixth, let us through appropriate committees undertake the study of definite scientific problems of importance to the state, and promote the scientific surveys very much needed.

Seventh, fortified by our especial studies, let us plan to recommend to the next Legislature legislation needed for the scientific interests of the state.

Eighth, let us with faith in our mission and with devotion to the cause make the Kentucky Academy of Science the most influential for good, the livest thing, in Kentucky.

The needs of the day call for such an expansion and such an increase in aggressive effort. We can not live in this good new day and be content with the past achievement. General Foch has said that no battle was ever won by an army on the defensive. To win we must be aggressive.

Paul P. Boyd

University of Kentucky

PRELIMINARY RESULTS OF ANALYSIS OF LIGHT DEFLECTIONS OBSERVED DURING SOLAR ECLIPSE OF MAY 29, 1919[1]

1. TABLE 1 summarizes the available observational data for deriving the amount of deflection of a light ray grazing the sun's limb as observed on the earth. The sources of the data are given in the remarks below the table. No. 2 has been rejected by the British astronomers because of the diffuseness of the star-images on the photographic plates obtained with the astrographic object glass of the Greenwich Observatory used in conjunction with a 16-inch cœlostat, the figure of which apparently changed appreciably during the plate-exposures. It will be observed that the indiscriminate mean results, I. and II., would indicate a value about midway between that (0″.87) computed on the basis of the Newtonian Mechanics and that (1″.74) computed according to Einstein's law of gravitation. If on the other hand the observational results are weighted inversely as the squares of the probable errors, than the weighted mean results, especially IV. (1″.76), are found to be in close agreement with Einstein's value, though the probable error (±0″.2) is still somewhat large.

TABLE I

Summary of All Observations Concerning Deflection of Light at Sun's Limb

No.	Eclipse	Station	Observers	Deflection at Sun's Limb	Probable Error	Approximate Weight
1	June 8, 1918	Goldendale. U. S. A.	Campbell-Curtis	0″.58	—	1
2	May 29, 1919	Sobral, Brazil	Davidson	0.93	±0″.3	1
3	May 29, 1919	Sobral, Brazil	Crommelin	1.98	±0.12	6
4	May 29, 1919	Île of Principe	Eddington	1.61	±0.3	1
	General results	I. Indiscriminate mean of all		1.28	±0.21	
		II. Indiscriminate mean without No. 2		1.39	±0.28	
		III. Weighted mean of all		1.67	±0.20	
		IV. Weighted mean without No. 2		1.76	±0.22	

Remarks: No. 1 was derived from Dr. Campbell's statement (see SCIENCE, March 26, 1920, page 310) that the mean of their results "came out at 0″.08 or 0″.15, according to which of Einstein's hypotheses was adopted"; the probable error of one star position is given as 0″.5, but the probable error of the mean result is not stated. Nos. 2, 3 and 4 are given in *Monthly Notices, R.A.S.*, Vol. LXX., p. 415, February, 1920. (See SCIENCE, March 26, 1920, p. 308.)

2. The weighted mean value IV. depends chiefly upon Crommelin's result (No. 3), obtained at Sobral, Brazil, during the solar eclipse of May 29, 1919, from 7 photographic plates, using a 4-inch lens of 19-foot focus and an 8-inch cœlostat, and from similar check-plates obtained at the same station before sunrise between July 12 to 18, 1919. These observations appear to be the best ones for undertaking a critical analysis of the results with the view to ascertaining, if possible, whether any other effect has been measured than that accredited to the sun's gravitational action. The following results of a preliminary analysis, as made by the Department of Terrestrial Magnetism at Washington, are based partly upon data already published in the British journals and partly upon those very courteously supplied by the Astronomer Royal, Sir Frank Dyson, to whom we desire to return our appreciative thanks. The chief purpose of our investigation was to ascertain the possible bearing of the geophysical observations, made by the two chief

[1] Résumé of papers presented before the American Philosophical Society at Philadelphia (February 6 and April 24), the American Physical Society (February 28 and April 24), and Bureau of Standards at Washington (May 7, 1920). For a general account of observations concerning the solar eclipse of May 29, 1919, and the Einstein effect, the reader may be referred to the author's "Résumé," published in SCIENCE, March 26, 1920, pp. 301–312.

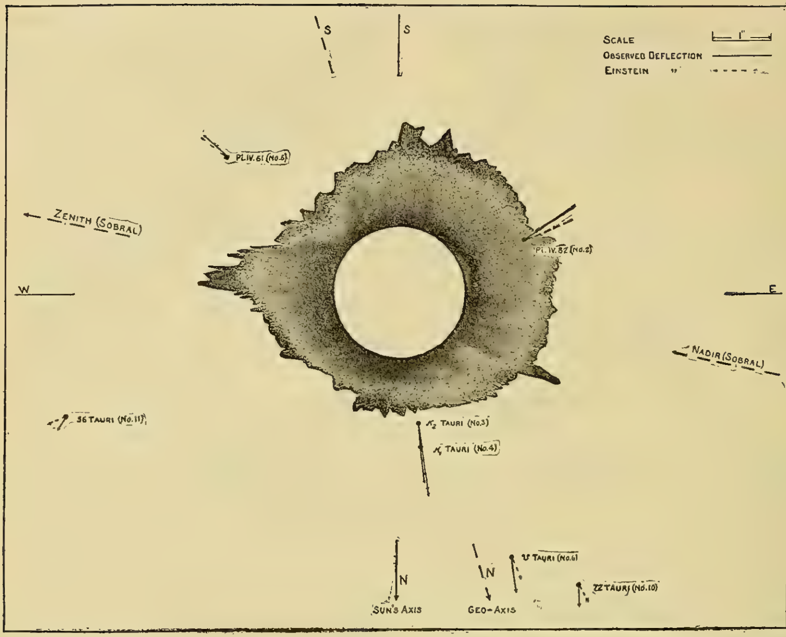

Fig. 1. Dr. Crommelin's observed light deflections at Sobral, Brazil, plotted for each star according to direction and a relative scale of magnitude.

(Full line is observed vector; broken line is the Einstein vector. It will be observed that, in general the observed vector departs from the Einstein vector in a direction *away* from a diameter of the sun passing through the zenith for Sobral as projected on the photographic plate; about this diameter, furthermore, the angular departures, or non-radical effects, are found to be symmetrical.)

expeditions of the Department of Terrestrial Magnetism during the solar eclipse of May 29, 1919, at Sobral (D. M. Wise, in charge) and at Cape Palmas, Liberia (L. A. Bauer, in charge) upon the complete interpretation of results of the astronomical observations. We also received from Dr. H. Morize, director of the Rio de Janeiro Observatory, meteorological data pertaining to his eclipse station, which was likewise Sobral, and desire to acknowledge our indebtedness to him. It may be recalled that the rays of light whose deflections were measured during the solar eclipse were subject chiefly: *a* to a gravitational action from the sun, *b* to optical refraction in the sun's atmosphere, and *c* to optical refraction in the earth's atmosphere. The bearing of the geophysical observations will be chiefly in relation to *c*.

3. Let α_0 be the gravitational deflection of a light ray grazing the sun's limb, α_r, the gravitational deflection of the ray at the distance ρ from the center of the sun expressed in units of the sun's radius; then, according to the Einstein law of gravitation, we have

$$\alpha_r = \frac{\alpha_0}{\rho} = \frac{1''.74}{\rho}.$$

The deflection by this law should everywhere be the same on a circle concentric with the sun, *i. e., condition* (*1*) the deflection should vary alone with the inverse distance, not also, for example, with heliographic latitude; furthermore, the deflection should be strictly radial, *i. e., condition* (2) the deflection should coincide in direction with a line drawn to the center of the sun. Plotting Crommelin's actually observed deflections, for each of the 7 stars, in magnitude and direction, as was done in Fig. 1 by the Department of Terrestrial Magnetism, a careful examination shows that there are systematic departures from both conditions (1) and (2) which apparently can not be explained wholly by errors of observation.[2] In addition we have the fact that the resulting value of α_0, No. 3 in Table I., is 1″.98 instead of 1″.74, or about 14 per cent. larger than the theoretical value. What was the chief cause of the superposed effects?

4. Table 2 contains our resolved components of the observed light deflections, namely, the strictly radial component, α_r, and α_p, the component perpendicular to the radius, representing the non-radial effects or angular departures, β, from radiality, exhibited in Fig. 1. *A* is the positon angle of the star counted continuously in the direction N, E., S., W., from the north end of the declination or geo-axis; the north end of this axis for Sobral at mid-totality was about 16°.8 east of the north end of the sun's axis of rotation. The two columns giving the probable errors, as deduced by us from the individual data derived from Crommelin's 7 plates, show that the average probable error for both the radial and non-radial components is about +0″.04. The angular departure, β, it will be observed, varies from —28° to +37°; a plus value means an angular departure in the positive direction of the angle *A*, *i. e.*, in the direction N., E., S., W. The sign of α_p corresponds with that of β. How many of the 7 plates gave a plus or a minus β is shown in the last two columns. It will be seen that for stars 6 and 10, the minus sign greatly predominates, and for stars 2 and 11, the plus sign greatly predominates.

TABLE II

Radial and Non-Radial Components of Observed Light Deflections at Sobral, Brazil, May 29, and Angular Departures for Radiality

Based on results from 7 photographic plates obtained by Dr. A. C. D. Crommelin with a 4-inch lens of 19-foot focus and using an 8-inch cœlostat.

No.	Star	Pos. Angle	Dist.	Einstein Deflection	Observed Deflection		Probable Errors		Angular Departure		
		A	ρ		Radial	Non-Radial	Rad.	N. R.	β	+	=
3	κ_2 Tauri	351°.8	1.99	0″.88	1″.02	−0″.05	0″.02	0″.02	− 2°.9	3	4
2	Pi. IV. 82	96.0	2.04	0.85	0.97	+0.16	0.04	0.05	+ 9.6	6	1
4	κ_1 Tauri	352.0	2.35	0.75	0.84	+0.01	0.03	0.03	+ 0.8	2	5
5	Pi. IV. 61	215.6	3.27	0.53	0.54	−0.02	0.05	0.04	− 2.5	3	4
6	υ Tauri	6.3	4.34	0.40	9.56	−0.16	0.04	0.04	−16.0	1	6
10	72 Tauri	15.0	5.19	0.34	0.32	−0.17	0.05	0.04	−27.9	0	7
11	56 Tauri	273.6	5.38	0.32	0.20	+0.15	0.06	0.02	+37.2	7	0

5. Table II. shows the following facts:

(*a*) The observed radial component is greater than the Einstein theoretical value for the first five stars (Nos. 3, 2, 4, 5 and 6) and less for the two most distant stars (Nos. 10 and 11). (The observed radial deflections for the two stars, Nos. 6[3] and 11, which depart most from the Einstein values, correspond, respectively, to deflections at the sun's limb of

[2] Dr. Silberstein has also directed attention to the existence of the non-radial effects. *Monthly Notices, R. A. S.*, Vol. 80, pp. 111–112.

[3] Curiously, Eddington's observed deflection for star 6, according to data kindly supplied recently, also departs most markedly from the Einstein law; in his case, however, the deflection reduced to the sun's limb is about 55 per cent. too *low* for that star.

$2''.43$ and $1''.11$, thus exhibiting a range of 75 per cent.)

(*b*) The observed non-radial component, which according to the Einstein law (1) should be zero, varies from $-0''.17$ to $+0''.16$; it amounts at times to one tenth of the Einstein radial deflection at the sun's limb and is from 3 to 7 times the probable error.

(*c*) The value of the deflection at the sun's limb as deduced from stars Nos. 3, 4, 6 and 10, near the sun's axis, is $2''.02$, and from stars Nos. 2, 5 and 11, near the sun's equator, $1''.88$; the two values differ $0''.14$ or 8 per cent. (The observed deflection therefore is a function not simply of distance alone, as required by the Einstein law, but also apparently of the position angle.)

6. After various trials the following preliminary formulæ were found to represent the observed quantities with good approximation:[4]

$$\alpha_r = \frac{1''.77}{\rho} + \frac{0''.29}{\rho}\sin^2(A - 239°), \qquad (2)$$

$$\alpha_p = 0''.0323\rho \sin 2(A - 233°). \qquad (3)$$

The close agreement in the independently-derived phase angles, 239° and 233°, led to the impression that some common cause produced the superposed radial effect, represented by the second term in (2), and the non-radial effects represented by (3). Now the position angle of the zenith for Sobral at mid-totality of the eclipse, projected on the plate, is 241°.6, which value could be substituted with fair approximation in place of the phase angles for (2) and (3). Thus the second term of (2) and the single term of (3) were found to be related in some manner to the local zenith. The effect of terrestrial atmospheric refraction on the sun and the stars is to shift them apparently all towards the zenith, those farthest from the zenith being shifted most. The question accordingly arises whether the superposed effects with which we are concerned may not have resulted from incomplete elimination of differential refraction effects in the earth's atmosphere. It may be observed also that by the introduction of our second term in (2), the value of the deflection at the sun's limb was reduced from $1''.98$ to $1''.77$, which agrees closely with the Einstein value.

7. With the effective aid of my colleague, Mr. W. J. Peters, in charge of the reduction of the atmospheric-refraction observations made aboard the *Carnegie*, the possible outstanding effects resulting from incomplete elimination of differential refraction effects in the earth's atmosphere have been investigated. The differential terrestrial refraction effects between the sun and each of the 7 stars were rigorously computed by two different methods for the time of exposure of the eclipse plates and the prevalent meteorological conditions. Lacking complete details regarding the precise times of exposures of the check-plates obtained before sunrise between July 12 and 18, our computed differential-refraction effects for the check-plates are for the present only tentative ones. The examination as far as it can be made at present indicates that outstanding effects in the differences between the differential terrestrial refraction effects for the eclipse-plates and the check-plates, may largely, if not completely, account for the non-radial effects in the observed light deflections, as also decrease the value ($1''.98$) of the radial deflection at the sun's limb. This is a matter that can be more definitely determined when the original data and complete details regarding the reductions of the measures are available. *The present indications are that precise allowance for differential terrestrial refraction effects may bring Crommelin's results into closer accord with the Einstein law of gravi-*

[4] The sum of the residuals squared on the basis of formula (1) was 0.093, whereas on the basis of (2) the sum was reduced to 0.037. Were the non-radial effects regarded solely as errors of observation, then the sum of the squares amounts to 0.106; however, the sum of the squares of the residuals resulting by applying formula (3) is but 0.016. Other formulæ were also established giving a still closer representation of the observed quantities than do (2) and (3), however, they did not admit of physical interpretation as readily as those given. This matter will be discussed more fully in the complete paper.

tation. Possibly also when reductions of the photographic measures have been made with every possible refinement, some outstanding effect may be disclosed to be referred to optical refraction in the sun's atmosphere, especially for stars in the polar regions like Nos. 3, 4, 6 and 10, where the length of the light path through the solar atmosphere would be considerably less than for stars 2, 5 and 11, in the equatorial regions (*cf.* § 5*c*).

A future communication will give further consideration to this matter.

8. In the foregoing paragraph nothing has been said as to the possibility of irregularities in the differential refraction effects in the earth's atmosphere such as have been disclosed by various investigators and which may not have affected every ray alike over a star field embracing about two degrees of arc. In brief, the actual differential terrestrial refraction effects, because of atmospheric conditions during totality of the eclipse or during the times when the check-plates were exposed, or because of the manner of mounting of the instrumental appliances, may have been appreciably different from those derived from mathematical formulæ and standard refraction tables. It would seem that in future tests of the Einstein effect, atmospheric-refraction observations and allied meteorological observations should be included as a necessary part of the program of work.

L. A. Bauer

Department of Terrestrial Magnetism,
Washington, D. C.,
May 11, 1920

FOURTH YEAR OF THE NEOTROPICAL RESEARCH STATION

The work of the New York Zoological Society Station in British Guiana began in 1916. Owing to the difficulty of transportation at the time of the war, there was a lapse during 1917, but work was resumed in 1918 and 1919. The station is now entering its fourth year. It has been directed with great ability by Mr. William Beebe, Honorary Curator of Birds at the Zoological Park, and has been supported by personal contributions of the trustees of the Zoological Society.

The distinctive research feature of this station is intensive biologic observation in one region, in fact, in one locality, as distinguished from the observations of Darwin, Bates, Waterton, Chapman, and many other explorers in the great biologic field of South America. The area chosen by Director Beebe is the eastern edge of the tropical rain-forest of South America, which extends unbroken across the greater part of the continent. The fauna and flora are uniform with those of the entire Amazonian region. The locality in Bartica District, British Guiana, at Kartabo, the point of junction of the Mazaruni and Cuyuni rivers, has proved ideal in every way as a permanent site for this station. Within ten minutes walk are sandy and rocky beaches, mangroves, grassland, swamp, and high jungle, each with a growth of life peculiar to itself. Free exposure to the trade winds, the absence of flies and mosquitos, invariably cool nights, excellent buildings assigned by the government—all these features contribute to the wide range of life and the unbroken health of the scientific staff.

This region affords a vast opportunity for studying the faunal and floral complex, independent and interrelated adaptations in all grades of life in vertical as well as horizontal life zones. The vertical division of the fauna and flora in distinctive zones, extending from the tree summits to the subsoil, is a biologic contribution of importance. The observations of the station extend from color changes and adaptations to anatomical and functional characters of the archaic as well as of the highly modernized forms of life.

All together seventy-five papers have been published on the scientific observations of this station, parts of which have already been reviewed in the volume "Tropical Wild Life" issued by the society in 1917. Three papers appeared in the first volume of *Zoologica* (1907–1915), and it has been decided to reserve the third volume of *Zoologica* exclusively to scientific papers on the station.

During the year 1919 Director Beebe's

work dealt chiefly with environmental problems and evanescent characters such as color, pattern, tissue form, developmental change and habits of the higher vertebrates. Elaborate studies were made of the eyes of reptiles and amphibians, also of the tongue, tarsus, and hyoid apparatus of three families of birds, the Formicariidæ, Cotingidæ, and Tyrannidæ, and the syringes of one hundred and twenty-two species of birds. The general notes on life histories of amphibians, reptiles, and birds were greatly increased and will shortly be ready for publication. Among the lower forms, six specimens of *Peripatus* were studied, one of which gave birth to eight young.

Without in any way interfering with the scientific work of the station it was found possible to collect and preserve for the American Museum a collection of two hundred and seven mammals, skins, skulls and skeletons, with full data, comprising about forty-three species. Among these was a series of thirteen red howling monkeys of various ages, part of which has been introduced in one of the groups in the Primates Hall of the American Museum. Every reptile and amphibian, excepting those involved in research problems, was preserved, a collection of two hundred being brought north to the American Museum. To aid current research on the Crocodilia, a series of crocodile skulls was sent north. Similarly a number of large electric eels was collected for Professor Ulric Dahlgren, of Princeton, and embryos of the red howling monkey were sent to Dr. Adolph H. Schultz, of Johns Hopkins University.

Mr. John Tee-Van, of the New York Zoological Park, in addition to the economic administration of the station, made five hundred pen and ink drawings of the syringes and tongues of birds, considered to be of great importance in classification. Mr. Alfred Emerson, of Cornell University, chose the Termites as his object of research and completed his biologic studies on fifty-six species. Professor Albert M. Reese, of the University of West Virginia, began a microscopic study of the swamp and river fauna, and an intensive environmental investigation of a hundred yards of sandy beach in front of the laboratory. His chief research was on the embryology of the crocodile, obtaining embryos of all stages. Mr. Clifford Pope, of the University of Virginia, worked on the fish life near the station and obtained valuable data on thirty-five species. Miss Isabel Cooper, of Bryn Mawr, made two hundred and forty-five paintings and drawings, in full color, of fishes, amphibians, reptiles, and invertebrates, most of them known heretofore only from colorless alcoholic specimens. Among the most interesting paintings are those of the living eye of amphibians and reptiles.

In the year 1919 the station was open from March first until October. Director Beebe and six associates and assistants are leaving New York May 8, 1920, for the fourth season's work.

SEASON OF 1920

The party leaving New York on May 8 for the fourth season includes William Beebe, director; John Tee-Van, scientific assistant and preparator; George Inness Hartley and Alfred Emerson, research associates; Clifford Pope, research assistant; Isabel Cooper and Anna Taylor, artists.

In addition to the continuation of the regular research work of the station of previous years, as outlined in the above report, there will be special studies on the habits of the hoactzins and the army ants, with the new Akeley moving picture camera. Attempts will be made to secure living giant armadillos and hoactizins for the Zoological Park of New York.

Professor Ulric Dahlgren, of Princeton, will visit the Neotropical Station in August to begin his researches on the electric eel *Gymnotus*. Professor William Morton Wheeler, of the Bussey Institution, with his son Mr. Ralph Wheeler, accompanied by Professor J. C. Bailey, will visit the station in July to study the ant fauna. Dr. Casey Wood, one of the leading authorities on the fundus oculi of the sauropsids and amphibians, expects to visit the station later in the year accompanied by Dr. Harold Gifford. Four artists will be at the station during the present year and will devote especial attention to recording the coloring of creatures too delicate to bear transportation alive to a temperate zone.

Among the incidental results of the work of the station is a rich and continuous supply of living animals to the New York Zoological Park, including such animals as the jaguar, ocelot, capybara, agouti, anaconda, and jabiru. This season a very much larger collection of living animals will be made and sent north.

HENRY FAIRFIELD OSBORN

PRESIDENT OF THE NEW YORK
ZOOLOGICAL SOCIETY,
May 6, 1920

SCIENTIFIC EVENTS

COLLECTIONS OF THE NATIONAL MUSEUM

THE annual report of the director of the U. S. National Museum states that the total number of specimens acquired by the museum during the year was approximately 526,845. Received in 1,198 separate accessions, they were classified and assigned as follows: Department of anthropology, 12,333; zoology, 442,383; botany, 40,357; geology and mineralogy, 4,750; paleontology, 26,050; textiles, woods, medicines, foods, and other miscellaneous animal and vegetable products, 884; mineral technology, 62; and National Gallery of Art, 26. As loans for exhibition, 3,096 articles were also obtained, mainly for the divisions of history and American archeology and the Gallery of Art.

Material to the extent of 539 lots was received for special examination and report.

The distribution of duplicates, mainly to schools and colleges for educational purposes, aggregated 3,441 specimens, of which 1,378 were contained in seven regular sets of fossil invertebrates averaging 47 specimens each and six regular sets of mollusks of 174 specimens each. The balance comprised 19 special lots, consisting of marine invertebrates, reptiles, fishes, fossils, minerals and ores, stone implements, and basketry specimens.

In making exchanges for additions to the collections, a total of 5,227 duplicate specimens were distributed. These consisted largely of plants.

Material sent out to specialists for study on behalf of the Museum amounted to 19,851 specimens, mainly biological.

In furtherance of its extensive historical exhibits, the Museum, early in the year, through cooperation with the War and Navy Departments, undertook the assembling and installation of a collection of materials connected with the World War, which may ultimately, require a separate building.

APPROPRIATIONS FROM THE HENRY DRAPER FUND OF THE NATIONAL ACADEMY OF SCIENCES

AT its recent meeting the National Academy of Sciences made the following appropriations on the recommendation of the committee on the Henry Draper Fund:

$400 to S. A. Mitchell, of the University of Virginia, to complete the purchase of a measuring microscope for use in the photographic determination of stellar parallaxes, on the basis of observations made with the 27-inch refracting telescope. The academy awarded the sum of $250 from the Draper Fund to apply on the purchase of this instrument and the proposed grant of $400 will complete the purchase. The microscope, costing $650, becomes in effect the property of the academy. Professor Mitchell will devote an equivalent sum, $400, to other needs of his parallax research.

$300 to Joel Stebbins, professor of astronomy in the University of Illinois, to assist in the further development of the photo-electric-cell photometer.

$400 to Frank Schlesinger, director of the Allegheny Observatory, to enable him to test an automatic zenith camera for the determination of terrestrial latitude, with the expectation that the results will be more accurate than any hitherto obtained by other means. It is proposed that this instrument be mounted temporarily at the International Latitude Observatory at Ukiah, California, where the astronomer in charge will operate it for a year or two as a labor of love. The grant is needed to install the instrument at Ukiah and to make certain auxiliary apparatus required in its operation. The Allegheny Observatory is loaning the objective and the photographic plates obtained will be measured by Dr. Schlesinger himself or under his immediate direction.

$175 to E. B. Frost, director of Yerkes Observatory, for the purchase of a Hess-Ives tint photometer for use in the Yerkes Observatory, to supplement the Hartmann micrometer in the measurement of various illuminants, of the transmission of filters for various wave-lengths, of the absorption of photometric gratings, and of other phenomena and subjects.

$500 to Dr. Antonio Abetti, director of the Arcetri Observatory, Florence, Italy, to apply on the cost of a combined spectrograph and spectroheliograph for use in combination with a 60-foot tower telescope now under construction. It is planned that this instrument shall be used by the son of the director, Dr. Giorgio Abetti, well known to many American astronomers, recently transferred from the Observatory in Rome to the Arcetri Observatory.

$200 to Major William Bowie, chief of the Division of Geodesy, U. S. Coast and Geodetic Survey, in temporary support of the International Latitude Observatory at Ukiah, California, to assist in meeting an emergency due to the failure of the Observatory's regular source of funds.

ASSOCIATION OF SCIENTIFIC APPARATUS MAKERS OF THE UNITED STATES OF AMERICA

The second annual meeting of the Association of Scientific Apparatus Makers of the United States as reported in the *Journal of Industrial and Engineering Chemistry,* was held at Washington, D. C., Thursday and Friday, April 22 and 23, 1920, and was attended by thirty of the leading manufacturers of scientific instruments, analytical balances, chemical glassware, optical instruments and pyrometers.

The purpose of this association is to improve the construction and design of the scientific apparatus of this country and to standardize the same so as to get uniform quality and sizes; also, the most important object is to build up in the United States a precision instrument industry that will be of aid to the national government in time of emergency. Prior to 1914, practically all instruments of precision were imported and when our government declared war in 1917, it was found that there were not enough instrument makers and manufacturers to provide adequate supplies of precision instruments for the laboratory control of essential factories and to build fire control instruments for the Army and Navy. The association is now working to perpetuate this industry and to make the nation independent of any foreign country. In carrying out their program they are working in conjunction with the National Research Council, the American Chemical Society, Bureau of Standards and the various scientific bureaus of the National government.

One of the most important addresses of the occasion was given by Dr. S. W. Stratton, director of the Bureau of Standards, in which he set forth the various activities of the Bureau and stated how it would be possible to cooperate with this association. On Friday afternoon, at the invitation of Dr. Stratton, the association was shown through the various departments of the Bureau of Standards.

Committees were appointed on standardization in the various departments to work in conjunction with the above-mentioned agencies and also, if possible to correlate their work with the committee of the Society of Chemical Industry of Great Britain, which is working along similar lines. There was also a committee appointed on publication which will report later. The officers for the coming year are as follows: *President,* M. E. Leeds, of the Leeds & Northrup Company; *Vice-president,* H. N. Ott, of the Spencer Lens Company; *Secretary-treasurer,* J. M. Roberts, of the Central Scientific Company.

THE GRADUATE SCHOOL OF MEDICINE OF THE UNIVERSITY OF PENNSYLVANIA

At the last meeting of the board of trustees steps were taken to further equip and advance the work of the university's graduate school of medicine. A budget of $158,079.37 was approved to meet such expenses as are not provided in the regular income of the school. Provost Smith appointed John C. Bell chairman of the joint committee on the graduate school of medicine.

A committee from the graduate school, consisting of Dean George H. Meeker, Dr. George E. de Schweinitz, Dr. Alfred Stengel and Dr. P. S. Stout, attended the meeting and explained the new plans of the school. What these men said concerning the work of the school is now doing and its recognition throughout the medical world greatly impressed the trustees. The following resolutions concerning the school were unanimously adopted:

Resolved, That in the judgment of the board of trustees the maintenance and development of the graduate school of medicine is essential alike to the cause of medical education in this commonwealth and to the leadership of the university in this field.

Resolved, That the budget of the graduate school of medicine for the year 1920–21, involving an estimated deficit of $158,079.37, be approved.

Resolved, That a committee consisting of all the members of this board and such others as may be appointed by the provost be empowered to cooperate with the managers of the hospitals of the graduate school of medicine in raising the necessary funds for the support of that school.

Resolved, That pending the receipt of the necessary contributions for the support of the graduate school of medicine the credit of the university be pledged and the treasurer be authorized to pay out of unrestricted funds not otherwise appropriated such sums as may be necessary, not exceeding the amount of the estimated deficit, $157,079.37.

OFFICERS OF THE NATIONAL RESEARCH COUNCIL

THE National Research Council has elected the following officers for the year beginning July 1, 1920: Chairman, H. A. Bumstead, professor of physics and director of the Sloane physical laboratory, Yale University; First Vice-Chairman, C. D. Walcott, president of the National Academy of Sciences and Secretary of the Smithsonian Institution; Second Vice-Chairman, Gano Dunn, president of the J. G. White Engineering Corporation, New York; Third Vice-Chairman, R. A. Millikan, professor of physics, University of Chicago; Permanent Secretary, Vernon Kellogg, professor of entomology, Stanford University; Treasurer, F. L. Ransome, treasurer of the National Academy of Sciences. The chairman of the various Divisions of the Council have not yet been all selected but will be announced later. As the general officers and the division chairmen of the council are elected annually, with the consequent possibility of an almost complete change of administrative officers at the end of any annual period, the council instituted the office of permanent secretary for the sake of effecting some degree of administrative continuity. Professor Kellogg, who has for the past year been serving as secretary of the council and chairman of its division of educational relations, will fill this office, and will resign from Stanford University on July 1 of this year.

SCIENTIFIC NOTES AND NEWS

ON the recommendation of the National Academy of Sciences the Barnard medal for meritorious service to science has been conferred by Columbia University on Professor Albert Einstein, of Berlin, in recognition "of his highly original and fruitful development of the fundamental concepts of physics through application of mathematics."

DR. ERNEST SOLVAY, Belgium, has been elected to honorary membership in the American Chemical Society.

THE honorary degree of doctor of science was conferred on Edward William Nelson, chief of the U. S. Biological Survey, at the recent commencement exercises of George Washington University.

ON the evening of May 22, a dinner was given at New Haven to Professor Russell H. Chittenden in honor of the fortieth anniversary of his receiving the degree of doctor of philosophy from Yale University. Sixty-five former graduate students and friends were present. The dinner followed the one hundred and eighth meeting of the Society for Experimental Biology and Medicine.

DR. EDGAR FAHS SMITH, retiring provost of the University of Pennsylvania, was a guest of honor at a dinner given by nearly 500 members of the faculty of the University of Pennsylvania at Weightman Hall, May 26.

DR. SIMON FLEXNER, of the Rockefeller Institute for Medical Research, has been appointed to represent the United States at the first formal meeting of the Medical Advisory

Board of the League of Red Cross Societies that will open at Geneva on July 5. The representatives of other nations at the conference will be Professor Brodet, Belgium; Professor Madsen, Denmark; Professors Roux, Albert and Calmette, France; General Lyle Cummins, Sir Walter Fletcher and Sir George Newman, Great Britain; Professor Bastianello and Dr. Castellani, Italy; Dr. Kinnostke Miura, Japan, and Dr. Chagas, South America.

Dr. George B. Frankforter, who has been during the war examiner of explosives, chemicals and loading in the Ordnance Claims Board and later technical adviser to the board, has returned to the University of Minnesota as professor of organic and industrial organic chemistry.

Dr. Austin H. Clark, assistant curator in the division of marine invertebrates of the Nation Museum, has been appointed curator of the division of echinoderms.

Dr. Frank E. Lutz, of the American Museum of Natural History, is in Wyoming continuing the museum's work on the ecological distribution of western insects.

The California Academy of Sciences has granted temporary leave of absence to Dr. G. Dallas Hanna, curator of invertebrate paleontology to enable him to comply with a request from the United States Bureau of Fisheries to take the annual census of fur seals on the Pribilof Islands, Alaska in 1920. Departure will be taken from Seattle about June first on the U. S. S. *Saturn*. Dr. Hanna was formerly attached to the staff of the Bureau and besides being associated with the census work since 1913 has made large collections of natural history material. It is expected these will be considerably augmented during the coming summer.

Dr. L. E. Griffin, professor of zoology at the University of Pittsburgh, formerly professor of zoology and dean of the arts college in the University of the Philippines, lectured before the West Virginia Scientific Society on May 27 upon "The Development of Science in the Philippines."

Dr. Carl O. Johns, of the Color Investigation Laboratory, Washington, D. C., recently lectured before the graduate students in chemistry of Yale University on "The application of organic chemistry in government work."

M. Pierre Janet, professor of psychology in the Collège de France gave recently three lectures at the University of London on "La tension psychologique, ses degrés et ses oscillations."

Clarence Ehnie Broeker, who, in collaboration with Dr. W. D. Harkins at the University of Chicago, according to their preliminary results, had successfully fractionated hydrogen chloride into what appear to be acids of isotopic forms of chlorine (Science, LI., 289, 1920), died on May 9, after a brief illness. In recognition of his skillful work and ability Mr. Broeker had been appointed to the Swift fellowship in chemistry, the highest honor in the gift of the chemistry department of the University of Chicago.

The Civil Service Commission announces examinations on July 6, for the positions of radio engineer (aeronautics) at $3,600 to $5,000 a year and of assistant radio engineer (aeronautics) at $2,500 to $3,600 a year. On July 15 an examination is announced for a position in metallurgical engineering at the Naval Ordnance Plant, South Charleston, W. Va., at $5,000 a year.

Dr. Benjamin White has been appointed director of the division of biologic laboratories of the Massachusetts State Department of Public Health to succeed Dr. Milton J. Rosenau, resigned. Dr. White has also been appointed lecturer on immunology in the Massachusetts College of Pharmacy and assistant in the department of preventive medicine and hygiene of the Harvard Medical School.

Mr. A. M. Muckenfuss, professor of organic and industrial chemistry and director of that subdepartment, Emory University, Atlanta, Ga., has resigned to accept the position of research chemist with the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J.

Dr. Cyril S. Taylor has resigned from the Bureau of Standards to accept a position in the research bureau of the Aluminum Company of America at New Kensington, Pennsylvania.

Dr. John S. Boyce has been placed in charge of a branch of the office of Forest Pathology of the Bureau of Plant Industry, cooperating with District 6 of the Forest Service, which has been established at Portland, Oregon.

The California Fruit Growers Exchange, an organization of 10,000 growers of citrus fruits, has established a research laboratory in Corona, California, in charge of Mr. C. P. Wilson, who was for thirteen years with the Bureau of Chemistry of the U. S. Department of Agriculture.

At the annual meeting of the Boston Society of Natural History, the following officers were elected: *President,* W. Cameron Forbes; *Vice-presidents,* Nathaniel T. Kidder, William F. Whitney, Theodore Lyman; *Secretary,* Glover M. Allen; *Treasurer,* William A. Jeffries, *Councillors for eight years,* Thomas Barbour, Henry B. Bigelow, Gorham Brooks, S. Prescott Fay, Robert T. Jackson, John L. Saltonstall, John E. Thayer, Charles W. Townsend. The following were elected honorary members of the society: G. A. Boulenger, Sidney F. Harmer, Aubrey Strahan, of London; Emmanuel de Margerie, of Paris; John Macoun, of Ottawa; Elmer D. Merrill, of Manila.

Mr. Gerard Fowke, a collaborator of the Bureau of American Ethnology, left St. Louis on April 1 for Honolulu. He will make an archeological reconnaissance of the Hawaiian Islands with a view to future intensive work by the bureau.

The tenth annual summer field course in geology of the University of Missouri will be conducted by Professor E. B. Branson and Mr. R. B. Rutledge during July and August. About one week will be spent in the Black Hills and the rest of the time in the Big Horn Mountains of Wyoming. The party will be limited to sixteen students. Messrs. Branson and Rutledge, who are now on leave of absence from the University of Missouri engaged in geological investigations in Costa Rica, will return to the United States late in June.

At a recent meeting of the Iota (Kansas) Chapter of the Society of Sigma Xi a resolution of commendation and congratulation was ordered to be transmitted, over the signatures of the president and secretary of the society, to Dr. Solomon Lefschetz for his memoir entitled " Sur Certains Nombres Invariants des Variétés Algébriques avec Application aux Variétés Abéliennes," for which the Bordin prize of 3,000 francs was awarded in 1919. The following is the resolution: " The Iota Chapter of the Society of Sigma Xi (University of Kansas) congratulates Dr. Solomon Lefschetz on the receipt of the Bordin Prize of the Paris Academy of Sciences as an appropriate acknowledgment of his mathematical ability and productive scholarship. It furthermore commends Dr. Lefschetz in the highest terms for his indefatigable industry in scientific research, and will await with interest his future contributions to mathematical science."

At the annual general meeting of the Royal Astronomical Society on February 13, the president, Professor A. Fowler, gave an address on the foundation of the society just a century before. According to an abstract in *Nature* he said that the four men who were most influential in its formation were the Reverend William Pearson, Mr. Francis Baily, Sir John F. Herschel and Mr. Charles Babbage. The two latter both lived until 1871, and there are no fewer than fifteen surviving fellows whose fellowships overlapped with theirs. One of these, Mr. Inwards, said that he remembered speaking to Sir John Herschel at a meeting of the society. There was at first a good deal of opposition to the new society on the part of the Royal Society, and the Duke of Somerset, who was elected the first president, quickly resigned this office owing to the pressure brought to bear upon him. He was succeeded after an interval by Sir William Herschel, who was then eighty-two years of age, and died in 1822. Mr. Stephen Groombridge, well known for his

Star Catalogue, was another of the original members. They were not called fellows until 1830, when the royal charter was granted, giving the society its present title; it was previously called the London Astronomical Society. The earliest publications of the society were in the form of memoirs; the Monthly Notices did not commence until several years later, and were at first only small pamphlets containing ephemerides of comets and other matters of transient interest.

The British Medical Journal writes:

Owing to the war the zoological station at Naples has suffered in many ways, and it is highly necessary that this very important international scientific institution should receive the support necessary to enable it to carry on its work without restriction. But, although its importance for zoological and morphological research has always been recognized, its advantages for physiological and biochemical studies are by no means as widely known as they ought to be. The station is fully equipped with all necessary apparatus and materials, and the section for physiology and biochemistry, being under the very capable direction of Professor Bottazzi, the professor of physiology in the University of Naples, students are assured not only of the opportunities of carrying out independent and untrammelled research, but of the best advice and direction from the staff. There is an admirable library, with very complete sets of periodical publications. The rent of a table is 2,500 francs a year (payable in gold), and the director of the station will furnish all details to students who propose to carry out any research there. The study of comparative physiology has bearings upon immunology, upon the question of functional activities, upon biochemistry and physiology in general, the importance of which in their relation to medicine needs no emphasis. The effect on international relations of a free use of these scientific facilities being made by British students and of their intercourse with Italian men of science is but little less important.

The American Fisheries Society will hold its fiftieth anniversary meeting at Ottawa, Canada, on September 20, 21 and 22, 1920. For this meeting the society will offer prizes of $100 for papers in competition in each of the following classes. (1) For the contribution showing the greatest advance in practical fish cultural work; (2) For the best contribution to biological work connected with fish problems in general; (3) For that which offers the greatest promise of the solution of problems affecting commercial fisheries work. The papers should be in the hands of the secretary not later than August 20. Further information can be obtained from the executive secretary, Professor Raymond C. Osburn, Ohio State University, Columbus, Ohio.

UNIVERSITY AND EDUCATIONAL NEWS

Yale University has received $1,000,000 from the General Education Board for the development of the New Haven General Hospital through the medical school of the university. The hospital will be made a full-time institution, the staff many of whom are members of the Yale Medical School faculty, giving all their time to the hospital and foregoing outside practise. When the Yale Medical School became affiliated with the New Haven hospital a few years ago, a gift of $500,000 from the General Education Board was received.

The General Education Board has made a gift of $500,000 each to the endowment funds of Smith College and Mount Holyoke College and $400,000 to that of Wesleyan University. It has also made an appropriation of $250,000 to Middlebury College on condition that an additional $750,000 be raised by subscription.

Mr. Edward Whitley has offered to Oxford University the sum of £10,000 towards the endowment of a professorship of biochemistry, and the British Dye-Stuffs Corporation has made a donation of £5,000 towards the cost of extending the laboratory of organic chemistry.

The Convocation of Oxford University has passed without opposition the statute providing for the matriculation and admission of women for degrees in the university. The Cambridge University Syndicate appointed to consider the question is divided in opinion; half have reported in favor of admission to full membership, and half in favor of a separate university at Cambridge.

DR. DAVID KINLEY, professor of economics and dean of the graduate school of the University of Illinois, has been elected president to succeed Dr. Edmund Janes James.

DR. LAUDER W. JONES, dean of the School of Chemistry and also of the College of Engineering and Architecture of the University of Minnesota, has accepted an appointment as professor of organic chemistry at Princeton University.

ALICE M. BORING, of the Peking Union Medical College, China, has been appointed assistant professor of zoology at Wellesley College, beginning with the academic year 1920–21.

DR. ELLSWORTH D. ELSTON, of Cornell University, has been appointed assistant professor of geology at Dartmouth College.

ASSOCIATE PROFESSOR J. WEMYSS ANDERSON, has been appointed to the recently established John William Hughes Chair of Engineering Refrigeration at Liverpool University.

DISCUSSION AND CORRESPONDENCE

MODERN INTERPRETATION OF DIFFERENTIALS AGAIN

TO THE EDITOR OF SCIENCE: I regret that in my criticism (SCIENCE, March 26) of Professor Hathaway's exposition of differentials (SCIENCE, February 13) I was led by an unwise desire for brevity into making a statement which, in its unqualified form, will not stand analysis. The statement that "lim $N\Delta y$ is inevitably zero" is certainly not true unless N remains finite, and Professor Hathaway is quite justified (SCIENCE, May 7) in chiding me for this error, since his N is not restricted to finite values.

At the same time I can not feel that I was essentially mistaken in contending that his presentation of differentials "would prove highly misleading to the modern student."

It is true that when he defines the differential dy as the limit of $N\Delta y$ for lim $\Delta y = 0$, he does allow the multiplier N to vary (as I should have stated); but it is also true that *he gives no indication whatever as to the manner in which N is to vary; and without some such indication his limit of $N\Delta y$, and hence his differential, dy, remain wholly undefined!*

On page 167 (I quote verbatim this time, to avoid the danger of renewed injustice), his formal interpretation of differentials is given as follows: they are "ordinary arithmetical increments, but in a variation defined as *in the first ratio*, or *as the variables begin to increase*, or, *in the instantaneous state*, which are all one."

I maintain that such vague statements are not likely to convey to any student's mind "a rigorous theory, neglecting no quantity, however small, leaving no unexplained symbol." They are much more likely to leave him with the traditional impression that differentials are really as Bishop Berkeley called them, the "ghosts of departed quantities," or, in Professor Osgood's phrase, abominable "little zeroes," unworthy of a place in mathematical discussion.

The object of my brief letter was, as stated, not to discuss historical questions (the importance and value of which no one can deny) but merely to contrast the obscurity of Professor Hathaway's presentation with the clearness and simplicity of the modern treatment—the treatment which has been the commonplace of every treatise of recognized standing since the middle of the nineteenth century.

EDWARD V. HUNTINGTON

HARVARD UNIVERSITY

POPULAR SCIENTIFIC LITERATURE

TO THE EDITOR OF SCIENCE: In the issues of SCIENCE for February 20 and 27 Mr. F. L. Ransome, of the U. S. Geological Survey, published a most interesting article on the "Functions and Ideals of a National Geological Survey."

In this article, attention was given to the educational work which such a survey might carry on. To a librarian, his statements are of more than casual interest. He called attention to the dearth of popular literature on certain scientific subjects, especially geology. While other branches of nature study, including plant and animal life, appeal to a wider circle, and have been considered in a large number of interesting and attractive books, the same is not true of geology or of some of the smaller forms of animal life, as, for example, insect and fresh water life.

May I venture to call the attention of some scientists who read your journal to the desirability of some small, well-illustrated and attractively written books on geology, both descriptive and historical; on some of the mineral products, such as iron and steel; on pond life; on microscopy; and on the lives of American scientists and scientific explorers.

A book is now in preparation for publication by Scribner's, "The strange adventures of a pebble." From the announcement, this is doubtless the sort of book which has been needed for some time. In the quarterly book-list of the Pratt Institute Library (which library has made a speciality of literature in this field) for January, there is a carefully selected "List of technical and scientific books for boys." Astronomy is pretty well covered. A fairly good boys' book on chemistry was published in 1918. The two titles on geology are those by Heilprin and Shaler, both rather old; and on physics, nothing better than a reprinted edition of Hopkins, "Experimental science," which could very well be entirely revised or even broken up into two less expensive volumes. Certainly there is need for more books of this sort.

In the same line, may I call attention to the need of having books lists, to be distributed through schools and libraries and printed in an attractive style with an illustrated cover, and giving descriptions of the books? The attention of many young people could be called to science as a life career if means like these were adopted. Another device to this same end would be a series of posters or printed reproductions of exhibits, showing some of the interesting phases of nature study or science. These could be printed by such a central bureau or by some national scientific society and distributed to be shown in schools and libraries and at Boy Scout and Camp Fire Girls headquarters.

Joseph L. Wheeler
The Youngstown Public Library

RULES OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

In reference to the applications made to the International Commission on Zoological Nomenclature for copies of the rules, the secretary desires to state that the commission has no supply of reprints for distribution. Several years ago, at request of the secretary, Mr. John Smallwood, 524 Tenth St., N. W., Washington, D. C., prepared several hundred mimeographed copies and he still has about 100 on hand. These are sold at a nominal price to cover expense of mimeographing and postage and zoologists desiring copies can obtain them, as long as the supply lasts, by applying directly to Mr. Smallwood.

C. W. Stiles,
Secretary

SPECIAL ARTICLES

ECHINODERMS IN BIRDS' STOMACHS

Through the courtesy of Mr. E. W. Nelson, chief of the Bureau of Biological Survey, Washington, four vials containing echinoderms taken from birds' stomachs have been sent to me for examination. As I think there are no published records of birds' using echinoderms for food, Mr. Nelson has kindly consented to my stating in Science the facts revealed by this trivial investigation and certain important inferences which may be made.

Two of the vials contained holothurian-like objects taken from the stomachs of gulls. The appearance and condition of these specimens indicate that they were picked up on the beach dead and more or less damaged. As they are now quite decalcified, they are hopelessly unidentifiable, and it is probable that one at least is not a holothurian.

The contents of the other two vials are of much greater interest. In each case, the material was taken from the stomach of a duck collected at Bayou Labatre, Alabama. One vial contains two small brown holothurians, somewhat damaged but with the calcareous particles in the skin not at all corroded or injured in any way. The condition of these specimens leaves no doubt in my mind that they were swallowed alive by the duck and that they had been in the stomach of the bird but a short time when the duck was taken. These holothurians are unquestionably some species of *Thyone*, and are very near, if not identical with, *Thyone scabra* Verrill, of the southern New England coast But *Thyone scabra* is not known from south of Delaware or from water less than ten fathoms deep. No holothurians of any sort are recorded from the Alabama coast. This duck's stomach therefore reveals the interesting fact that a species of *Thyone*, possibly *scabra* but probably distinct, lives in shallow water on the Alabama coast and serves as a part of the diet for bottom-feeding ducks.

The contents of the fourth vial confirms this conclusion and reveals further the notable fact that brittle-stars also serve as food for ducks. The material in this case is in very bad condition and is more or less digested, but the calcareous particles in the fragments of a holothurian indicate it is the same *Thyone* as in the other vial, though it has quite lost its pigmentation. Besides these *Thyone* fragments there are numerous arm-plates of a brittle-star. These are however, beyond identification and one can not even guess the genus, which they represent. The brittle-star was however an individual of moderate size and was certainly not the small and well-nigh ubiquitous *Amphipholis squamata*. No brittle-star is as yet recorded from the Alabama coast. It is to be hoped that the publication of the results of the collecting done by these two ducks may lead to equally effective efforts by some zoologist on the Gulf Coast.

HUBERT LYMAN CLARK
MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS.,

THE AMERICAN PHILOSOPHICAL SOCIETY. II

Morning Session—10 o'clock

ARTHUR A. NOYES, Sc.D., LL.D., Vice-president, in the chair

The components and colloidal behavior of protoplasm: D. T. MACDOUGAL, Ph.D., LL.D., director of the Desert Laboratory, Carnegie Institution, Tucson, Arizona, and H. A. SPOEHR. The living matter of plants is composed chiefly of mucilages and albuminous compounds in varying proportions mixed in the form of an emulsion or as a jelly. The molecules of solid matter are aggregated into groups which also include a number of molecules of water. Growth consists of the absorption of additional water to these groups, with more solid material being added at the same time, the process being termed hydration. The resultant increase may be detected by determination of increased dry weight, or measured as increase in length, thickness or volume. More exact studies in growth have become possible by the establishment of the fact that mixtures of 25 to 50 per cent. mucilage and 50 to 75 per cent. albumin show the hydration reactions of cell-masses of plants. It is also found that certain amino-compounds, such as histidine, glycocoll, alanin, and phenyl-alanin which are known to promote growth also increase the hydration of the *biocolloids* as the above mixtures are called. Following these empirical tests which have defined the character and field of research upon growth, measurements are now being made of the action of various ions or substances upon the components of protoplasm. Thus the strong metallic bases, potassium, sodium and lithium, exert a limiting action on hydration of carbohydrate (agar) in hundredth normal solution according to their position in the electromotive series, potassium being the strongest and reducing swelling most. Rubidium, however, did not take its place at the head of the list in the single series of tests made, for reasons we are not able to describe. At dilute concentrations (0.000, 1N) all these bases promote hydration, an effect also produced by amino-compounds. The inclusion of substances in a liquefied colloid, afterwards dried, produces a hydration effect different from that which results from placing the substance in the water in which the biocolloid may be placed. This fact has wide significance in the physiological action of cell-masses. Renewal or replacement of hydrating solutions may result in pulsations or rapid swellings followed by slow shrinkages or retractions. Gels similar to those entering into living matter may take on structure by which small masses or sections may display highly differentiated action, increases in size and changes in forms after a manner which presents important possibilities in the behavior of cell-organs.

Respiration: W. J. V. Osterhout, professor of botany, Harvard University. A simple method of measuring respiration has been developed whereby determinations can be made at frequent intervals (as often as once every three minutes). The application of this method to the study of anesthesia shows the incorrectness of the theory of Verworn, according to which anesthesia is a kind of asphyxia, due to the inhibition of respiration by the anesthetic. In the study of antagonism it is found that the antagonistic substances may increase or decrease respiration, but when properly combined they show little or no interference with normal respiration. The study of the action of acids and alkalies shows that these substances may increase or decrease respiration and that the effect varies greatly with different organisms.

The behavior of the sulfurea character in crosses with Œnothera biennis and with Œnothera franciscana: Bradley M. Davis, professor of botany, University of Michigan.

Œnothera funifolia, a peculiar new mutant from Œnothera lamarckiana.

A third duplication of generic factors in Shepherd's purse: George H. Shull, Ph.D., professor of botany and genetics, Princeton University. In the third generation of a cross between a wild biotype of the common shepherd's-purse (*Bursa bursa-pastoris*) from Wales and Heeger's shepherd's-purse (*B. Heegeri*) there appeared a small number of plants of unique type, having a more coriaceous texture than in the plants of either of the two original strains involved in the cross. This new type has been designated *coriacea*. It differs from the common form, not only in texture, but the lobing of the leaf is reduced and simplified and the angles of the lobes are almost spinescent. The proportion of *coriacea* to the typical sibs in this F_3 family was 12: 187 or almost exactly a 1: 15 ratio. This suggested at once the presence of two independently inherited factors for the normal texture, the *coriacea* type being produced only when these two factors K and L were absent. Subsequent breeding has shown that *coriacea* breeds true when selfed, and has also confirmed the interpretation of this as a third case of duplication of factors in this species. The two characters previously shown to be thus constituted are the triangular form of capsule, and the division of the leaf to the midrib which brings to light the characteristic lobing found in the form designated *rhomboidea*. The duplication of the capsule determiners is practically universal while that of the leaf-lobe factor is less frequently found. Studies on the *coriacea* character are still too limited in extent to justify a statement as to the prevalence of duplication of the factor for the usual texture of the leaves.

Some effects of double fertilization in maize: Edward M. East, Ph.D., professor of experimental plant morphology, Harvard University.

The chemistry of the cell: Thomas B. Osborne, Ph.D., Sc.D., research chemist, Connecticut Agricultural Experiment Station. (Introduced by Dr. Harry F. Keller.)

The relation of oxygen to charcoal: George A. Hulett, Ph.D., professor of physical chemistry, Princeton University.

Products of detonation of TNT: Charles E. Munroe, Ph.D., LL.D., professor of chemistry, George Washington University, and S. P. Howell. TNT has not only proved a most efficient explosive for war purposes but, following the advice of the Bureau of Mines, the surplus has been now used in large quantities on various public projects with remarkable success, thus completely disproving the opinions given in various quarters following the armistice that it was unfit for industrial use, dangerous to store, and should be thrown away. Notwithstanding the success attained it is believed that with a more complete knowledge of its behavior even better results in its use both for military and industrial purposes could be attained. It is particularly desired to know the kind and quantities of products it yields on explosions. These are known broadly but it is also now known that they vary with the different conditions under which the TNT is exploded and this study has been made to gain more precise information regarding these conditions. It is already known that among the products are considerable quantities of carbon monoxide, hydrogen and some hydrocarbons, such as methane, together with free carbon in a soot-like form. Hence TNT is not suitable for use in underground work or close places because the gas evolved is poisonous and inflammable and can form explosive mixtures with the atmosphere in these close places.

A new map of the vegetation of North America: John W. Harshberger, Ph.D., professor of botany, University of Pennsylvania.

On the vibrations of rifle barrels: Arthur Gordon Webster, Sc.D., LL.D., professor of physics, Clark University.

FRIDAY, APRIL 23

Afternoon Session—2 o'clock

HAMPTON L. CARSON, M.A., LL.D., vice-president, in the chair

Symposium on Psychology in War and Education

Introduction: LIGHTNER WITMER, Ph.D., director of the Psychological Laboratory and Clinic, University of Pennsylvania.

Methods: J. MCKEEN CATTELL, editor of SCIENCE. The speaker reviewed the development of experimental and quantitative methods in psychology, and especially the transfer of its main concern from introspection to the study of individual differences in behavior. This has made possible the applied psychology which was of such service to the nation in time of war and will prove of increasing value in education and in industry. Efforts to alter conduct by a direct appeal to consciousness, as undertaken, for example, by the churches, the schools and the law courts, have yielded small results. But individuals can be selected for the work for which they are fit and can be placed in the human and physical environment in which their reactions are what we want. By cooperation with other sciences, it is also possible for psychology to change the environment, and behavior can be controlled more effectively by a change in the environment than by a change in the constitution of the individual. The older psychology must be put in its proper place; it can not be altogether discarded. As far as production goes, consciousness may be only a spectator; but it is the ultimate consumer.

Psychological examining and classification in the United States army: ROBERT M. YERKES, Ph.D., chairman of Division of Research Information, National Research Council, Washington. (By invitation.) Psychological examining in the United States army was made possible by the prompt action of American psychologists, who individually and collectively, in committees and conferences, formulated plans, prepared methods and induced the army and the navy to utilize psychological service. The methods of examining which were finally adopted are based upon principles previously used but they exhibit also new and important features which constitute significant contributions to the technique of practical mental measurement. The personnel for psychological examining was carefully selected in accordance with qualifications and the men were especially trained at the Camp Greenleaf School for Military Psychology. This intensive training in the rudiments of military science and military psychology ranks next in importance in its relations to the final success of the service to the superior quality of the army's psychological personnel. The initial purpose of examining was the discovery and prompt segregation or elimination of men of markedly inferior intelligence. The uses which were actually made of results of psychological examinations were extremely varied and covered the classification of men to facilitate military training, the selection of men of superior ability for training as officers or for special tasks, the segregation and special assignment of men whose intelligence was inadequate to the demands of regular military training, and finally the elimination of the low-grade mental defective. It was the demonstration of values in these and several other directions that converted military skepticism concerning the serviceability of psychology into belief and active support. After the official trial of methods approximately 75 per cent. of the officers concerned believed that they should be used further. On the signing of the armistice 90 per cent. of the officers of the army, if we may judge by the opinions of the commanding officers of camps and divisions, were highly favorable to the psychological service.

The relation of psychology to special problems of the army and navy: RAYMOND DODGE, Ph.D., professor of psychology, Wesleyan University. (By invitation.) To help mobilize the human factors that were needed by the army and navy to win the war, that was the task for which the psychologists of the country were organized under the leadership of the National Research Council. Two great achievements stand to their credit; first the sorting of the conglomerate of the draft army with respect to general intelligence under Major Yerkes; and second the discovery, indexing and assignment of trade experience, special skill and presumptive ability to perform the tasks needed by a modern army, under Colonel Scott. These achievements are regarded by experts as an important factor in the supposedly impossible undertaking of building a great fighting organization in a few months time. New demands were made on human nature during the late war, many of which were only imperfectly understood. The task of flying is a good illustration. Psychologists cooperated with the Air Service in studying the effects of high altitudes and in discovering test indicators of the ability to stand them. They were responsible for the mental tests in picking those who could learn to fly with a minimum expense and risk. Gas warfare and adaptation to the wearing of gas masks, the development and maintenance of morale, the development of the less fit recruits, the acceleration of training and the reeducation of the wounded, the detection of promising candidates for special schools, finding human material for the best and quickest development of submarine listeners, of lookouts, and of gunpointers, all these were primarily psychological problems and the psychologists cooperated in their military solution. We had no military system developed to provide for these details. The enemy military authorities confidently regarded our lack of it as prohibiting effective participation in the war. The rapid development of a great fighting machine needed all our knowledge of human capacity and individual differences, and all our relevant laboratory techniques. Psychology took an honorable and not inconspicuous part in the democratic triumph of meeting a national crisis by the mobilization of the experience of non-military experts. To some of us it seems that we are again facing a national crisis in which the major symptoms are psychological. Again the enemy counts on our lack of organization. Our salvation depends on the re-mobilization of the expert experience of citizens.

Relation of psychology to the National Research Council: James R. Angell, A.M., Litt.D., chairman of the National Research Council, Washington (by invitation). The National Research Council is based upon forty or more scientific societies representing physics, astronomy, mathematics, engineering in all its branches, chemistry and chemical technology, geology and geography, medicine, biology and agriculture, anthropology and psychology. The council is organized to promote the interests of pure and applied science (both inside and outside the industries) in every practicable way throughout the United States. Its relation to psychology is precisely similar to its relation to the other sciences mentioned. In each instance, the supporting scientific societies elect representatives who compose the several divisions of the council, and these in turn, comprising as a rule about twenty men, selected for their eminence in their particular branch of work, come together and determine the special needs and opportunities for the improvement of research in their own fields. Special attention is paid to the possibilities of bringing about effective cooperation among research men and research agencies. Scientific investigation has hitherto been largely individualistic, and the most pressing need at the present moment is not so much the expansion of research agencies, although this is desirable, as the more effective employment of those already in existence. The Division of Psychology and Anthropology has formulated a number of cooperative projects, of which two may serve as illustrations. One of these has to do with the examination of the mental and physical characteristics of four important alien groups, *i. e.*, Mexicans, Scandinavians, Sicilians and Japanese. Some two thousand of each group are to be scientifically examined by the best modern methods. The result of this study ought, as regards these special races, to give us far more accurate and useful knowledge than we now have of the problem which confronts us in our present attempt to assimilate these racial stocks into our native American people. The other project contemplates an expedition to Central Africa in the upper regions of the Congo for a study of the same scientific sort upon the aboriginal natives who are still to be found there largely untouched by the influences of civilization. The expedition will be sent out under a psychologist who commands the languages of the regions, and with the methods at present available, scientific results may be expected of a character hitherto wholly impossible.

Psychological methods in business and industry: Beardsley Ruml, Ph.D., Philadelphia. (By invitation.)

The individual in education: Arthur J. Jones, Ph.D., professor of education, University of Pennsylvania. (By invitation.)

FRIDAY EVENING, APRIL 23

Reception from 8 to 11 o'clock in the hall of the Historical Society of Pennsylvania.

Robert Williams Wood, LL.D., professor of experimental physics, Johns Hopkins University, spoke on "Invisible light in war and peace" (with experimental illustrations).

Arthur W. Goodspeed

(*To be continued*)

SCIENCE

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The price of the paper on which SCIENCE is printed has increased to 16 cents a pound; five years ago it was 4⅛ cents. Within this period the cost of composition and press work has about doubled; the charges for binding and mailing have increased even more.

The subscription price of 'Nature' in England is now $10.50. It has been possible to supply SCIENCE at the present rates only on account of the advertisements. But advertising contracts are usually for a year, and the increases in the cost of printing and paper during 1920 have been such that the charges for most of the advertisements in the journal are now less than the actual cost of printing them. The rates have been increased for new contracts, but with continually increasing prices they now only about meet the cost of printing, except when preferred positions are purchased.

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The maintenance and improvement of SCIENCE are of importance for the advancement of science. Those men of science who will see that the journal is in all libraries and laboratories where it would be of service and who will read and use the advertising pages will assist the journal, while at the same time benefiting themselves and contributing to the conditions favoring scientific research.

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Lancaster, Pa. Garrison, N. Y.

SCIENCE

Friday, June 18, 1920

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE SURVIVAL OF THE UNLIKE[1]

Some years ago, studying the agaves or century plants of the West Indies, I found that they represent not only many species but numerous rather distinct groups, and that the aggregates of individuals that we call species, and of species in these larger groups, resemble and differ from one another in a sort of proportion to the depth of water between the islands on which they are found, which was translated into differences somewhat proportionate to the length of time that their habitats have been separated by water barriers.

Those of near-by and apparently rather recently separated islands were not found to differ progressively and adaptatively in a single character such as flower-shape or size of seed-vessels nor was there a correlated difference in these respects, but sometimes one and sometimes another such character was different, while no indication was evident that the plants were not living under essentially identical conditions so far as pollination and dissemination are concerned.

When the idea of organic evolution was presented before the Linnean Society in 1858 in a convincing way, by Darwin and Wallace, the latter spoke of the process as a survival of the fittest, and the former, as the result of natural selection, in the struggle for existence which effects kinds or species as well as individuals of living things.

The dissociation of parts of the ancestral stock of these West Indian agaves without any marked climatic difference in their homes appeared to me to have left each final island with a stock essentially in harmony with its environment and capable of deviating considerably in flower and fruit proportions from

[1] Address of the president before the Illinois Chapter of the Society of the Sigma Xi, May 19, 1920.

the parent type without derangement of this harmony. I was unable to see that either flower or fruit change within the observable limits rendered its possessor either better or less fitted to survive. Deviation from the type appeared to have followed some innate tendency and to have been possible in quite different directions within rather wide limits without rendering its possessor either more or less fit to survive. Within such limits, the changes of form seemed to have been free to wander at will along a number of differentiating paths.

These plants apparently illustrate the survival of the equally fit, though unlike, rather than of the fittest whether alike or dissimilar, under the operation of Darwin's selective process which would weed out promptly those not really fit to meet the general conditions of life, while permitting secondary differences to appear and persist for a very long time.

This is a rather self-evident presentation of one of the physiologist's exasperating troubles, the controlling existence of a harmonious optimum as he calls it, in conformity with which his cultures succeed best under conditions that sometimes differ annoyingly from those that he has reason to believe are the optima for the individual functions that he wishes to investigate experimentally one by one. It recalls forcibly, though not paralleling, the dominance of certain features in unskilfully made composite photographs. It parallels the transformation of that peculiar function, productive investigation, to the promotion of which the society of the Sigma Xi devotes its efforts. Conditions being collectively favorable, many differences that appear, whether fluctuating or mutant, represent variation rather than real evolution.

Apt in aphorisms, Bailey once hit on the expression survival of the unlike for that outcome of natural selection or the survival of the fittest to which the name evolution usually is applied. It calls up the picture of a changing or changed environment which eliminates the harmoniously fit of the past and allows their successors of the present to fight it out among themselves for the final perpetuation or disappearance of individual idiosyncrasies that they may have inherited or acquired.

The organic change may or may not be abrupt because the change in environment may or may not have been sudden: very commonly it appears to have been gradual. Its product may or may not please us. Except through the artificial selection that we apply in the broad field of agriculture, we have not intentionally changed the controlling conditions. The great response of organic nature is not conformed to our wishes or ideals but to that innate law of living matter that compels it to perpetuate itself and the forms through which it may best do this. The product is as varied in effectiveness as in form, but it tends to efficiency in peopling the earth and in making use of by-products and waste as well as of the raw materials offered by inorganic nature.

The lesson of organic evolution is at once discouraging and hopeful: discouraging as showing that the individual or the kind that can not keep to the gait must fall out of the procession; encouraging as showing that keeping the pace is not necessarily keeping in step; and hopeful in that as the world of dead matter changes, the world of living matter effectively shifts its life processes and vital machinery toward ultimate conformity to the great opportunity that is its own for the moment—a conformity which if perfect would eliminate finally disharmonies, and realize a perfect teleology of self-contained adaptation.

Even inert matter is coming more and more to evolutionary recognition, as its heavier elements are found to be older and more complex, their unaided combinations to tend into an instable complexity that approaches the surpassingly labile living matter, and their dissociated particles to gather through unmeasured space into solar systems perhaps all at some time as capable of supporting life as our own is known to be at present. The greatest law of nature seems to be that of spontaneous aggregation of matter into complex forms and of the shaping of these into efficient forms.

We are given now to naming our chosen activity—whether in science, literature, history or art—research, and the dictionaries permit each of us who cultivates it productively, to be spoken of as a researcher. I do not like the words: the second is not euphonious to my ear; and the first is too suggestive of the cyaniding of the tailings of an abandoned mine or of the sifting of what may be called variously a dust-bin or an ashpile. Unfortunately it is true that neither mining nor furnace management nor refuse collection is exhaustive, and re-search of their refuse must be made over and over again as values change or methods are improved. But I like to think of our profession as that of investigation and of our colleagues as investigators—trailing the truth wherever it must be sought—through the débris left by our predecessors when necessary, but by preference in the virgin field of nature.

This profession in its history parallels in many ways that of a phylum of plants or of animals. It has had its days of fruitless aimlessness; some of its products appear grotesque to us of to-day; some of its branchlets, like those of a cottonwood or an elm in autumn, have been cast off, perhaps to the benefit of the whole, when they did not continue to produce in proportion to their early promise or in comparison with others more favorably environed. Some, too favorably circumstanced, may even have been pruned out as unfruitful or destructive of a collectively effective balanced symmetry because of their rank vegetation. Natural and artificial selection have worked on it since its beginning, and there is little reason to suppose that they will not continue operative until its end.

The parallel may be carried somewhat further than one would carry it at first thought.

Long before man began to find the products of organic nature profitable—indeed long before his appearance on the scene—plants had developed the power of making food and of applying it to their needs; and animals had acquired the habit of carrying its use into a much more dynamic field. The greatest tilth of this field is by man, the present culmination of the family tree of our living world; and what the struggle for existence among his more lowly relatives had produced, that he could use, he has selected and favored and modified to his greater benefit.

The strife between purposeful intelligence and productive capability, in which within limits the former is fore-ordained to dominate the latter, is not peculiar to human civilization and to the dominance of man over man: it reaches far into his relations with his fellow-creatures of lesser endowment. He has shaped them to his needs or fancies, very often in opposition to the selective law of nature; he has multiplied, at the expense of others, those that he fancied, and thereby has increased the power of the earth to support human life and human activity far beyond its unaided capacity; he has become a potent factor in natural selection, and will continue operative as long as he does not kill the goose that lays the golden egg. It is significant that what he does not use, directly or indirectly, he commonly permits to exist through indolence or impotence rather than tolerance.

He knows that what he calls vermin are troublesome if not injurious. He protects himself and what he considers his property against them more or less consistently and completely; but in proportion to their power to evolve helpfully in harmony with conditions of life in the chinks and crannies of the world into which he can not or does not follow them, they escape and thrive not only despite him but at his expense and literally on him. The rat is his uninvited guest the world over, and the gray rat, if he were worshipful and learned, would render daily thanks to the patron who has made him the rat of rats, transporting, housing and feeding him to an almost unbelievable extent. Rust, smut, mildew, and fermentative germ thrive under his régime; the world population of codling moth and chinch bug has enlarged a myriadfold through the ability of these self-seeking creatures to get forward as riders on man's own self-seeking progress.

Perhaps in this survival and increase of parasites and other vermin lies the token that the earth and the fulness thereof are not to man; for if the Nature whose product he is permits his enemies to thrive and multiply notwithstanding his effort to protect himself, she gives in this permission a strong suggestion that his power is only an expression of her own power, and that while he sleeps and relaxes effort her activity continues unabated along the line of peopling the earth toward its full capacity with a million forms of creatures to each one of which she offers the same fundamental problem as his own—perpetuation of the individual and of its kind, or restriction and disappearance, according to its fitness and adaptability under the conditions of the moment.

We owe the privilege of wearing the key of the Sigma Xi to the fact that at some time or other each one of us has been recognized by investigators as something of a zealot in their own field, giving promise or bearing the first fruits of his own investigation. In our turn, we welcome to companionship the brothers of a newer day.

Most of us enter this fellowship from the novitiate of university life under guidance and supervision. The founders of the society, themselves, had achieved in college or professional school the qualifications that they prescribe for membership. Their forerunners in investigation through the centuries, for the most part had traveled the same route. Our organization is represented in laboratories rather than in the halls of classic learning.

Those of us who have been connected with the society very long have no difficulty in calling to mind a number of men of our own or an earlier or a later generation, whose lot has not been cast in with the university or the college, but who in purposeful prying into science have shown the zeal that our society stimulates and who in productive and stimulating accomplishments may have surpassed us of seemingly greater opportunity. Those who initiated the inquiry into nature out of which such enormous knowledge and utility have poured into the lives of men within the last few generations, trained themselves or founded the schools in which others have been trained. Their zeal and industry and wisdom were the attributes of the highest human mentality: often, but unfortunately not always, infectious; exceptionally, and this happily, of such quality as to confer immunization on those who came into closest contact with them.

Like other forms of human social development, the specialization of investigators offers many parallels to the specialization of organs and of organisms in nature. Its beginnings were very individualistic and sporadic. Its spread was limited by the natural barriers of sea and mountain, and the quite human obstacles of differing race and language. Investigation usually has meant not a road leading to a successful career—as the animal success of man is measured, but a bypath more often leading to poverty and misunderstanding, and usually at best a way that could not be traveled safely very far from the beaten path of approved and utilized learning. My own university mentor, Farlow, like his great leader, Asa Gray, studied in the practical field of medicine so that he might be assured of the privilege of wandering—nobody could tell how far—into investigation apart from its immediate application in a necessary art.

No doubt it is true that to some investigators the thought that no practical application could be made of their discoveries has lent added fascination to their work. No doubt to others an investigation undertaken with the purpose of securing the answer to an economic question still lacks in attractiveness. The greatest incentive to such work has been an innate thirst for knowledge for its own sake and a love of its pursuit.

Even with the multiplication and broadening and deepening of universities that the last generation has witnessed, the privilege of adding to knowledge, of shaping something up by one's own effort, has resided very largely in the opportunity offered by a university chair for stealing a little time and a little effort from the first and paramount duty of the professor, teaching what is known already and training adaptable minds to meet life's needs.

Even to-day and among our own friends are to be found men who fail to see that the university that we know not only watches with some care over teaching schedules so that the man who wishes to follow productive lines in his scholarship may not find that he has no time left for this after completing his prescribed task as a teacher, and who fail to comprehend that one is misplaced in a true university if he can merely retail what others have made known.

As yet, most of us who have been judged worthy of membership in the society of the Sigma Xi have acquired our status as investigators as a byproduct of our opportunity as teachers; for what are called research professors are few and far between, and organizations for investigation only are none too common. We find encouragement in the stimulating fraternal association. We touch at a tangent the productive activities of colleagues in our own department or in related departments. We lay our little offerings before local or state or national gathering of our confreres, and come home with suggestions for bettering and amplifying our own activities. We get what we may out of an undigested and heterogeneous program, and give little thought to the assimilability in it of what we contribute to it.

We are individualistic to a surprisingly large degree. As a rule we are generous to a fault with what we have to offer to others and as a rule we are not greedy in seizing on such help as they offer to give to us; above all we are not markedly seekers after advice or direction. We enjoy the prerogatives of the present, but cling to the methods of the past.

From the time when learning awoke after the world's long sleep, when civilization began really to have meaning outside of very restricted circles, the occupation that has become our profession has resembled my Antillean century plants in following its inherent bent. The conditions of its environment have presented an increasingly harmonious optimum for its simple existence, with neither serious competition nor any great obstacle interposed anywhere to its drift along the lines of least resistance—or in this case of greatest attractiveness. That conditions have changed is evident enough, but they have changed gradually and the changes have been in favoring directions.

The aggregate utility of what is called research had led, even, to its sedulous cultivation in a limited way: but even under cultivation it has shown few mutations unfitting it for continued existence if once more thrown over to the unrestricted action of natural selection. It has scarcely become domesticated. Its survival and increase have been of the fit rather than of the fittest, where change about us has been gradual and of degree rather than of kind, and where neglect rather than encouragement have favored it. It has resembled the wayside weed doing too little harm to be worth repression, and more or less useful for fodder or bedding-down when the trouble was taken to harvest its produce.

Almost suddenly we are confronted with totally different environing conditions. The last decade has seen an interest in scientific investigation that was unknown before. The period of the war has brought its real value to recognition. The harmless weed has been seized on as most promising for intensive cultivation. Its natural attributes are being selected and blended with a skill such as the agriculturist uses in bettering his crops and his stock. Its maximum development is favored by a more or less serious effort to remove or reduce disturbing competitors. The stigma that science, the organizer of knowledge, has not organized itself seems about to be removed.

"Tempora mutantur, et nos, in illis." The almost catastrophic changes that the last few years have brought into the human world is placing scientific research on a business basis. It is not too much to expect great things from its effective organization as a means to an end: or to expect it to yield quickly in orderly controlled team play results that individual fatuous effort could bring about slowly and disconnectedly if at all.

Is science capable of transplantation and cultivation under artificial conditions? If so, the product will differ from the original in kind as well as in degree quite as much as the highly specialized animals and plants of the farm do from their undomesticated prototypes. If so, its nature will have shown a plasticity to be looked for in nature hardly elsewhere than in the outgrowth of human intelligence.

Transplantation is actually at work. The investigating manpower of the world is being registered with startling rapidity, preliminary to preferred enrollment or selective conscription. There is scarcely a person here present who will not feel its force within a few years if the signs of the times are to be trusted. To the organizer, it promises new and enlarged opportunity for leadership. To the drudge it holds opportunity for the kind of shoulder-to-shoulder effort before which mountains crumble and the bowels of the earth yield up their secrets; but the drudge by birth is a rara avis among men moved by the real spirit of investigation, and the drudge from necessity is neither a happy nor always a profitable artefact.

That the new order will survive is almost certain. That its survival will be through artificial rather than natural selection is probable. That it will be a survival of the unlike is self-evident.

That waifs and escapes from it will be found outside the cultivated fields is to be expected. Whether these shall profit the gleaner like strays of wheat, or foul the fleece like the carrots of the roadside, or prove all but baneful like the reverting parsnip, remains to be proved. In any event, if not destroyed, they may be counted on through the centuries to furnish vestiges of the old and primitive stock as rudiments for a new start when, if ever, the cultivation of research is abandoned—provided that the present cultivation is not so intensive as to destroy them utterly.

In the primitive desultory gratification of human interest in human environment lies the essence of investigation for investigation's own sake. The amateur in science has entered, occupied uncontested the center, and is passing from the scene.

The largest creel of fish may be secured by seining or dynamiting or drugging the pool; and the largest bag of birds, by the skilful use of a net on a drizzly day. The market, unless glutted, will pay for the haul. But the sportsman does not wish to become a pothunter, and the naturalist knows that game must be protected to a reasonable extent if fishing and hunting are to continue and if sportsmanship is to endure. Forest and mine are most attractively exploited by organized onslaughts that take what it pays to take and sometimes leave a wake of destruction behind. The profit of the day is great, the rapid material progress to which it contributes is held to justify the attack: but what of the future?

Organization of attacks on the secrets of nature differ from organization of attacks on the material products of nature in this very essential respect, that the former do not destroy but rather bring the world's material resources to more effective and economic utilization. But is such purposeful organization likely to hamper or put an end to unorganized though purposeful and intelligent investigation? Is the seiner likely to foul the pool or barricade it against the sportsman?

Organization backed by a probable profit and loss sheet and a program for each enterprise—once called a proposition, and now a project—enlists capital in business. Such organization and reinforcement are enlisting already, for research, capital looking to ultimate return, and also impersonal endowment because of the established repute of science as conducing to the general welfare of man.

To the investigator, investigation may become a renumerative profession when he bears his alloted share in cooperative effort. For the most part, up to the present he has paid amply for the privilege of doing such work; and to enjoy the privilege of doing it even on these terms he has rather gratefully if sometimes complainingly sold his services as a teacher at a ridiculously low figure when measured by his training and talent.

He has done and is doing this under the spur of that most intangible but most essential trait of man that we call character, and because of those chimæras of the mind of man that we call ideals. Is he sanely enough balanced to conform his ideals to the trend of the times, to the chance for subordinating them to the broader plans of leadership; or are ideals never ideals when his own mind does not shape them, when from sport—which one pays for, they become work—for which one is paid? And if the zealot who can not modify his view still continues in our midst, as he must, is he to be weeded out; or allowed on sufferance to occupy the waste places of research; or to be kept purposefully from extermination, against a day when the nourishing hand of society may be withdrawn, and zeal in research again becomes synonymous with its primal meaning—devotion with all one's character to one's inborn ideal?

As we, the professionals in science who follow the amateur on to the stage, find ourselves marshalled in the ranks or leading the artisans of science, it may be well to remember that a Galileo, a Newton, a Berzelius and a Darwin lived and worked—not in vain—before the day of organization and intensive team work had dawned!

William Trelease
The University of Illinois

THE STRUCTURE OF THE HELIUM ATOM

Acccording to the model which Bohr proposed in 1913, the helium atom consists of two electrons moving in a single circular orbit having the nucleus at its center. The electrons remain at the opposite ends of a diameter and thus rotate in the same direction about the nucleus. The angular momentum of each electron is assumed to be $h/2\pi$, where h is the quantum constant. The ionizing potential of helium calculated by this theory is 28.8 volts. Recent experimental determinations by Franck and Knipping have given 25.4 ± 0.25 volts. Bohr's theory is approximately right but does not give the true structure.

For the hydrogen atom and helium ion, atoms containing but a single electron, Bohr's theory seems to be rigorously correct. For atoms containing more than one electron there are many facts which indicate that modifications or extensions are needed.

The chemical properties of the elements, particularly the periodic relationships and the phenomena of valence, have shown definitely that the electrons are not in general arranged in coplanar orbits. According to the theory which I advanced last year, the electrons in their most stable arrangements move only within certain limited regions about the nucleus, each of these cells containing not more than two electrons. The atoms of the inert gases were found to have their cells arranged symmetrically with respect to an equatorial plane, no electrons however ever lying in this plane. According to this view, the two electrons in the helium atom should not move in the same orbit but in separate orbits symmetrically located with respect to the equatorial plane. The two electrons in the hydrogen molecule (and in every pair of electrons which acts as a chemical bond between atoms) must be related to one another in the same way as those of the helium atom.

The most obvious model of this type is one in which the two electrons move in two circular orbits in parallel planes equidistant from the nucleus. By properly choosing the diameters of the orbits, the force of repulsion between the electrons is compensated by the component of the attractive force of the nucleus perpendicular to the plane. This model however proves impossible as it gives a negative value (— 5.8 volts) for the ionizing potential.

A. Landé[1] has recently proposed a model for the eight electrons of an octet in which each electron occupies a cell bounded by octants of a spherical surface. The eight electrons move in such a way that their positions are symmetrically placed with re-

[1] *Verh. d. phys. Ges.*, 21, 653, October, 1919.

spect to three mutually perpendicular planes which pass through the nucleus. When one electron approaches one of these planes it is retarded by the repulsion of the electron on the other side of the plane and is thus prevented from passing through the plane. Although each electron remains within a given octant of the spherical region about the nucleus, yet the momentum of the electron is transferred to the electrons in adjacent cells across the cell boundaries. In this model the momentum travels continuously around the atom in a circular path, being relayed from electron to electron. Thus even though the electrons do not leave their respective cells, the mathematical equations for their motion are very closely related to those which apply to the motions of electrons in circular orbits about the nucleus. Landé's calculations lead to the conclusions that this type of motion is less stable than one in which all eight electrons move in a single plane orbit. This objection can be overcome if we assume that the angular momentum of each electron is $h/2\pi$ instead of the double value which is usually assumed for the electrons in the second shell. In fact, this conception gives grounds for believing that all electrons in their most stable positions in atoms, have orbits corresponding to single quanta and it is only because we have assumed coplanar orbits that we have been led to the conclusion that the outer orbits correspond to increasing numbers of quanta.

This model of Landé's has suggested to me that there should be a similar interrelationship between the two electrons of the helium atom, and also of the hydrogen molecule, and of the pair of electrons constituting the chemical bond.

I assume that the two electrons have no velocity components perpendicular to the plane which passes through the nucleus and the two electrons. The motion is thus confined to a single plane. The two electrons, however, are assumed to rotate about the nucleus in *opposite* directions, and in such a way they are always located symmetrically with respect to a line passing through the nucleus. Consider for example that this line of symmetry is horizontal and that one electron is located directly above the nucleus at a unit distance, and is moving horizontally to the right. Then the other electron will be located at an equal distance below the nucleus and will move in the same direction and with the same velocity. If there were no forces of repulsion between the two electrons, and if we choose the proper velocities, it is clear that the two electrons might move in a single circular orbit about the nucleus, but in opposite directions of rotation. This would require, however, that the electrons should pass through each other twice in each complete revolution. When we take into account the mutual repulsion of the electrons, we see that their initial velocities will suffice to carry them only within a certain distance of each other, and they will then tend to return in the general direction from which they came. With properly chosen initial conditions the electrons will return back exactly on the paths in which they advanced and will then pass over (towards the left) to the other side of the nucleus and complete the second half of an oscillation. Each electron has its own orbit which never crosses the line of symmetry. The orbit however does not consist of a closed curve, but a curved line of finite length along which the electron oscillates.

Unfortunately the equations of motion for this three-body problem are difficult to handle and I have only been able to determine the motion by laborious numerical calculations involving a series of approximations. These however, can be carried to any desired degree of accuracy. By four approximations I have been able to calculate the path and the velocities, etc., to within about one tenth per cent. It is to be hoped that a general solution of this special type of three-body problem may be worked out, if indeed one is not already known to those more familar with this type of problem.

The results of this calculation show that the path of each electron is very nearly an arc of an eccentric circle, extending 77° 58′ each way from the mid-point (as measured from the nucleus). If we take the radius vector at the mid-point to be unity then the radius at the end of the arc is 1.138. The angular velocity of the electron at the mid-point of the path is such that if it continued with this velocity it would travel through 105° 23′ during the time that it actually takes to move to the end of its orbit (*i. e.*, through 77° 58′).

By imposing the quantum condition that the angular momentum of each electron at the mid-point of its path shall be $h/2\pi$, it becomes possible to calculate the radius vector and the velocity in absolute units. The radius vector for the electron at its mid-point is 0.2534×10^{-8} cm. which is 0.8359 of the radius of the orbit of Bohr's model (0.3031×10^{-8} cm.). Even at the end of the orbit the radius (0.2882×10^{-8} cm.) is less than that of the Bohr model. The angular velocity at the mid-point is 1.431 times that of electrons of the Bohr atom. The number of complete oscillations per second is 24.63×10^{15}, which is 1.222 times as great as the number of revolutions in the Bohr atom (20.16×10^{15} per second). The total energy (kinetic plus potential) of the oscillating atom is 0.9615 of that of the Bohr atom. The ionizing potential of helium according to the new model should be 25.59 volts which agrees with Franck and Knipping's experimental determination within the limits of error given by them, but differs from the 28.8 volts given by Bohr's theory by nearly ten times the experimental error.

The oscillating model is thus not only satisfactory from a chemical point of view but is in quantitative agreement with the properties of helium. The fact that there can be no corresponding structure with three electrons is in accord with the fact that lithium (which has three electrons) is an element having totally different properties from helium.

The calculation for the hydrogen molecule involves greater difficulties. Bohr's model with the two electrons moving in a single circular orbit gives a heat of dissociation of about 63,000 calories, whereas experiment gives about 90,000. The calculations for helium have shown that the radius of the oscillating atom is considerably smaller than that of the Bohr atom, so that the force of attraction between the electrons and the nucleus is much (20 per cent. or more) greater. In the hydrogen molecule this increased force may result in drawing the two nuclei closer together thus increasing the stability of the molecule. Calculations of the orbits of the electrons in the hydrogen molecule are in progress.

The final results with a description of the methods of calculation will be published probably in the *Physical Review* and the *Journal of the American Chemical Society.*

IRVING LANGMUIR
RESEARCH LABORATORY OF THE
GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y.,
June 5, 1920

ALFRED WERNER[1]

ALFRED WERNER, professor of chemistry in the University of Zurich, died on November 15, 1919, at Zurich, Switzerland.

Professor Werner was elected an honorary member of the American Chemical Society at the general meeting held in New Orleans, La., April 1, 1915. It is now desired to leave upon the permanent records of this society a tribute to his genius and indomitable energy, and to the wealth of the contributions which he made to our science.

Born at Mulhausen in Alsace on December 12, 1866, he was educated at the technical schools of Mulhausen, Karlsruhe, and Zurich. Later he studied with Berthelot at Paris.

His first published work of note was upon the stereoisomerism of organic compounds containing nitrogen. Applying these theories to the unclassified mass of complex inorganic ammonia compounds, he realized the inadequacy of accepted ideas of valence to explain their constitution. Largely from a study of isomers among these complexes, whose consti-

[1] Tribute prepared by a committee of the American Chemical Society consisting of C. H. Herty, H. L. Wells and Arthur B. Lamb.

tution could be explained only on a basis of stereoisomerism, he developed an extension of the valence hypothesis and introduced the concept "coordination number" of elements.

This conception was the stimulating cause of a great mass of researches which embodied the discovery of many new compounds, many new examples of isomerism, brought rational classification into the whole field of complex inorganic compounds and led by logical development of theoretical views to the discovery of optically active inorganic compounds. None realized more clearly than he that in his extension of the valence hypothesis he had not reached any ultimate truth but had merely added one definite stepping stone.

To the little laboratory in Zurich, with its all too limited equipment, he attracted students from every part of the world. Eventually adequate funds were placed at his disposal, with which was constructed one of the model laboratories of Europe. His fear at the time was that he might not be able to carry into the commodious new quarters the spirit which had permeated the old laboratory. This fear was groundless, as the character of the researches from the new laboratory abundantly proved.

In 1912 Professor Werner was LeBlanc Medallist of the Société Chemique de France. In 1915 he was elected an honorary member of the Chemical Society (London) and in the same year was awarded the Nobel Prize in Chemistry.

An indefatigable seeker after truth has gone to his rest. The example of his life remains a constant inspiration.

SCIENTIFIC EVENTS

THE UNITED STATES COAST AND GEODETIC SURVEY AND RECENT CONGRESSIONAL LEGISLATION

During the past session of Congress, the U. S. Coast and Geodetic Survey was benefited by provisions in three bills.

In the act making appropriations for the naval service for the fiscal year ending June 30, 1921, it is provided "That the superintendent of the Coast and Geodetic Survey shall have the relative rank, pay and emoluments of a captain in the navy, and that hereafter he shall be appointed by the president, by and with the consent of the senate, from the list of commissioned officers of the Coast and Geodetic Survey not below the relative rank of commander for a term of four years, and he may be reappointed for further periods of four years each.

In the act making appropriations for the sundry civil expenses of the government for the fiscal year ending June 30, 1921, it is provided "That the title of 'superintendent' of the United States Coast and Geodetic Survey is hereby changed to 'director,' but this change shall not affect the status of the present incumbent or require his reappointment, provided further that the secretary of commerce may designate one of the hydrographic and geodetic engineers to act as assistant director."

The third act which contains legislation affecting the commissioned personnel of the Coast and Geodetic Survey is one entitled, "An act to increase the efficiency of the commissioned and enlisted personnel of the Army, Navy, Marine Corps, Coast Guard, Coast and Geodetic Survey, and the Public Health Service, through the temporary provision of bonuses or increased compensation." This act provides for certain increases in salary for all commissioned officers varying in amount from \$480 to \$840 per annum. It contains the following provision affecting the commissioned force of the Coast and Geodetic Survey:

> That in lieu of compensation now prescribed by law, commissioned officers of the Coast and Geodetic Survey shall receive the same pay and allowances as now are or hereafter may be prescribed for officers of the Navy with whom they hold relative rank as prescribed in the act of May 22, 1917, entitled, "An act to temporarily increase the commissioned and warrant and enlisted strength of the Navy and Marine Corps, and for other purposes," including longevity; and all laws relating to the retirement of commissioned officers of the Navy shall hereafter apply to commissioned officers of the Coast and Geodetic Survey; *Provided*, That hereafter longevity pay for officers in the Army,

Navy, Marine Corps, Coast Guard, Public Health Service and Coast and Geodetic Survey shall be based on the total of all service in any or all of said services.

This law makes a substantial increase in the pay and allowances of the commissioned personnel of the Coast and Geodetic Survey who hold relative rank from second lieutenant to colonel in the army and from ensign to captain in the navy. The commissioned personnnel of the Surveys will also be greatly benefited by the retirement clause of this act. The salary scale for the commissioned personnel of the survey had previously been so inadequate that it was impossible to secure applicants for the vacant positions. This is shown by the fact that there are to-day about 40 vacancies in the commissioned force of 140. This has been increased to 50 by the retirement of ten officers who have reached the retirement age. In the future the pay and allowances of the lowest commissioned grade will be about $2,500 per annum. Appointments to this grade will be made from the grades of junior engineer and deck officer, the entrance positions. Six months' experience in the lowest grade is necessary before promotion to the commissioned personnel.

The U. S. Civil Service Commission will shortly announce an examination to be held about the middle of July from which to secure eligibles to fill the entering positions.

THE ROCKEFELLER FOUNDATIONS ENDOWMENT OF UNIVERSITY COLLEGE, LONDON

THE Rockefeller Foundation has offered to give about $6,000,000 to University College, London, and its hospital. Dr. George E. Vincent has issued a statement in which he says:

Since the Rockefeller Foundation is cooperating with governments in many parts of the British Empire it recognizes the importance of aiding medical education in London, where the training of personnel and the setting of standards for health work throughout the empire are so largely centered.

The University College and Hospital School have been selected because of the physical unity of the hospital and medical school buildings and the close relationships existing between the University College, which provides the laboratory courses, and the University College Hospital and Medical School, which furnishes clinical teaching.

The college and school are fortunate in having assembled a group of able men who are deeply interested in teaching and research. E. H. Starling and William M. Bayliss, physiologists, and G. Elliot Smith, anatomist, are scientists of distinction, while T. R. Elliott, G. Blanker Thomas Lewis, Sir John Bradford, C. C. Choyce, H. R. Kenwood, H. Betty Shaw and Sydney Martin are clinicians of recognized standing.

The authorities of the schools, supported heartily by the faculty, have organized full-time clinical "units" in such a way as to combine the care of patients and research with the teaching of students. This feature of the work especially influenced the foundation to decide to assist in furthering a plan which it is believed will have an important effect upon the development of British medicine.

The building program for which £590,000 have been appropriated will include an institute of anatomy comparable with any in the United States. A new home for nurses, new quarters for resident physicians, a biochemical building, laboratory facilities in close connection with hospital wards, the remodeling of a hospital with the addition of twenty beds, and a new obstetrical unit with a capacity of sixty patients. These additions will provide a total of 500 beds.

It is proposed to increase the annual expenditures by the approximately £50,000, of which the foundation will provide endowment to produce an income of £30,000. This additional maintenance will be expended upon a new staff in anatomy, an increase in the staff of physiology, the provision of a full-time unit in obstetrics and various items of increased laboratory and clinical service throughout the institutions concerned. It is believed that the obstetrical unit plan offers prospects of a success which will be of value to the entire world. The subject now in England, as elsewhere, is poorly taught and needs reorganization under improved conditions.

The foundation has a special interest in the proposed Institute of Anatomy because thus far under British auspices a true university department which combines both teachings and research in the fields of anatomy, histology and embryology has not been developed. It is believed that such an institute, by unified efforts in these three branches of anatomy, is of prime importance not only to the teaching of the medical student but also for the progress of anatomy, particularly on its research side.

GIFTS TO UNIVERSITIES AND COLLEGES

Trustees of the General Education Board and of the Rockefeller Foundation announce appropriations of $20,251,900 for various purposes of general education and for the development of medical schools. The statement of the trustees is as follows:

For appropriations from the fund of $50,000,000 which Mr. Rockefeller gave last December nearly 250 institutions have made application to the General Education Board. A careful statistical inquiry shows that in order to raise the level of salaries in a sufficiently large number of these institutions, to a degree somewhat commensurate with increased cost of living, their endowment funds would have to be increased by from $150,000,000 to $200,000,000.

It is evident that to accomplish this result the $50,000,000 in the hands of the board will have to be supplemented by funds from other sources in the ratio of two or three to one. This has been kept in mind in making appropriations which have been made contingent upon the raising of additional amounts.

At the recent meeting appropriations were made to ninety-eight colleges and universities out of those which are under consideration. To this group of institutions the General Education Board appropriated for endowment to increase salaries the sum of $12,851,666 on condition that they would themselves reach the goal they had set and secure for the same purpose supplementary sums aggregating $30,613,334. Thus, these colleges and universities if successful will increase their endowments available for teachers' salaries to the extent of $43,465,000.

In a few cases institutions are not asking for endowment funds but only for temporary contributions toward a certain total annual subscription which it is hoped later to fund permanently. The board has made a number of such appropriations on a two- or three-year basis.

For these purposes an additional sum of $2,184,384 was appropriated covering a period of one to three years, making a total appropriation by the general education board from Mr. Rockefeller's special gift of $15,036,050.

In the following list appropriations to medical schools in the United States were made by the General Education Board, while those to institutions in Brussels and Halifax were voted by the Rockefeller Foundation.

Washington University Medical School, St. Louis—For endowment, $1,250,000; for additional laboratory facilities and equipment, $70,000.

Yale Medical School—For endowment (toward a total of $3,000,000), $1,000,000.

Harvard Medical School—For improved facilities in obstetrics, $300,000; for the development of teaching in psychiatry, $350,000.

Johns Hopkins Medical School—For development of a new department of pathology (toward a total of $600,000) $40,000.

Dalhousie University Medical School, Halifax—For buildings and equipment, $400,000. For endowments, $100,000.

Medical Research Foundation of Elizabeth, Queen of the Belgians, Brussels—For general purposes of medical research, 1,000,000 francs.

ENDOWMENT OF THE MEDICAL SCHOOL OF THE UNIVERSITY OF ROCHESTER

Mr. George Eastman and the General Education Board have given the University of Rochester $9,000,000 for a school of medicine, surgery and dentistry. In connection with it the Rochester Dental Dispensary, an institution recently built and endowed by Mr. Eastman, will furnish the clinic for the study of dentistry, at the same time continuing its present work in caring for the teeth of children. The details of the endowment were announced at Rochester on June 12, by Dr. Rush Rhees, president of the university; Dr. Abraham Flexner, secretary of the General Education Board, and Mr. Eastman, head of the Kodak industry, at a meeting of the trustees of the university, dispensary and local hospitals and other persons directly interested. Of the $9,000,000 the General Education Board gives $5,000,000 and Mr. Eastman $4,000,000. This is in addition to the dispensary which with its endowment is valued at $1,500,000. The most modern laboratories for anatomy, physiology and pathology and a 250-bed teaching hospital are to be constructed.

SCIENTIFIC NOTES AND NEWS

New York University has conferred the doctorate of laws on Dr. William H. Nichols, president of the General Chemical Company of New York, and recently president of the American Chemical Society.

The University of Maine has conferred the Ph.D. on Dr. Lamson Scribner, of the United States Department of Agriculture.

The University of Arizona has conferred the degree of doctor of laws on Thomas Henry Kearney, of the U. S. Department of Agriculture, in recognition of his work in the breeding of Egyptian long-staple cotton at the Sacaton Station in Arizona. Here he and his colaborers isolated the first plant of the Pima variety of cotton, so well adapted to the southwestern region, propagated it to the extent necessary to make commercial plantings, and are still occupied in producing a large amount of absolutely pure seed each year. The Pima cotton crop of Arizona was worth approximately $20,000,000 in 1919.

The honorary degree of doctor of science was conferred upon George N. Hoffer, of the U. S. Department of Agriculture, by Lebanon Valley College, at their fifty-fourth annual commencement exercises, in recognition of his contribution to our knowledge of cereal diseases. Dr. Hoffer graduated from Lebanon Valley in 1909 and is at present working at the experiment station at Purdue University.

During a visit to Millbank Hospital on June 8, King George bestowed on Major General William C. Gorgas, former surgeon general of the United States army, the insignia of Knight Commander of the Order of St. Michael and St. George. General Gorgas was a patient in Queen Alexandra's Nursing Home for Officers.

The president of the French republic has conferred the honor of Officer of the Legion of Honor on Dr. Aldo Castellani, of the London School of Tropical Medicine, for his method of combined typhoid-paratyphoid and enteric-cholera vaccination.

At the end of the present academic year Professor Frederic S. Lee retires, at his own request, from the directorship of the department of physiology of Columbia University, and hereafter he will occupy a research professorship. He sails for Europe early in July and expects to spend the coming year abroad.

Mr. G. W. Morey, of the Geophysical Laboratory, Carnegie Institution of Washington, who has been on leave of absence and in charge of the optical glass plant of the Spencer Lens Company of Buffalo, New York, since November, 1918, has returned to resume his research work at the laboratory.

Professor Charles Baskerville, in recognition of his investigations on inhalation anesthetics, has been elected a member of the research committee of the National Anesthesia Research Society.

At the St. Louis meeting of the American Chemical Society a communication was presented from Dr. W. F. Hillebrand regarding the apparently organized thefts of platinum ware that are taking place throughout the United States, with the suggestion that a committee be appointed to consider whether or not legislation might not be recommended to Congress which would assist in controlling the matter. The council voted that such a committee be appointed, and the president appointed R. B. Moore, of the Bureau of Mines, Washington, D. C., Chas. H. Kerk, of J. F. Bishop & Company, Malvern, Pa., and Geo. F. Kunz, of Tiffany & Company.

Sir Humphrey D. Rolleston, Royal College of Physicians of London; Colonel H. J. Waring, Royal College of Surgeons of London; Dr. Norman Walker, Royal College of Physicians and Royal College of Surgeons of Edinburg and the Royal Faculty of Medicine and Surgery of Glasgow, and Professors Gustave Roussy and E. E. Desmarest, of the University of Paris, were present at the meeting of the American Medical Association at New Orleans and have been visiting the leading medical centers of the country. They are the guests of the National Board of Medical Examiners of the United States.

Dr. W. C. Phalen, formerly geologist in the U. S. Geological Survey and mineral technologist in the Bureau of Mines, has been engaged as geologist by the Solvay Process Company with headquarters at Syracuse, N. Y.

A meeting of the New York Section of the Société de Chimie Industrielle was held at Rumford Hall, on the evening of May 14. The following officers were elected: *President,* Marston T. Bogert; *Vice-president,* J. Enrique Zanetti; *Treasurer,* J. V. N. Dorr; *Secretary,* Charles A. Doremus; *Council,* Jerome Alexander, L. H. Baekeland, Charles Baskerville, Henri Blum, Charles F. Chandler, René Engel, Georges de Geofroy, Ellwood Hendrick, Charles H. Herty, George F. Kunz, W. H. Nichols, G. E. Valabrègue. The meeting was addressed by M. Maurice Casenave, minister plenipotentiary, director-general of French Services in the United States on "Commercial relations between France and the United States," and by Mr. Joseph H. Choate, general counsel of the Chemical Foundation, Inc., on "Conditions of the chemical industry in the United States before the war."

Dr. L. Hektoen, of the John McCormick Institute for Infectious Diseases, Chicago, delivered the Noble Wiley Jones lectures of the University of Oregon, on May 31 and June 2, the subject of the first lecture being "Old and new knowledge of humidity" and of the second "Phases of streptococcus infection."

Dr. W. Van Bemmelen, director of the Magnetic and Meteorological Observatory of Batavia, delivered an address on "The volcanoes of Java," before the Washington Academy of Sciences on June 15.

On May 24, 1920, a statue of Edward Van Beneden was unveiled at Liège, Belgium, with appropriate exercises. Dr. Robert W. Hegner, of the school of hygiene and public health of the Johns Hopkins University, acted as the American representative on this occasion.

In the issue of Science of April 23 it was stated that the family of Mr. Henry Phipps had given $500,000 to the Henry Phipps Institute of the University of Pennsylvania for the study of tuberculosis. We are requested to state that this sum is given contingent on the raising of a total of $3,000,000 for the endowment of the institute.

Dr. J. Lunell, physician and botanist at Leeds, N. D., since 1894, has died. Dr. Lunell was an enthusiastic botanist and published a number of articles on North Dakota plants, the most extensive of these is the Catalogue of the Vascular Plants which was noted in this journal for November 1, 1918.

The tenth season of the Marine Laboratory of Pomona College will begin June 24, at Laguna Beach, Orange county, California. There will be several courses in general biology and general zoology. There are opportunities for special work, and eight private laboratories are reserved for investigators.

The publication committee of the Zoological Society, London, has issued a notice calling the attention of those who propose to offer papers to the great increase in the cost of paper and printing. This, it is stated, will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Dr. Cornelius Betten, for the past five years secretary of the New York State College of Agriculture, has just been made vice-dean of resident instruction, the appointment to take effect July 1, 1920. Dr. Betten is a graduate of Cornell, of the class of 1906, where he was fellow in entomology. After graduation he went to Lake Forest College at Lake Forest, Illinois, where he was professor of biology and head of the department. In 1915, he returned to his alma mater as secretary of the college of agriculture. Under authorization of recent legislation for the college of agriculture, provision is made for three vice-deans or directors; a vice-dean of the college, a vice-director of extension, and a vice-director of the experiment station. The faculty of the college was asked to make nominations, and Dr. Betten was practically selected by his associates, the actual appointment by the trustees of the university being a ratification of the faculty's choice. Professor M. C. Burritt has been for some time vice-director of extension. The vice-director of experiment stations still remains to be chosen. Under the present plan, Dean A. R. Mann has the aid of three vice-officers as executives in the three main branches of the work of the college; resident instruction, extension, and research.

THE geological department of the New York State Museum will send into the field this year a considerable corps of workers for the purpose of collecting the fossil terrestrial plants of the Devonian Period. The collections of the museum are already very rich in such plant material, but it has all been acquired incidentally to the study of the fossil faunas of the state, and the reports of the museum have given inadequate attention to this important field. The physical conditions under which the Late Devonian deposits were laid down in New York were distinctly favorable to the accumulation of terrestrial plants in the shallow water offshore sands and shales, and it was said by Sir William Dawson that the state museum possessed a more extensive representation of this early land flora than was to be found elsewhere. The standing tree ferns found many years ago in the sands of Schoharie county and which are exhibited in the museum, are the oldest representatives of a terrestrial forest growing in place; the unique Archeosigillaria, 18 feet in length, is another extraordinary plant from this flora and these striking objects, supplemented by much unstudied material, give promise that the field may be opened to a more adequate knowledge of the first great land flora of the earth.

UNIVERSITY AND EDUCATIONAL NEWS

DR. FREDERICK CHARLES HICKS, Sinton professor of economics, has been elected president of the University of Cincinnati, succeeding Dr. Charles W. Dabney, who retires on reaching the age of sixty-five. Dr. Hicks went to the University of Cincinnati in 1900 as head of the department of economics, having previously taught in the University of Michigan and the University of Missouri.

MR. HOMER P. LATIMER, professor of anatomy at the University of Nebraska, has been granted leave of absence for the year 1920–21. He will spend this summer and next year in study at the Institute of Anatomy of the University of Minnesota. Mr. D. S. Brazda has been appointed instructor in anatomy to take charge of some of the classes during Professor Latimer's absence.

PROFESSOR S. ELIZABETH VON DUYNE, M.D., resident physician and professor of physiology and hygiene at Converse College, has resigned to accept a similar position at Goucher College, her alma mater.

DR. LINUS W. KLINE, formerly professor of psychology and education in the Duluth Normal School, who has been engaged in research at the Johns Hopkins University during the past year, has been appointed professor of psychology and education in Skidmore College.

DR. P. W. WHITING, in charge of biology at Franklin and Marshall College, Lancaster, Pa., has resigned to accept a position at St. Stephens' College, Annandale-on-Hudson, New York.

DR. RICHARD J. HARDING, McGill University, has been appointed professor of chemical pathology in the University of Toronto by the board of governors of the university.

DISCUSSION AND CORRESPONDENCE

SCIENTIFIC WORK IN THE HAWAIIAN ISLANDS

HAVING recently returned from a tour of the Hawaiian Islands, and having familiarized myself with the scientific work that is being done there and which remains to be done in the Islands to the south, I am particularly interested in the success of the Congress so ably planned by Professor Herbert E. Gregory, of Yale University, who is now resident in Honolulu as director of the Bernice Pauahi Bishop Museum.

While the problems presented by the Islands are chiefly in geology, volcanology, and anthropology, there is also a great deal of interest in various fields of zoology and oceanography.

The cooperation planned by Professor

Gregory is designed to extend to the scientific men of New Zealand and Australia, and to take into consideration the larger work of the future, particularly as suggested by the vanishing anthropology of Polynesia. Unless this work is begun immediately and carried through with great energy and system, it will not be done at all. The material in physical anthropology is disappearing with almost incredible rapidity. The ravages of influenza during the past two years have swept away a large part of the members of the Polynesian race. The survivors on certain of the Islands constitute a very small percentage of the original population.

Scientific cooperation has begun through the special research in physical anthropology of the Hawaiian group established between the Bishop Museum and the American Museum of Natural History. Dr. Louis R. Sullivan of the American Museum staff has already left for the Islands and will make as complete a survey as possible of the pure and mixed Hawaiian races among the remnants. These results will be published in the *Memoirs* of the Bishop Museum. It is expected also that Curator Clark Wissler will represent the American Museum at the Pan-Pacific Scientific Congress in August.

Henry Fairfield Osborn

THE ENERGY OF SMALL OSCILLATIONS

To the Editor of Science: The well-known theorem that in any linear harmonic oscillation the total energy is, on the average, half kinetic and half potential is so important in many fields that perhaps the following very simple and elementary proof will be of general interest. It can hardly be new, it is so simple and obvious, but at any rate it is not common, for it does not appear in any of the best known treatments which have been consulted.

Consider a particle of mass m which is displaced from its equilibrium position a distance x, and is vibrating in a circle. Then, as is well known, the kinetic energy is equal to the potential energy. For let the elastic restoring force be given by kx. We must then have $kx = mv^2/x$ for steady motion. The potential energy of the particle when at a distance x from the equilibrium position is equal to the work done in displacing it this distance, which equals the distance times the average force, which equals $1/2(kx)\cdot x$. Substituting the above value of kx we have for the potential energy $1/2mv^2$, and the proposition as stated is established. But any such circular vibration may be thought of as composed of two exactly similar linear harmonic oscillations. (When considering energy the phase difference and direction of oscillation is obviously irrelevant.) Therefore we must associate, on the average, half of the total kinetic and half of the total potential energy of the circular vibration with each of the linear vibrations. Since these are equal in the case of the circular vibration they must also be equal in the case of the linear vibration. The result is obviously perfectly general for any linear harmonic oscillation.

Warren Weaver
California Institute of Technology

CARBON DIOXIDE AND INCREASED CROP PRODUCTION

To the Editor of Science: Should one infer from Mr. Harrow's note in the latest issue of Science (May 7, 1920) that the question of "fertilizing" with carbon dioxide were not known to plant-physiologists and agricultural chemists in this country?

If so, it might be worth while to mention that for a number of years, at least for the last ten years, this topic has been the subject of many experiments in Europe, especially in Germany.

The botanists, Hugo Fischer and Adolf Hansen among others, have contributed much to its study. It has even found its place in modern German text-books of plant physiology—for instance in Molisch's "Pflanzenphysiologie"—and no doubt, also in those of agricultural chemistry, such as Schneidewind's "Ernährung der landwirtschaftlichen Kulturpflanzen."

M. W. Senstius

VACANCIES IN THE GRADE OF ASSISTANT CIVIL ENGINEER, U. S. NAVY

APPICATIONS are being received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., to fill 30 vacancies, more or less, in the commissioned grade of assistant civil engineer, U. S. Navy, with the rank of lieutenant (junior grade). The pay and allowances at entrance are approximately $3,200 per annum, with increases up to $9,000, depending upon length of service and promotions.

The candidate must be an American citizen, between the ages of 21 and 34 years on August 1, 1920; must have received a degree in engineering from a college or university of recognized standing; must have had not less than 12 months' practical professional experience since graduation, and must be of good moral character and repute.

The preliminary examination to determine general fitness will be based on papers submitted by the candidates, reaching the Board on or before August 23, 1920, covering college record, testimonials, references and professional experience. The candidate is not required to report in person for the preliminary examination. Physical examination by a board of medical examiners will be made of those candidates who qualify in the preliminary examination.

Those who qualify in the preliminary and physical examinations will take the final oral and written examinations to be held in Washington, D. C., as soon as possible after the preliminary examination papers have been passed on by the Board.

Officers of the Corps of Civil Engineers are detailed principally to the various navy yards and naval stations to supervise the work under the Bureau of Yards and Docks, Navy Department, Washington, D. C., consisting of the design and construction of all the public works of the naval establishment on shore as well as the maintenance and repair of existing structures. The work is exceptionally varied and offers an attractive field for able and ambitious young engineers.

C. W. PARKS,
Chief of Bureau

ARISTOTLE AND GALILEO ON FALLING BODIES

A DRAMATIC event in the history of physics is Galileo's dropping a one pound shot and a hundred pound shot together from the leaning tower of Pisa, to disprove Aristotle's law of falling bodies. In 1913 Professor H. H. Turner of Oxford, in a lecture at the Royal Institution, quoted Galileo's version of Aristotle's law:

> Aristotle said that a weight of ten pounds, for example, fell ten times as fast as a weight of one pound.[1]

To this J. H. Hardcastle replied,[2] "Aristotle never said this at all"; he refers any one who "wishes to find out for himself" to Aristotle's "Physica," Book IV., cap. 8. He does not quote from Aristotle, but quotes from Thomas Aquinas's commentary on the passage in Aristotle to which this reference points. Accepting Hardcastle's statement, G. Greenhill, William Ramsay and Oliver Lodge arrive at the conclusion[3] that Aristotle has been misunderstood. Greenhill interprets Aristotle as teaching "that the terminal velocity of a body in a medium is proportional to the weight," a law "justified by Newton in his experiments in St. Paul's"[4] and exemplified in the motion of "a raindrop or hailstone falling vertically in the air, or of a smoke particle up the chimney"; Galileo discussed an altogether different question, viz., "the start of such a body from rest." Ramsay refers to Ostwald as pointing out that "Aristotle was much more impressed with the retarding effect on the velocity of the mass of the medium through which the falling mass fell, than with the laws of 'free fall.'" Lodge emphasizes "the fact that 'terminal velocity' is the best instance of Newton's first law of motion in actual operation."

1 Galileo, ''Dialogues concerning two New Sciences'' (Ed. Crew and De Salvio), New York, 1914, p. 62.

2 *Nature* [London], Vol. 92, 1914, p. 584.

3 *Nature*, Vol. 92, pp. 584, 585, 606.

4 ''Principia,'' Book II., Prop. 40.

These remarks are interesting, but not altogether to the point. Those modern apologists do not actually quote Aristotle, nor do they base their reasoning on what Aristotle actually said.

Aristotle discusses falling bodies in six or more different parts of his "Physica" and "De Cœlo."

1. He considers[5] a body falling through media of different densities—air, water and media indefinitely rare. Then he considers also bodies of different weights falling through the same medium. Endeavoring to disprove the existence of a vacuum, Aristotle says:

> That which is heavier . . ., other things being equal, moves faster through the same space, and indeed faster according to the ratio of the magnitudes of the things, so that this must happen also through a vacuum. But this is impossible; for why should it move faster? In a plenum this is necessarily true, because the larger moves more rapidly by its power of greater penetration.

Thus, according to this Aristotelian passage, not only do the larger bodies move faster through a medium, but they would move faster even through a vacuum, if such existed.

2. Aristotle asserts[6] that each of the bodies constituting the universe was originally at rest (as taught by Anaxagoras), that each was heavy or light and had power to move.

> For suppose *A* without weight, but *B* possessing weight; and let *A* pass over a space *CD*, but *B* in the same time passes over a space *CE*—for that which has weight will be carried through the larger space. If now the heavy body be divided in the proportion that space *CE* bears to *CD*, . . . and if the whole is carried through the whole space *CE*, then it must be that a part in the same time would be carried through *CD*. Consequently the body without weight and the one possessing weight pass over the same distance, which is impossible.

Here Aristotle's law is applied to bodies initially at rest.

3. Aristotle argues[7] that "if there were an unlimited increase in the weight, there would be also an unlimited increase in velocity." The volume of a falling body is specially considered in "De Cœlo," Book IV., cap. 1:[8]

4. In "De Cœlo," Book I., cap 6,[9] we find:

> If such and such a weight is moved so and so far in such and such a time, then some larger weight will be moved through the same distance in still shorter time, shorter in the inverse ratio of the weights. . . . A limited weight can pass over any limited line in a limited time.

5. In "De Cœlo," Book IV., cap. 2,[10] Aristotle argues, likewise, that the more fire will proportionally move upward with greater speed and the less fire with less speed, and similarly for the downward motion of more gold or more lead. Here, as in most other passages, the shapes of the moving bodies are not considered.

The above shows that Aristotle considered his law applicable when the motion took place from rest as in (2), when there was no upper limit to the weight that the moving body may have as in (3), when the time of motion may be reduced or increased as in (4), and when the moving bodies are different weights of any metal, like gold or lead, as in (5). No restriction is placed by Aristotle to the combination of some or all of these four conditions in one and the same motion. To our surprise, he was willing to apply his law even to motion in a vacuum (were a vacuum possible) as is seen in (1). It appears therefore that Aristotle allowed his law a generality of application which certainly did include the special conditions under which Galileo performed his experiment of dropping a one-pound shot and a hundred-pound shot through the air from the leaning tower.

Florian Cajori
University of California

5 "Physica," Book IV., cap. 8. We are using Carl Prantl's "Aristoteles' Werke. Griechisch und Deutsch," Bd. I., Leipzig, 1854, pp. 187–191.

6 "De Cœlo," Book III., cap. 2; Prantl, Vol. 2, pp. 203–205.

7 "De Cœlo," Book I., cap. 8; Prantl, Vol. 2, p. 65.

That body is heavier than another which, in an equal bulk, moves downward quicker.

8 Prantl, Vol. 2, p. 243.

9 Prantl, Vol. 2, p. 47.

10 Prantl, Vol. 2, p. 249.

SPECIAL ARTICLES

AN ACCURATELY CONTROLLABLE MICRO-PIPETTE

A number of pipette devices have been employed for the injection or extraction of minute quantities, which have served their purpose quite satisfactorily. Among these may be mentioned the several methods described by Toldt,[1] Barber[2] and Chambers.[3] However, in certain recent work I was unable to use with the necessary accuracy any of these methods and so undertook to construct a micropipette which could be very reliably and precisely controlled.

The simple apparatus now being used serves my needs so surprisingly well that I offer this description of it hopeful that the method will be of service to others. By its use I have succeeded in extracting the micronucleus from the ciliate *Euplotes,* have injected very minute quantities of various solutions into the cytoplasm and macronucleus and have induced the formation of vacuoles near the contractile vacuole in such manner as to obtain significant data on the behavior and function of the latter structure. An account of these results will be published in later papers; I shall here only describe the method employed. I am indebted to Professor S. O. Mast for several important suggestions in the construction of the apparatus.

The general principle involved in the operation of this mechanism is the inducement at will either of large or of very delicate changes in a given volume of mercury by means of a small steel needle attached to a finely threaded thumb-screw.

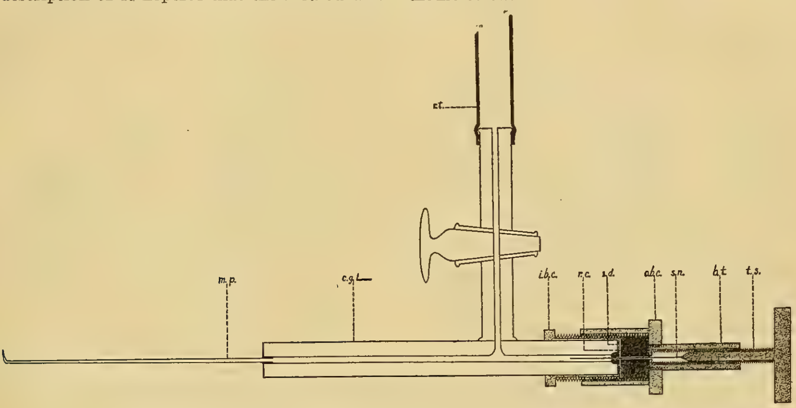

Fig. 1. *bt.,* brass tube; *c.g.t.,* capillary tube; *i.b.c.,* "inner" brass cap; *m.p.,* micropipette; *o.b.c.,* "outer" brass cap; *r.c.,* rubber cylinder; *r.t.,* rubber tube; *s.d.,* steel disk; *s.n.,* steel needle; *t.s.,* thumb-screw.

The mercury is contained in a capillary glass tube 7 cm. in length and 6 mm. in diameter with a bore of about 1 mm. Into one end of the tube is sealed the micropipette (*m.p.*) and over the other end an "inner" brass cap (*i.b.c.*), as shown in Fig. 1.

The end of this "inner" cap is covered and sealed by a thin steel disk (*s.d.*) having a central projection which inserts a short distance into an enlargement of the capillary bore. Through the center of the disk is a hole of

1 Toldt, "Die Injection unter messbarem Drucke," *Archiv. f. Mikr. Anat.,* 1869, 5, 167, Taf. XI.

2 Barber, M. A., "The Pipette Method in the Isolation of Single Microorganisms and in the Inoculation of Substances into Living Cells," *The Philippine Jour. Sci.,* Sec. B, Trop. Med., 9, 307.

3 Chambers, R., "The Microvivisection Method," *Biol. Bull.,* 1918, 34, 121.

size just convenient to accommodate the entrance of the steel needle into the capillary tube. The needle, 3 cm. long and about 2/5 mm. in diameter, is soldered on to a finely-threaded thumb-screw (*t.s.*) which operates in a brass tube (*b.t.*). This tube is screwed firmly into the base of an "outer" brass cap (*o.b.c.*). In the inner end of the brass tube, the needle passes through a hole having a diameter the same as that in the steel disk. Into the "outer" cap is fit very closely a soft rubber cylinder (*r.c.*), in length one half that of the cap, through the center of which passes the needle. Inserting the needle into the hole in the steel disk, the "outer" cap is now screwed tightly on to the "inner" cap.

The device is supported and adjusted on the microscope stage by means of the Barber pipette-holder.

After the capillary tube and pipette are filled from a column of mercury contained in the rubber tubing (*rt.*), the system is then closed by the stopcock and is ready for operation. This is accomplished by regulating the thumb-screw which is threaded 60 turns to the inch. Very slight movements of it induce gradual changes of the meniscus of mercury in either direction in the tip of the micropipette (having a lumen of about five microns); these changes may be so delicate as to be almost imperceptible under a magnification of 400 diameters.

Two precautions are here worthy of note, viz., the use of glass tubing and mercury which are thoroughly clean, and the avoidance of air-bubbles anywhere within the system. To clean glass tubing, I have found the following method very effective: after sealing one end of the tube, put into it a few drops of 95 per cent. alcohol and a like amount of concentrated HNO_3. Upon adding a drop or two of H_2SO_4, an explosive reaction occurs which apparently oxidizes thoroughly any substances adhering to the surface of the glass. (The tube, of course, should be turned away from one's face before adding the H_2SO_4.) Break off the sealed end and wash the tubing well with distilled water.

To hasten the filling of the system with mercury and to remove air that may appear, it is advisable to fill nearly full the capillary tube (and add a drop of dust-free, distilled water which can be forced through the pipette point more easily than mercury) just before sealing in the pipette.

It is advantageous, also, to have the shank of the pipette fit fairly well the bore of the tube; air-bubbles are then less likely to appear in the sealing-wax between the shank and the surface of the bore.

The needle-pipette operates inside a moist chamber similar in design to that described by Chambers (*loc. cit.*). Distilled water or solutions of any sort for injection purposes may be drawn into the pipette after the mercury has been forced to the tip by turning the thumb-screw, then dipping the tip into a hanging drop of the solution and drawing a desired quantity of this into the pipette by reversing the movement of the screw. Obviously, cleansing with distilled water, which is sometimes essential, may be done in a similar way.

To extract cytoplasm or to remove a nucleus, a small amount of distilled water is drawn into the pipette, the tip then inserted into the organism and the operation completed by carefully manipulating the thumb-screw.

C. V. Taylor

The Johns Hopkins University

THE AMERICAN PHILOSOPHICAL SOCIETY. III

SATURDAY, APRIL 24

Executive Session—9:30 o'clock

Stated Business.—Candidates for membership ballotted for. Appropriations for the ensuing year passed. Annual address of the president.

Morning Session—10 o'clock

George Ellery Hale, Ph.D., Sc.D., LL.D., vice-president, in the chair

The problem of the evolution of the solar system: Ernest W. Brown, Sc.D., professor of mathematics, Yale University.

Certain aspects of recent spectroscopic observations of the gaseous nebulæ which appear to establish the relationship between them and the stars: W. H. Wright, astronomer, Lick Observatory.

(Introduced by Professor Robert G. Aitken.) The paper summarizes in non-technical terms the evidence afforded by a study of the stellar condensations in the planetary or small gaseous nebulæ, which are shown to be spectroscopically identical with stars of the Wolf-Rayet group (Pickering's Class O). A brief account is given of some of the present day conceptions of stellar evolution, for the purpose of indicating the somewhat critical nature, with respect to these ideas, of the relationship indicated. A complete account of the investigation, of which the paper summarizes a part, is given in Volume XIII., part 6, of the Publications of the Lick Observatory.

The Einstein theory: Edwin Plimpton Adams, Ph.D., professor of physics, Princeton University. Following Newton's statement of the law of universal gravitation, the goal of all physical explanations of natural phenomena was to reduce them to actions at a distance between elements. After Maxwell showed that electric and magnetic phenomena could be accounted for by a system of pressures and tensions in a universal medium—the ether—the goal changed, and the attempt was made to explain physical phenomena by direct action through a medium. Attempts to account for gravitational forces, however, in this way met with little success. The extension, by Einstein, of the principle of relativity and the resulting revision of the concepts of space and time, led to Einstein's interpretation of gravitation as a property of space itself when modified by the presence of matter.

The results of geophysical observations during the solar eclipse of May 29, 1919, and their bearing upon the Einstein deflection of light. (Illustrated): Louis A. Bauer, Ph.D., Sc.D., director of the department of terrestrial magnetism, Carnegie Institution of Washington. This paper is a continuation of the one presented at a stated meeting of the society on February 6, 1920. In that paper[1] a résumé was given of the geophysical and astronomical observations concerning the solar eclipse of May 29, 1919, and the Einstein effect made by the various expeditions sent out by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and the various astronomical expeditions sent out by Great Britain, the Rio Janeiro Observatory, and the Smithsonian Institution. It was shown how the results of the geophysical observations may have an important bearing upon the complete interpretation of the astronomical observations showing the deflections of light during the eclipse. A brief analysis of the light deflections was given and it was pointed out that there were non-radial effects of such a systematic nature that they could not be accounted for by errors of observation. The present paper gives the results of a special study of the cause of the non-radial effects of the light deflections observed by the British expedition at Sobral, Brazil. It is shown that these non-radial effects may be completely accounted for by incomplete elimination of differential refraction effects in the earth's atmosphere. The same cause may apparently also explain why the observed radial deflections of light exceeded, on the average, by about 14 per cent. the amounts predicted on the basis of the Einstein law of gravitation.

[1] "Observations in Liberia and Elsewhere of the Total Solar Eclipse of May 29, 1919, and Their Bearing on the Einstein Theory."

The high voltage corona in air: J. B. Whitehead, professor of applied electricity, Johns Hopkins University. (Introduced by Dr. Pender.) The paper describes the nature of the corona and recent studies of the laws governing its appearance in high voltage circuits. Its influence as a limiting factor in long distance transmission occurs through deterioration of insulation and a leakage loss of power between the high voltage lines. The appearance of corona on a clean round wire is very sharply marked and may be used for the measurement of high alternating voltages to a degree of accuracy not heretofore possible. Experiments and observations on the corona voltmeter, an instrument devised for this purpose, are recorded; and an example of the instrument, suitable for voltages up to 300,000 volts, is described.

The velocity of explosive sounds: Dayton C. Miller, D.Sc., professor of physics, Case School of Applied Science, Cleveland. In 1918–1919 the writer had the privilege of making an extended series of experiments on the pressure waves from large guns in action, at Sandy Hook Proving Ground. One series of experiments was for the purpose of determining the variation in the velocity of the sound of the gun explosion as measured from the muzzle outward, and for the determination of the velocity of sound in free air. Most of the experiments were made in connection with 10-inch and 12-inch rifles, though a few were made with 6-inch and 8-inch guns. The amount of powder charge and the value of the internal pressure developed in the gun are taken into account. The sounds were received by means especially constructed carbon-granule microphones, while others were of a very sensitive type. The records were made by an especially constructed moving-film camera in connection with a string-galvanometer capable of recording from six stations simultaneously, of the type used by our army for sound-ranging. Stations were located at the muzzle of the gun, and at points in front of the guns at distances of about 100, 200, 300, 400, 500, 600, 1,000, 2,000, 7,300 and 21,000 feet, six of these stations being used at one time. The locations were determined with precision. Meteorological observations were made by special observers in the distant stations and on the field near the guns, at the time of the experiments and continuous records were made at the Proving Ground Headquarters and at the United States Weather Bureau Station. These observations covered temperature, barometric height, humidity, wind velocity and wind direction. Measurements were also made of the velocity of the sound at a series of stations located on a line at right angles to the line of fire, and on a line at 45° to one side of the line of fire. In all, seventy-two sets of velocity determinations were made, eleven sets extending to the most distant stations at 21,000 feet from the gun, while the other sets relate to various groups of stations within 2,000 feet of the gun. Heretofore there has been a general impression that explosive sounds travel much farther than do ordinary sounds, the velocity being perhaps several times the normal velocity. These experiments show conclusively that the velocity at a distance of one hundred feet from a 10-inch gun is about 1,240 feet per second, or 22 per cent. above normal; at two hundred feet from the gun the velocity is only about 5 per cent. above normal. For all distances above five hundred feet from the gun the velocity of the explosive sound from the largest sized gun is practically normal. The value of the velocity of sound over the long range of 21,000 feet has not yet been calculated with all corrections applied, the preliminary value is in entire agreement with other determinations, and is about 1,089 feet per second at the freezing temperature. It is expected that the final value will be of a precision equalling the best heretofore obtained.

The U. S. navy MV-type of hydrophone as an aid and safeguard to navigation: Harvey C. Hayes, Ph.D., U. S. Naval Engineering Experiment Station, Annapolis. (Introduced by Professor John A. Miller.)

The transient process of establishing a steady alternating electric current on a long line from laboratory measurements on an artificial line: A. E. Kennelly, A.M., Sc.D., director, Research Division, Electrical Engineering Department, Massachusetts Institute of Technology, and U. Nabeshima. When a power-transmission electric conducting line is switched on to the generator at the power house, the alternating-current on that line settles down to a final state, under steady load, in a time which is theoretically indefinitely long, but which is usually practically covered in a small fraction of a second. The paper discusses the transient phenomena which occur along the line during this process of upbuilding the final current and voltage. The subject has been studied theoretically by a number of writers; but very few practical observations have been published concerning this transient state. It is known that the current and voltage do not build up steadily and continuously, but advance by little jumps which occur at regular short intervals of time, accompanying successive reflections of electromagnetic waves from one end of the line to the other. The authors present in the paper a number of observations which have been secured photographically, of the rise of voltage and current on a long artificial electric power-transmission line in the laboratory, and have compared the observed rates of growth with those which are indicated by theory, with a fairly satisfactory agreement. The observed results indicate the manner and mechanism by which electric power may be conceived of as being transmitted along such a line.

The strephoscope: N. W. Akimoff. (Introduced by Professor Eric Doolittle.)

New features in the eclipsing variable U Cephei: R. S. Dugan, professor of astronomy, Princeton University. (Introduced by Professor H. N. Russell.)

Arthur W. Goodspeed

(*To be concluded*)

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

IRREVERSIBLE DIFFERENTIATION AND ORTHOGENESIS

The publication in 1919 of the three noble volumes of posthumous works of the late Professor Whitman[1] redirects our attention to the problem of orthogenetic evolution. The evidence here presented may be regarded as demonstrative that in pigeons variations do not occur in all cases at random around fixed modes as unit characters in accordance with the laws of probability, but that they tend to appear in the course of phylogeny in an irreversible series.

Numerous other students of evolution have formulated similar conceptions under the names, orthogenesis, orthoplasy, directive evolution, etc., some of which are referred to by Whitman, and others are cited at length by Baldwin in his book on "Development and Evolution" (New York, 1902). Most of these statements leave much to be desired from the scientific standpoint and they frequently lead to the expressed or implied postulation of metaphysical factors.[2] Nägeli's principle of perfection is of this sort and has not been especially fruitful. Others, like Eimer,[3] though basing their conclusions on extensive critical observation, have allowed themselves to be swept along by controversial

1 "Orthogenetic Evolution in Pigeons." Posthumous Works of Charles Otis Whitman. Edited by Oscar Riddle. Published by the Carnegie Institution of Washington, 1919.

2 The term orthogenesis has been applied in a great variety of senses, some of them decidedly mystical. These are summarized by Vernon L. Kellogg in "Darwinism To-day," New York, 1907, pp. 274–288.

3 Eimer's Leyden address published by The Open Court Publishing Co., Chicago, 1898, under the title, "On Orthogenesis and the Impotence of Natural Selection in Species-Formation," gives a summary of his views with citation of the original sources of his data.

currents beyond the safe haven of calm and well-considered evaluation of all factors in the problem.

Competent naturalists of wide experience in many scientific fields are, however, continually bringing forth new confirmatory evidence that the direction of the evolutionary process is to some extent and in some way determined from within and that the course of differentiation of organic forms is not in its entirety directly and passively shaped by the environmental mold. That these internal factors are ultimately to be referred to the reaction between the living substance and its environment was clearly recognized by Eimer, as is shown by the following quotation:[4]

> In my view development can take place in only a few directions because the constitution, the material composition of the body, necessarily determines such directions and prevents indiscriminate modification. But through the agency of outward influences the constitution must gradually get changed. The organisms will thus acquire more and more physiological individuality and respond to outward influences more and more in a manner harmonizing with their specific individuality—and so new directions of development will be produced.

Eimer's further contention that this conception implies the unqualified acceptance of the inheritance of acquired characters has doubtless been an obstacle to the more general approval of his views. To this point we shall return.

As the currents of thought regarding the truth of evolution in general drifted more or less impotently in a sea of speculation until Lamarck, Darwin, DeVries and others confined it within scientifically definable banks by presenting plausible explanations of the possible mechanism of the process, so orthogenesis has remained an ill-defined and at times quasi-mystical hypothesis as long as we had no comprehensible account of the causative factors which may direct the course of future differentiation. It may be regarded as established that orthogenesis in some form is an evolutionary factor. But what of the method?

Child[5] has laid down some general principles which point the way in this inquiry. Undifferentiated tissues with active metabolism (termed tissues of the "young" type by Child) contrast sharply with the more stable and mature tissues whose protoplasm has assumed characteristic structural patterns in adaptation to specific functions (muscle, gland, etc.). The tissue patterns of the latter group not only maintain their individuality during the life of the organism, but their stability extends deeper into the hereditary organization of the species and their characteristic forms run true in successive generations. There is accordingly, as Child expresses it, a secular change in the character of protoplasmic organization in the direction of a fixation or stabilization of the more labile and metabolically active tissues of the embryonic or generalized type into more highly specialized and stable patterns. This process of evolution of form is, of course, concomitant with a differentiation and fixation of heritable behavior patterns.

The general physiological processes involved here have been analyzed by Child and the underlying physico-chemical apparatus has been experimentally studied in an illuminating series of researches on bio-electric phenomena and their inorganic analogies by R. S. Lillie.[6]

This process of progressive maturing of tissue in the course of evolution is not different in fundamental biological character from that seen in the course of ontogenetic development, and both are expressions of more efficient adjustment of the living substance to

[5] "Senescence and Rejuvenescence," Chicago, 1915.

[4] *Loc. cit.*, p. 22

[6] "Transmission of Activation in Passive Metals as a Model of the Protoplasmic or Nervous Type of Transmission," Science, N. S., Vol. 48, 1918, pp. 51–60. "Heredity from the Physico-chemical Point of View," *Biol. Bul.*, Vol. 34, 1918, pp. 65–90. "Nervous and Other Forms of Protoplasmic Transmission," *Sci. Mo.*, Vol. 8, 1919, pp. 456–474, 552–567. "Precipitation Structures Simulating Organic Growth. II. A Contribution to the Physico-chemical Analysis of Growth and Heredity," *Biol. Bul.*, Vol. 36, 1919, pp. 225–273.

the manifold diversities of the environment, that is, in the wide view they are adaptive. Natural selection may (or may not) act upon the products of this differentiation as they are formed. Inheritance of acquired characters in the ordinary sense of this expression is not implied here, though some recasting of current ideas of the individuality of the germ plasm and the nature of the mechanism of heredity is a necessary consequence of the recent studies in general protoplasmic physiology to which reference has been made.

Now this process of senescence of tissue is to a large extent reversible; that is, a specialized tissue may dedifferentiate and return to the embryonic type, as happens in the ordinary processes of reproduction, regeneration and the like. But this capacity for dedifferentiation is not universal, nor where it occurs is it always accomplished with equal facility. In general, specialized tissues return to the undifferentiated condition with greater difficulty than do the simpler and more generalized kinds and the capacity for form regulation diminishes *pari passu* with the increase in complexity of bodily organization. In higher organisms groups of general body cells are incapable of reproducing the whole body as in lower forms; in a salamander an entire limb can be regenerated, but in a man this is impossible; and differentiated nerve cells are incapable even of cell division. To this extent, tissue differentiation is irreversible.

This progressive stabilization of heritable patterns of organization is an essential factor in evolution, and to the extent that these patterns are irreversible the future course of evolution is predetermined. For, given a particular inherited structural pattern, variations will be distributed around this as a mode is accordance with a different frequency curve than would be shown if the inherited pattern were different; and the same applies to mutations..[7]

An aquatic species which has acquired adaptation to life on land has established new modes around which its variations and mutations are distributed. True, it may in time return to the water, though never in a higher animal by the process of dedifferentiation to the original aquatic form but only along lines of further differentiation derived from and congruous with its established terrestrial patterns.

Again, with the establishment of the ladder type of central nervous system as seen in annelid worms, a stable pattern was laid down with certain functional capacities. On the other hand, with the establishment of the tubular type of central nervous systems in early vertebrate ancestors, a different pattern was fabricated with its own characteristic correlated behavior. On the basis of each of these matured and stabilized tissue differentiations a wide variety of central nervous systems has been derived—from the annelid type the whole series of arthropods and from the protochordate type the whole series of vertebrates. But throughout each of these phyla the fundamental pattern has not been changed, nor have we any adequate evidence that one has ever been transformed into the other.

In other words, from the time when these two structural patterns were first established and stabilized, the process was irreversible; the tissues concerned have in this respect and to this extent passed from the "young" or labile state to the "mature" or rigidly determined form. The undifferentiated type antecedent to both of these phyla was labile in the sense that under appropriate conditions it could differentiate in either direction; but having passed over to either one of the differentiated forms, it has apparently lost its capacity to transform to the other type, either by dedifferentiation and remodelling of its pattern or by any other method. At any rate we have no convincing evidence that this has been done. In short, the whole future course of evolution of the vertebrate phylum was set in a different direction from that of the arthropods from the first appearance of a neural tube.

[7] Metcalf, M. M., "Adaptation through Natural Selection and Orthogenesis," *Am. Nat.*, Vol. 47, 1913, pp. 65–71.

The insects comprise the highest invertebrates and as a group they are remarkably efficient animals; but their extremely diverse specialization is spread out on a rather low plane and the behavior of each individual member of the group is tolerably rigidly limited to a narrow range of instinctive acts with small capacity for individual modifiability. The extreme plasticity of the group of ants as a whole, so graphically portrayed by Wheeler,[8] has been biologically determined through natural selection or otherwise by the adaptation of each of the diverse species and castes for a very special mode of life which must be followed through, with no considerable deviation. This is in sharp contrast with the plasticity of the higher mammals which rests rather on capacity for modifiability, docility and intelligent adaptation to new conditions of each individual animal.

Similarly, within the vertebrate phylum we find divergent modifications of the primary tubular pattern of the central nervous system, each of which, as soon as matured and stabilized in the inherited organization, favors subsequent differentiation in certain directions and precludes it in others, for this differentiation is irreversible.

The teleostean type of forebrain is quite unlike anything else in nature. It probably was early forecast in primitive ganoids with brains like those of the modern sturgeons, where there is no evagination of the cerebral hemispheres but instead local thickenings in the unevaginated walls of the rostral portion of the neural tube. Once this method of differentiation was established, there is no evidence that it ever gave rise to the type represented by Amphibia and all Amniota with hollow hemispheres. The teleosts, like the insects, are very efficient organisms and in the aggregate they adjust to a wide variety of conditions, but they are differentiated on a relatively low plane, the structural and behavior patterns of each species are rigid and narrowly circumscribed, and the group has given rise to none of the higher types.

In the primitive reptilian stock there was another divergence in pattern of forebrain evolution. One type developed masive basal nuclei in the cerebral hemispheres, as in modern saurians. This line of differentiation advanced to culminate in modern birds with basal nuclei (striatum complex) more massive than in any other animals and with very insignificant cerebral cortex. In correlation with this, the birds on the behavior side present the culmination of instinct, with intelligence of low order. A second reptilian type, starting with brain forms more like those of the modern turtles, followed a different line of differentiation and led up to the mammalian type with wide lateral ventricles and extensive superficial cerebral cortex. This type seems better adapted to develop into an adequate organ of intelligent behavior, and in this direction it appears not yet to have reached its limit.

In speaking of the influence of the arboreal habitat upon the evolutionary history of Primates, F. Wood Jones,[9] draws an interesting contrast between this phylum and the arboreal marsupials (Metatheria), in the following passage:

> These arboreal Metatherians have had all the educational advantages of a thoroughly arboreal life; nothing that we have pictured has failed to exert its influences upon them, and yet it is obvious that the advantage that they have taken of it has been slight. There are metatherian convergent mimics of Carnivora, Rodentia, Insectivora, and of most other Eutherian orders, but there is no metatherian convergent mimic of the eutherian Primates. It would not be unnatural, therefore, to assume that the full advantage could not be grasped by the metatherian animals, since the ground-plan of their brain would not permit it.

The argument continues that the absence of the corpus callosum in Metatheria gives the clew to this orthogenetic limitation.

From these and innumerable similar instances familiar to every comparative anatomist it may be argued that the process of differentiation, so far as this represents an irreversible process, is itself a natural cause of limitation of the future course of evolution

8 "Ants," New York, 1913.

9 "Arboreal Man," London, 1916.

within the boundaries set by the efficient working of the established pattern.

Looking at the animal kingdom from the behavioristic side, most animal activities are compounded of two factors: (1) innate and heritable factors (reflexes, instincts, and the like), and (2) acquired modifications of the inherited patterns (culminating in docility and intelligence). In some animal phyla the first component is dominant, in others the second. And the differentiation of an apparatus adequate for a highly refined and very elaborate instinctive behavior complex may preclude the development of the more labile modifiable types, as appears to be the case in insects, higher fishes, and to a less extent birds. The structural patterns serving the higher intelligent types of behavior have not been evolved from those lower brains exhibiting highly differentiated and stabilized inherited patterns correlated with complex instincts, but rather from more generalized forms which have remained more plastic (from the evolutionary standpoint) because less of their material has passed on into the mature form of tissue.

The higher forms retain their dominant position and continue advance in this direction because parallel with the elaboration of their stable, heritable nervous and instinctive patterns they retain sufficient labile nervous tissues of the "young" and plastic type to enable each individual to make his own adaptations to a great variety of environmental conditions and to profit by this experience.

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EDUCATIONAL INSTITUTIONS REPRESENTED IN THE MELLON INSTITUTE

"It is not so much to know how to direct research men as it is to know where to find them."—*Old chemical proverb.*

AN inquiry which is received frequently by the administration of the Mellon Institute is, "Where do you obtain your research chemists?" It is a familiar truth that there is a serious scarcity of men of demonstrated research ability; and since, *ceteris paribus,* the institute adheres to the policy of starting new investigational work only as competent men are available, the question is, therefore, of scientific interest. It can not, however, be answered except with certain conditional stipulations. In the first place, there is a diversity of opinion as to the basic qualifications for research, and particularly for industrial research. Then, there is the requisite of considering the exact nature of the investigation and the definite type of researcher needed therefore. And, finally, there must be borne in mind the fact that the finding of every research man is attended with difficulty because it frequently involves the gift of prophecy on the part of the searcher—or, at least, the application of a proleptic study which is at present in an inchoate condition. The supply of men capable of working at high efficiency as scientific investigators has been, and probably always will be, well below the demand; and scientists having the requisites and spirit of the researcher are, indeed, difficult to find even by ones widely experienced in the direction of research. Perhaps the most effective instrument for the recognition of investigational keenness is the comparative method, but the study of its use is still in its infancy.

On account of the extraordinary importance of new ideas, particular emphasis should always be laid upon locating and supporting brilliant investigators. Such individuals can best be found in the universities, although it should be the ambition of every research director to attract, rather than to seek, qualified scientific investigators. The function of the university is to operate with the beneficent idea of increasing the sum of human knowledge, and among its most valuable products are those young men of initiative who will work for the exercise of the investigative instinct and the pleasure of overcoming difficulties. Dr. Robert Kennedy Duncan once said:

That "good men" are scarce is, of course, a truism; but it is terribly apposite in these days. The modern manufacturer advisedly economizes in everything but salaries, and the very considerable salaries paid to "good men" are ample evidence of their rarity. Now, the purlieus of adolescent "good men" are the laboratories of the university. There it is that men are "tried out," and there it is, too, that men are known better than they know themselves.

Supporters of scientific and industrial research must aid in helping to establish a condition which will ensure a greater number of scientific teachers who are also trained as productive scientists. It can not be gainsaid that it is a highly desirable plan to arrange curricula so that every teacher whose favorite pursuit is research may develop it by the assistance of his students. The most important problem in industrial research today is not, how shall use be made of trained scientific investigators? It is, rather, how may there be produced annually active young students of science at a greater rate and of higher quality? And in this connection, thought must be expressed in terms of thousands per year of the type of trained men represented, say, by the doctor's degree or by two or more years of individual experimental work following the completion of appropriate undergraduate training.

The following list presents the institutional source of the incumbents of the Industrial Fellowships of the Mellon Institute from the time of its foundation in 1912 to the present day. It is the experience of the administration of the institute that a knowledge of the domestic history of the important research-schools facilitates the prognosis of the investigational possibilities of applicants therefrom. This information also renders less difficult the occasional quests for experts or research men possessing specific qualifications of a high order. Every large industrial research laboratory whose operation discloses telesis has received innumerable benefits from the establishment of cordial relations of cooperation with the various researchful university laboratories.

INSTITUTIONS REPRESENTED IN THE MELLON INSTITUTE, 1912–20

Names of Institutions	Degrees		
	B.S. and A.B.	M.S. and M.A.	Ph.D. and Sc.D.
Alfred University	3		
Allegheny College	4	1	
Amherst College	1	1	
Augustana College	1		
Beloit College	1		
Carnegie Institute of Technology	2		
Clark University	4	3	1
Clarkson College of Technology	1		
College of the City of New York	2		
Columbia University	1	1	1
Cornell College	1		
Cornell University	5	2	2
Dakota Wesleyan University	1		
Dalhousie University	1	1	
Delaware College	1		
DePauw University	1	1	
Dickinson College	1		
Emporia College			1
Fairmount College	1		
Franklin & Marshall College	1	1	
George Washington University		1	1
Harvard University	1		2
Haverford College	1	1	
Hiram College	1		
Iowa State College		1	
Johns Hopkins University	3		5
Kansas State Agricultural College	1	2	
Lafayette College	3		
Leland Stanford, Jr., University	2	1	
McGill University	2		
Marietta College	1	1	
Massachusetts Agr. College	1	2	
Massachusetts Institute of Technology	1	1	2
Monmouth College	1		
Muhlenberg College	1		
Nebraska Wesleyan University	1		
New Hampshire College	8	2	
New York University	2		2
Northwestern University		2	
Ohio State University	9	8	4
Ohio University	2		
Oklahoma A. & M. College	2		
Oregon Agricultural College	1		
Pennsylvania State College	2		
Purdue University	2		
Richmond College	1		
Ripon College	1		
Rose Polytechnic Institute	2	1	
Southwestern College	3		
Syracuse University	1		
Tuft's College	1		
Tulane University		1	

INSTITUTIONS REPRESENTED IN THE MELLON INSTITUTE, 1912–20 (*Concluded*)

Names of Institutions	Degrees		
	B.S. and A.B.	M.S. and M.A.	Ph.D. and Sc.D.
University of California	1		
University of Chicago	1	1	9
University of Colorado	1		
University of Göttingen			2
University of Halle		1	1
University of Heidelberg		1	1
University of Illinois	6	5 2 E.E.	1
University of Kansas	28	10	2
University of Kentucky	1		
University of Leipzig			2
University of London	2		
University of Missouri	2	1	
University of Nebraska	3	4	
University of North Carolina	1	1	1
University of Oklahoma	1	1	
University of Paris	1		
University of Pennsylvania	3		
University of Pittsburgh	14	14	13
University of Southern California	1	1	
University of Tennessee	1		
University of Toronto	3		2
University of Washington	2	2	
University of Wisconsin	3	6	2
Victoria University	1	1	1
Wabash College	4	2	
Wake Forest College	2		
Washburn College	1		
Washington & Jefferson College	2	1	
Wesleyan University	1		
Westminster College	1		
Wooster College	2		
Yale University	2	1	6

W. A. HAMOR

MELLON INSTITUTE OF INDUSTRIAL RESEARCH,
UNIVERSITY OF PITTSBURGH,
April 1, 1920

SCIENTIFIC EVENTS

THE CARDIFF MEETING OF THE BRITISH ASSOCIATION

ACCORDING to an article in the London *Times* the arrangements for the 1920 meeting of the British Association, which opens at Cardiff on August 24, are well advanced. The inaugural meeting will be held in the Park Hall on the evening of the opening day, when Professor W. A. Herdman, ex-general secretary, will assume the presidency in succession to Sir Charles Parsons.

Professor Herdman in his presidential address will give a general survey of the subject of oceanography, dealing in detail with certain special problems and recent investigations with particular reference to sea fisheries. On Thursday evening, August 26, an address will be delivered by Sir Richard T. Glazebrook, who recently retired from the post of Director of the National Physical Laboratory. The subject has not yet been fixed. The second evening discourse is to be delivered by Sir Daniel Hall, permanent secretary of the Board of Agriculture since 1917, whose subject will be "A grain of wheat from the field to the table."

The president of the mathematical and physical science section will be Professor A. S. Eddington, who recently came prominently before the public as a leading protagonist in the discussion on the Einstein theory of relativity. Dr. F. A. Bather is to be the president of the geological section, and his address will discuss the general problems of paleontology, especially in their relation to zoology. The presidents of the other sections, the subjects of whose addresses are not yet fixed are: Zoology, Professor J. S. Gardiner; geography, Mr. J. McFarlane; economics, Dr. J. H. Clapham; engineering, Professor C. F. Jenkin; anthropology, Professor Karl Pearson; physiology, Mr. J. Barcroft; botany, Miss E. R. Saunders; education, Sir Robert Blair; and agriculture, Professor F. W. Keeble.

The citizens' lectures, which developed out of the single lecture which used to be given to the operative classes of the towns visited by the association, are now arranged in collaboration with the local branch of the Workers' Educational Association. The lecturers this year will be Professor Boulton, of Birmingham, Professor Lloyd Williams, of Aberystwyth, Professor A. W. Kirkaldy, of Nottingham, and Dr. Vaughn Cornish. The president of the Conference of Delegates of Corresponding Societies will be Mr. T. Sheppard, curator of the Municipal Museums at Hull.

THE ENGLISH DEEP-SEA FISHERIES

A SPECIAL correspondent of the London *Times* who has visited some of the chief fishing ports of the country has shown in a series of articles that trawler owners are losing money owing to the low prices realized for the catches of their boats.

The difficulties of the industry appear to be due to the greatly increased cost of labor, coal, gear and repairs, to the very large quantities of fish recently landed, and to the lack of facilities for transporting fish from the ports to the inland markets. Working costs can not easily be reduced under existing conditions, and the only remedy for the situation would seem to lie in better distribution and an increase in the consumption of fish. The help of the government is sought to improve the means of distribution, but the trawler owners complain that the government takes no interest in deep-sea fishing as an industry.

The view taken by the National Sea Fisheries Association is that more would be done for the fisheries if the ministry of agriculture and fisheries were organized in two divisions, each with its own secretariat and each with its own vote. The association suggests that a fisheries division of the ministry should be developed, with three branches, dealing respectively, with administrative, executive and research affairs, and that the functions to be distributed among these branches should include the administration of the fisheries vote, the promotion of fisheries legislation, matters relating to international fishery conventions or agreements, executive work bearing on the catching, preparation, marketing, and distribution of fish, and researches into the natural history of fish and their treatment as food after capture.

A further proposal is that England and Wales should be divided into seven fishery areas, and that each area should be in charge of a commissioner of fisheries with a staff of inspectors and fishery officers sufficient to enable him to deal with all problems of catching and the distribution of fish in his jurisdiction. Each commissioner would act as the connecting link between the government and the industry, between capital and labor within the industry, and between the producer and the distributor. The staff, it is proposed, should give assistance in matters affecting the safe dispatch, transport, and delivery of fish from port to market at reasonable rates, in improving conditions at existing markets and inaugurating new markets, in the daily telegraphic publication of wholesale prices at port and market, and in the improvement of fast lateral railway traffic for the carriage of fish from the coasts to the main centers of population.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

THE National Exposition of Chemical Industries returns to the Grand Central Palace in New York, where it will be given during the week of September 20 to 25, 1920, inclusive. *The Journal of Industrial Chemistry* states that this year's exposition will be the largest distinctly industrial exposition ever held. In 1915 the first exposition was composed of 83 exhibitors, the second increased to 188, the third to 288, the fourth to 334, and the fifth, in which the available space was much restricted and exhibitors were held to a minimum, admitted 351 exhibitors. The present number of 358 can not be much increased because of the limited amount of space remaining. Another floor has been added, giving four floors of the Grand Central Palace, each of which covers a city block. To the first exposition there came 63,000 visitors, to the second 80,000, and this has steadily increased till at the last the attendance exceeded 111,000.

This year there will be three special sections: the Electric Furnace, the Fuel Economy and the Materials Handling Section. The two latter are new sections. The first will, as its name implies, be one of electric furnace exhibits; the Fuel Economy Section will consist of exhibits of machinery and apparatus, furnaces, producers, stokers and all devices for the economic utilization or more efficient combustion of fuel. The possible exhaustion of our fuel reserves in the not far distant future and the present high cost of fuel make this section one of much interest to all industrial plants. The Materials Handling Section will be a series of exhibits of machinery and equipment for the handling of material, such as conveying, transporting, elevating, and included in this will be weighing, measuring and power transmission equipment. So important have these mechanical features become for all industrial plants due to the shortage and high wage for man power that an unusual interest is expected in this new section.

The program for the exposition will have session on subjects the phases of which will be developed in the exhibits of these latter two sections. There will be sessions on chemical engineering for which an elaborate program is planned. Motion pictures which will have an interest for mechanical men will form part of the program, and there will be popular public addresses as well.

THE WORK OF THE NATIONAL COMMITTEE ON MATHEMATICAL REQUIREMENTS

THE National Committee on Mathematical Requirements held a meeting in Chicago on April 23 and 24. The principal topic discussed at this meeting was the preliminary report on "Junior High School Mathematics" prepared for the committee by Mr. J. A. Foberg. After detailed discussion and some amendment and revision, the report was adopted by the committee and its publication as a preliminary report authorized. It has been submitted to the U. S. Bureau of Education for publication as one of its secondary school circulars.

Reports of progress were made by subcommittees on the training of teachers, experimental schools and courses, disciplinary values and transfer of training, elective courses in mathematics for high schools, and mental tests. It is expected that preliminary reports on all of these topics will be ready for consideration by the committee at its next meeting on September 2, 3 and 4. The attention of experimental schools throughout the country is called to the report on this subject being prepared for the committee by Mr. Raleigh Schorling of the Lincoln School, New York City. Any experimental school or schools giving experimental courses in mathematics who desire to be represented in this report should communicate with Mr. Schorling without delay, if they have not already done so. A subcommittee on the standardization of terminology and symbolism, with Professor D. E. Smith as chairman, and a subcommittee on junior college mathematics, with Mr. A. C. Olney as chairman, were appointed. J. W. Young, Raleigh Schorling and W. F. Downey were authorized to take steps to initiate investigations into the mathematical elements entering into various industries, professions, vocations, etc.

A budget for the coming year based on the recent appropriation of the General Education Board of $25,000 for the use of the committee in completing its work was adopted. It is hoped that the increase in the item allowed for traveling expenses in this budget will make it possible for representatives of the committee to reach educational meetings in all sections of the country where such representatives are desired to discuss the various reports of the committee. Nearly 70 organizations are at present actively cooperating with the committee and it is hoped that many others will communicate with the chairman in the interest of furthering the nationwide study and discussion which is already underway. J. W. Young, 24 Musgrove Building, Hanover, N. H., and J. A. Forbeg, 3829 North Tripp Avenue, Chicago, Ill., were reelected chairman and vice-chairman, respectively, of the committee for the ensuing year.

J. W. YOUNG,
Chairman

THE ELLIOT MEDAL IN ZOOLOGY AND PALEONTOLOGY

TERMS of the award of the Daniel Giraud Elliot Medal for zoology are written in the deed of gift to the National Academy of Sciences as follows:

> One such medal and diploma shall be given in each year and they, with any unexpected balance of income for the year, shall be awarded by the said National Academy of Sciences to the author of such paper, essay or other work upon some branch of zoology or paleontology published during the year as in the opinion of the persons, or a majority of the persons, hereinafter appointed to be the judges in that regard, shall be the most

meritorious and worthy of honor. The medal and diploma and surplus income shall not, however, for more than two years successively, be awarded for treatises upon any one branch of either of the sciences above mentioned. Professor Henry Fairfield Osborn, of New York, the scientific director of the American Museum of Natural History in New York City and the secretary of the Smithsonian Institution at Washington for the time being, are appointed as such judges. Vacancies at any time occurring in the number of the judges shall be filled by the Council of the said National Academy of Sciences, and in each case of a vacancy it is the wish of the said Margaret Henderson Elliot that the council will, if practicable, appoint to the position an American naturalist eminent in zoology or paleontology.

As science is not national the medal and diploma and surplus income may be conferred upon naturalists of any country, and as men eminent in their respective lines of scientific research will act as judges, it is the wish of the said Margaret Henderson Elliot that no person acting as such judge shall be deemed on that account ineligible to receive this annual gift, and the medal, diploma and surplus income may in any year be awarded to any one of the judges, if, in the opinion of his associates, he shall, by reason of the excellence of any treatise published by him during the year, be entitled to receive them.

The committee of the award includes Secretary Charles D. Walcott, of the Smithsonian Institution; Director F. A. Lucas, of the American Museum, and President Henry Fairfield Osborn, of the American Museum. The committee invites nominations from the works of the year 1919. The award for 1917 was to Frank M. Chapman's "Birds of Colombia." The award for 1918 was to Beebe's "Monograph of the Pheasants."

Henry Fairfield Osborn

American Museum of Natural History, New York

SCIENTIFIC NOTES AND NEWS

Princeton University has conferred its doctorate of laws on Dr. Raphael Pumpelly, the geologist, and its doctorate of science on Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research. Dr. Carrel has also received the same degree from Brown University.

The degree of doctor of science was conferred upon Dr. Frank Schlesinger, director of the Yale Observatory, by the University of Pittsburgh at its commencement on June 9.

The degree of doctor of science was conferred on Professor Lewis William Fetzer, of the department of physiology and pharmacology in the Baylor University College of Medicine, at the recent commencement exercises of the University of Dallas.

The degree of doctor of laws has been conferred by the University of Pennsylvania on Professor John M. Macfarlane, who is this year retiring from the chair of botany after a service of twenty-eight years.

The degree of doctor of science has been conferred by the University of Liverpool on Professor F. G. Donnan, formerly professor of physical chemistry in the university, and now professor of chemistry in University College, London, and on Professor W. A. Herdman, formerly Derby professor of natural history, and now professor of oceanography, in the university.

The honorary degree of doctor of letters has been conferred by the University of Oxford on Dr. Temistocle Zammit, professor of chemistry in the University of Malta and curator of the Valetta Museum.

Dr. B. L. Robinson, Asa Gray professor of systematic botany in Harvard University, has been elected a corresponding member of the Czecho-Slovakian Botanical Society.

The Stewart prize of the British Medical Association has been awarded to Dr. Harriette Chick, an assistant in the department of experimental pathology of the Lister Institute.

Sir William J. Pope has been elected president of the Society of Chemical Industry.

Professor Augustus Trowbridge, of the department of physics of Princeton University, has been granted a leave of absence for the coming academic year in order to become chairman of the Committee on Mathematics, Physics and Astronomy of the National Research Council.

HENRY L. WARD, for the past eighteen years director of the Public Museum of the city of Milwaukee, has tendered his resignation to become effective on or before January 1, 1921.

ALEXANDER L. PRINCE, M.D., assistant professor of physiology in Yale University Medical School, has resigned in order to accept a position in the industrial research department of the Ætna Life Insurance Company at Hartford.

DR. ALFRED N. COOK, for sixteen years professor of chemistry at the State University of South Dakota and for thirty-nine years a teacher of chemistry, has resigned to take effect at the close of the present academic year. He will make his future home in southern California.

DR. A. NEIVA, chief of the public health service of the state of S. Paulo, Brazil, has been commissioned by the authorities to study the organization of the public health service in Japan and in the United States, and the prophylaxis of leprosy in Norway, the Philippines and Hawaii.

PROFESSOR EDMUND HARVEY, of Princeton University, has received leave for the first term of next year, during which he will join a scientific mission to the East Indies for the Carnegie Institution to study animal luminescence.

DR. FRANK E. LUTZ, of the American Museum of Natural History, of New York City, has started on the third of a series of expeditions planned to trace the distribution of insect life in the western part of the United States. The first of these expeditions collected in the Santa Catalina Mountains and the deserts of Southern Arizona; the second—made last year—worked in the Colorado Rockies. This year special attention will be paid to regions north and west of Colorado.

MR. E. P. VAN DUZEE, curator of entomology in the California Academy of Sciences, and Dr. E. C. Van Dyke, of the University of California, who attended the annual meeting of the Pacific Division of the American Association for the Advancement of Science in Seattle, will remain for a month in the state of Washington for field work. Mr. Van Duzee, who specializes in the Hemiptera, has in his collection and that of the California Academy of Sciences probably the most representative collection of Hemiptera in America. Dr. Van Dyke will collect Coleoptera in which he is a specialist.

DIRECTOR HOMER R. DILL, of the Vertebrate Museum, State University of Iowa, is to accompany Mr. Ernest W. Brown on a fish collecting expedition to the Hawaiian Islands during the months of July and August. The specimens collected will be divided between Mr. Brown's private collection and the Iowa Museum. The first of September an expedition headed by Professor Dill will be sent to the Cascade Mountains in northeastern Washington and British Columbia for the purpose of studying the mountain goats in their native haunts and collecting specimens for museum exhibits. The State Museum of Washington will be represented by Curator C. J. Albrecht. Other members of the party are Mr. Robert Brown, Mr. Russell Hendee and Mr. B. E. Manville. Mr. Ernest Brown, of Des Moines, is assisting the undertaking by meeting a considerable part of the expense.

DR. LIBERTY HYDE BAILEY, of Ithaca, now president of the American Pomological Society, is reorganizing the society throughout the country, and is establishing junior branches in a number of agricultural colleges in the United States and Canada. The American Pomological Society, organized in 1847, is the oldest of our national agricultural societies. The society proposes under its new plan to consider national affairs which touch upon the growing of fruits, such as legislation, quarantine, export, transportation and standardizing of methods.

THE Imperial Entomological Conference was opened in London on Tuesday, June 1, by Lord Harcourt. We learn from *Nature* that the official delegates to the conference are: Canada and South Africa, Mr. C. P. Lounsbury; Australia, Professor R. D. Watt; New

Zealand, Dr. R. J. Tillyard; India, Mr. C. F. C. Beeson; Queensland, Mr. F. Balfour Browne; British Guiana, Mr. G. E. Bodkin; Ceylon, Mr. F. A. Stockdale; East Africa Protectorate, Mr. T. J. Anderson; Federated Malay States, Mr. P. B. Richards; Gold Coast, Mr. W. H. Patterson; Imperial Department of Agriculture for the West Indies and Leeward Islands, Mr. H. A. Ballou; Mauritius, Mr. G. G. Auchinleck; Northern Rhodesia, Dr. Aylmer May; Southern Rhodesia, Mr. R. W. Jack; Seychelles, Dr. J. B. Addison; Sierra Leone, Mr. H. Waterland; Straits Settlements, Mr. P. B. Richards; Sudan, Mr. H. H. King; Trinidad, Mr. F. W. Urich, and Uganda, Mr. C. C. Gowdey.

Professor C. E. McClung, head of the department of zoology in the University of Pennsylvania, national president of the Sigma Xi, and chairman of the section of biology and agriculture of the National Research Council, addressed the Michigan Chapter of the Sigma Xi at the annual initiation and banquet on June 3 on the "Relation of the Sigma Xi to the National Research Council." Professor E. C. Case, of the University of Michigan, gave a brief memorial of Samuel Wendell Williston.

Frenatæ, the Entomological Club of the University of Minnesota, holds regular meetings every Tuesday throughout the year, at 4:30 P.M. in the entomological laboratories, University Farm, St. Paul. During the summer special field trips will be arranged. Entomologists visiting the Twin cities are invited to attend and to take part in these meetings. Among the visitors and speakers of the past year have been: H. E. Ewing, of the National Museum; W. E. Dove, Bureau of Entomology; T. B. McGath, of the Mayo Institution; H. E. Strickland, of the Canadian Entomological Service; Professor H. L. Osborn, of Hamline University, and Professor Sadao Yoshida, of Osaka, Japan.

The death is announced of Mr. Henry Lindenkohl, cartographer of the U. S. Coast and Geodetic Survey, in his eighty-second year, after fifty-nine years of service with the Survey. Mr. Lindenkohl was born in Hesse-Cassell, Germany, and became an American citizen in 1861.

Dr. James Hervey Hyslop, secretary of the American Institute for Psychical Research, formerly professor of philosophy in Columbia University, died on June 17, in the sixty-sixth year of his age.

Dr. Frank Shipley Collins, who for many years has been recognized as one of the foremost American authorities upon the *Algæ*, died suddenly of heart disease at New Haven, Conn., on May 25, in his seventy-third year. Born on February 6, 1848, he was for the greater part of his life a resident of Malden, Mass., where he became an expert accountant in the employ of a large rubber manufacturing company. He early developed an interest in botany and was a leading spirit in the Middlesex Institute, a local scientific organization which did much creditable work, including the preparation of the Flora of Middlesex county, Mass., of which Mr. Collins was co-editor with the late Lorin L. Dame. In 1895 Mr. Collins was one of the founders of the New England Botanical Club, of which he was president from 1902 to 1905. In 1899 he became one of the associate editors of *Rhodora,* the journal of the club, a position that he held with distinguished ability until his death more than twenty-one years later. The greater part of his contributions to science relates to the marine algæ, on which group he published many papers. In association with Professor W. A. Setchell and the late Isaac Holden, he edited an extensive and highly valued series of algal *exsiccatæ,* the *Phycotheca Boreali-Americana.* In recognition of his excellent scientific work he was appointed associate of the Harvard University Museum, was elected a fellow of the American Academy of Arts and Sciences, and received the honorary degree of D.Sc. from Tufts College.

The following quotation is taken from the *Bulletin* of Wheaton College under the heading "Our new professors":

Our former biology teacher because of a change in view or for some other reason was teaching the doctrine that human beings have descended from animals. This not being the belief of the college, which accepts the Bible account of creation in all its details, she resigned her position and her resignation was accepted. God sent to us in a very definite manner Professor S. J. Bole, an A.B. from the University of Illinois, who was for nine years an instructor in the Illinois State University, but whose religious views were positive and clear and made him desirous of a change. He has entered upon his work with enthusiasm and is very highly esteemed by his fellow teachers and students. In view of the general situation among university men, we consider his coming to us distinctly providential.

The Indian mathematician Srinivasa Ramanujan, F.R.S., fellow of Trinity College, Cambridge, has died at the age of thirty-two years.

The death is announced at the age of seventy-seven years of Clement Arkadievitch Timiriazeff, emeritus professor of botany in the University of Moscow, recently elected to the Moscow soviet. Professor Timiriazeff was known for his work on the participation of the different rays of the visible spectrum in the photosynthetic activity of the green leaf. He was the author of a number of books on botany and agriculture, his earliest being a work on "Darwin and his Theory" published in 1863.

The Biological Station of the University of Michigan will hold its twelfth session on the shores of Douglas Lake near Pellston in northern Michigan, June 28 to August 20, under the directorship of Professor George R. La Rue. The instructors are: Professor Frank Smith, University of Illinois; Assistant Professor Paul S. Welch, University of Michigan; Dr. Dayton Stoner, State University of Iowa; Assistant Professor Frank C. Gates, Kansas State Agricultural College; Assistant Professor George E. Nichols, Yale University; and Dr. John H. Ehlers, University of Michigan. Special and research courses in zoology and botany and facilities for research are also offered to qualified students.

The summer courses in biology at the Hopkins Marine Station, Pacific Grove, California, began on June 22 and will end on September 3. Instruction is offered in general zoology, the classification and ecology of marine invertebrates, comparative anatomy of vertebrates; the fishes of California, elementary physiology, general physiology, the algæ and special work in zoology, physiology and botany. The faculty will consist of Professors W. K. Fisher, Edwin C. Starks, and Gertrude Van Wagenen in zoology; Professors E. G. Martin, J. P. Baumberger, and J. M. D. Olmsted in physiology and J. I. W. McMurphy in botany. Dr. Frank R. Lillie, of the University of Chicago, spent the winter quarter at the station and Dr. H. H. Newman is there during the spring quarter.

UNIVERSITY AND EDUCATIONAL

The will of Richard M. Colgate gives $100,000 to Yale University and to Colgate University.

Drury College has completed the raising of $400,000 in order to secure an additional sum of $200,000 from the General Educational Board. The net productive endowment of the college is now over one million dollars. As a consequence of the success of this endowment, salaries of professors and teachers have been increased from 25 to 60 per cent.

At its last meeting the Yale corporation elected Dr. Milton Charles Winternitz dean of the Yale School of Medicine to succeed Dr. George Blumer. Dr. Winternitz joined the Yale faculty in the fall of 1917 as professor of pathology.

At Washington and Lee University, L. J. Desha, Ph.D., formerly professor of chemistry in the Medical College of Tennessee, has been elected professor of chemistry; W. D. Hoyt, Ph.D., associate professor of biology, has been promoted to professor of biology and head of the department.

At Oberlin College Associate Professor W. D. Cairns has been promoted to be professor of mathematics and head of the department, professor F. Anderegg having retired after thirty-three years of teaching in Oberlin.

At Princeton University, William Lauder Jones has been appointed professor of organic chemistry. Charles Rogers, of the Museum of Natural History, has been appointed curator of the biological museum. Charles Jones Browne, head of the department of hygiene and physical education at the University of North Carolina, has been appointed to be an assistant professor in that department. James Alexander, on leave of absence for war service, has been made an assistant professor of mathematics. Professor Raymond Smith Dugan was promoted to a professorship of astronomy. Dr. Carl C. Brigham was appointed assistant professor of psychology, and Benjamin F. Howell was raised to the rank of assistant professor of geology.

At the Carnegie Institute of Technology Henry L. Moore, assistant professor of physics at the Mississippi Agricultural College, will be assistant professor of physics, Ruth E. Canfield, instructor of ceramics at Alfred University, instructor of ceramics and weaving. James R. Everett, assistant professor of mathematics at Baker University, and George W. Hess, professor of mathematics at Bethany College, will become instructors in mathematics.

Professor J. T. Wilson, professor of anatomy in the University of Sydney, has been elected to the chair of anatomy at Cambridge, rendered vacant by the death of Professor Alexander Macalister.

DISCUSSION AND CORRESPONDENCE

THE USE OF THE TERM FOSSIL

There is probably no word more widely and loosely used by geologists than *fossil*. Paleontology, the study of ancient life, is literally the study of fossils; and stratigraphy, or the correlation of formations, is principally dependent upon fossils as horizon markers. The broad subject of historical geology, or the evolution of the earth and its organisms, is also largely a study of fossils. All workers in the above mentioned divisions of earth science would define a fossil as the evidence of former life, no matter how much they might disagree as to the full and exact definition of the term. Unfortunately, however, the term is often used by geologists in general as an adjective to denote age of geologic magnitude; hence: "fossil volcano," "fossil river channel," "fossil sand dunes," etc.; all of which objects are obviously of inorganic origin.

Fossil is derived from the Latin, *fossilis*, "dug up or dug out." The latest edition of the Century Dictionary defines the term as follows:

> Any rock or mineral, or any mineral substance, whether of an organic or inorganic nature, dug out of the ground. Specifically, in later geological and mineralogical use, anything that has been buried by natural causes, or geologic agencies, and bears in its form or chemical composition the evidence that it is of organic origin.

In spite of the above, there are literary persons who use the adjective form of the word in the sense of ancient or out-of-date; *i. e.*, "fossil poetry," "fossil statesman." Sometimes the "bad use" of the word is merely ludicrous, as in the case of a paleobotanist who frequently refers in the text to the student of fossil plants as a "fossil botanist."

In the latest text-book of paleontology[1] a fossil is defined thus: "A fossil is the remains of a plant or animal, or the record of its presence, preserved in the rocks of the earth."

A definition more exact than any to be found in the modern text books is proposed as follows: *A fossil is an object which indicates former existence of an organism which has been buried and preserved by geological causes, previous to historic time.* According to this definition the mastodon preserved in the arctic ice is a fossil; the leaf buried in the gutter is not. The remains of an organism may be a true petrifaction and yet not be a fossil. Fossil and petrification are not synonymous. Simply because a species has become extinct does not make it a fossil, even if its remains are petrified, or the knowledge

[1] "An Introduction to the Study of Fossils," H. W. Shimer, Macmillan Co., 1914.

of its former existence is preserved to us by means of impressions, molds or casts. On the other hand, certain shells preserved in the Pre-Pleistocene formations and which are not only practically unaltered but also have living representatives, are true fossils. The element of time as here applied to the definition may seem to certain biologists and geologists to be unessential. It is necessary, however, to have some term which may be applied to the "medals of creation" to set them apart from the realm of organisms which are living, or have lived within historic time.

Fossils may be briefly classified as follows:

A. Direct evidence.

1. Actual remains (spore cases; Oligocene ants, etc.).
   - (*a*) Hard and soft parts preserved.
   - (*b*) Hard parts only preserved.
   - (*c*) Hard parts minus organic matter.
   - (*d*) Hard parts plus mineral salts grading into:
2. Minute replacements (coal balls; labyrinthodont, teeth, etc.).
   Replacement molecule by molecule of the original organic matter by mineral salts, resulting in petrifaction which may or may not show structure. Results of metasomatic processes.
3. Coarse replacements (bulk of Palezoic fossils).
   - (*a*) Molds of the exterior and interior.
   - (*b*) Casts of the exterior and intermediate structures.
4. Prints (leaves; jelly fish, etc.). Plus or minus organic matter in the case of plants.

B. Indirect evidence.

1. Coprolites.
   - (*a*) Whole or part of original substance.
   - (*b*) Casts of original substance (coprolites of dinosaurs).
2. Artifacts (ant hills; prehistoric flints, etc.).
3. Tracks, trails or burrows (Arthrophycus; dinosaur tracks, etc.).

We may smile when the novelist uses the adjective, *fossil,* in a broad way; we may even argue with the petrologist, or physiographer when he uses the term to describe inorganic phenomena, but what are we to do when the paleontologist speaks of "fossil ripple-mark"? Clearly the word is rapidly becoming so used that it will soon be useless in a scientific sense. Since the paleontologist is more interested in fossils than the petrographer, geographer or even the "general" geologist, and since he alone has defined what fossils are, is it too much for him to ask his brother geologists to either adopt his definition or else to coin a new term which will better express the antiquity of inorganic structures. Perhaps it would be well for the paleontologists to set an example in the "good use" of the term, by using it correctly themselves. As they are also vitally interested in the geologic time-table, perhaps it would not be out of place for them to suggest that Paleozoic, Mesozoic, or Tertiary prefixed to "ripple-mark" or volcanoes would be much more descriptive and accurate than the adjective *fossil.*

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THE FIXATION OF ATMOSPHERIC NITROGEN

TO THE EDITOR OF SCIENCE: Allow me through the columns of SCIENCE to give publicity to a most unique experiment related to me by the late Dr. Paul Heroult, the inventor of the electric steel furnace, and simultaneously with Hall of the electrolytic process for the isolation of aluminum.

It serves to show in a simple but striking way the "fixation of atmospheric nitrogen" of which we have heard so much in the past four years.

Although described and shown to many scientific friends it was new to them all, and as it lends itself to lecture demonstration deserves to be better known.

The experiment consists in thoroughly mixing 90 grams of fine aluminum powder with 10 grams of lamp-black. This mixture is poured on a tile or an iron plate making a cone. A piece of magnesium tape, about 5 centimeters long, has one end thrust into the top of the cone, the other end being bent down so that it is easily lighted by the flame of a match.

Contrary to expectation there is no violent puff or explosion, as with magnesium powder, but a steady progressive combustion, vivid and brilliant, emitting little smoke. When the whole has burned down there remains the most beautiful mass of crystals of aluminium nitride, Al_2N_2, mixed with some crystals of aluminium oxide.

The greater part of the air which took part in the combustion is thus solidified, only the small amount supporting the combustion of the carbon going off as gases.

When this nitride is heated with a solution of sodium hydrate ammonia gas is evolved.

When the ammonia is mixed with oxygen or air and passed through heated platinum gauze, nitric acid is produced.

When the ammonia and nitric acid are made to react on each other the valuable fertilizer ammonium nitrate results. When this ammonium nitrate is mixed with aluminium powder a very safe but powerful explosive, "Ammonal" is produced.

Thus we learn how intimately these chemical reactions are related in peace to fertilization, and in war to destruction. The experiment illustrates: Combustion in which the nitrogen of the air, as well as the oxygen acts as a supporter of combustion; the production of a crystalline nitride, Al_2N_2; synthesis of ammonia; synthesis of nitric acid; fixation of nitrogen to serve as fertilizer; fixation of nitrogen to serve as explosive. It would be unwise for us to conclude that explosives serve only in war. Far from it. Man's best and most serviceable feats in engineering have been made with the aid of these powerful agents. We should not forget how seven acres of rock under Hell Gate were blown to bits by one blast, and our harbor opened up to vessels of greater size.

Charles A. Doremus

CURRENT RESEARCH AND PUBLICATION IN THE AMERICAN MUSEUM[1]

In cooperation with the United States National Museum and other museums, North America from the Arctic to the Isthmus is now well covered by American Museum activities. Its work includes explorations, publications and photographic collections, relating to historic and prehistoric races of men, to the insects, fishes, amphibians, reptiles, birds and mammals, as well as to the extinct ancestors of these living groups. Especially noteworthy serial publications on recent explorations, completed or well advanced, are papers on the "Anthropology of the Southwest" with the Archer M. Huntington Fund, the "Bibliography of Fishes" with the Jesup Fund, continued by Professors Dean and Gudger, and six volumes on "Fossil Vertebrates" with the Jesup Fund. Aided by the Jesup Fund, Professor Osborn, as a member of the staff of the United States Geological Survey, has just completed his monograph, "Titanotheres of Western America," on which he has been engaged for nineteen and a half years.

About $75,000 has been expended since 1910 on South American exploration and publication through successive expeditions led by Chapman, Roosevelt, Cherrie, Miller and Richardson. The senior curator, Dr. J. A. Allen, has produced a series of standard papers on South American mammals. Expeditions into the interior bear the name of Theodore Roosevelt. Dr. Chapman's "Distribution of Bird-Life in Columbia," recently awarded the Daniel Giraud Elliot Medal by the National Academy of Sciences, is a classic and leads to similar volumes on the birds of Ecuador, of Peru and of Chile.

The Museum has thus far expended $190,000 on African exploration, research and publication. Unrivaled collections of reptiles, birds and mammals are in storage awaiting the construction of the African Hall, as the result of the untiring field work of a suc-

[1] Modified from the fifty-first annual report of the president, Henry Fairfield Osborn, May, 1920.

cession of explorers, namely, Roosevelt, Tjäder, Akeley, Rainsford, Barnes, Rainey, Lang and Chapin. The two last named have rendered monumental service to African natural history in bringing out the most complete and the most perfectly preserved collection which has ever come from Africa, with precise field notes and 9,500 photographs. The results are being issued in a series of twelve volumes entitled "The Zoology of the Belgian Congo." To these volumes many other specialists of the country are contributing, notably Director W. J. Holland, of the Carnegie Museum, Professor William Morton Wheeler, of Harvard University, and Dr. Henry A. Pilsbry, of the Academy of Natural Sciences of Philadelphia. The first two Congo volumes were recently presented to the King of the Belgians following his visit to the Museum. A duplicate collection of Congo types is being sent to the great Congo Museum at Tervuren, Belgium, according to the agreement of the Museum with the Belgian government.

Through the successive journeys of Mr. Roy C. Andrews in Japan, Korea, the Provinces of Yunnan, Fukien, Shansi, and in Mongolia, aided by the Rev. Harry R. Caldwell, the Museum has made a notable beginning in the collections representing the eastern mountain, plain and desert life in Asia. Examples of the life of tropical Asia and Indo-Malaya are still required. All together there has been expended $35,000 in Asiatic exploration and publication up to the present time.

Popular scientific works are carrying the work of the Museum to readers all over the world. The series of popular volumes by Peary, Stefánsson, MacMillan, Roosevelt, Chapman, Miller, Wissler, Andrews and Lutz constitutes a library of standard reference on Arctic exploration, on African, Asiatic and South American travel, and on the ancient and recent history of the primitive races of Europe and of North America. Among these volumes are the following:

Peary, Robert E.
  Northward Over the Great Ice, 1898.
  The North Pole, 1910.
  Secrets of Polar Travel, 1917.
Stefánsson, Vilhjalmur
  My Life with the Eskimo, 1913.
MacMillan, Donald B.
  Four Years in the White North, 1918.
Roosevelt, Theodore
  Through the Brazilian Wilderness, 1914.
Chapman, Frank M.
  Bird Studies with a Camera, 1898.
  Camps and Cruises of an Ornithologist, 1908.
  Handbook of Birds of Eastern North America, 1912.
  The Travels of Birds, 1916.
  Our Winter Birds, 1918.
Miller, Leo F.
  In the Wilds of South America, 1918.
Wissler, Clark
  North American Indians of the Plains, 1912.
  The American Indian, 1917.
Andrews, Roy C.
  Whale Hunting with Gun and Camera, 1916.
  Camps and Trails in China, 1918.
Lutz, Frank E.
  Field Book of Insects, 1918.
Osborn, Henry Fairfield
  The Age of Mammals, 1910.
  The Origin and Evolution of Life, 1917.

For publication as well as for the enrichment of the collections and the preparation of exhibitions, the total sum of $1,412,839.32 has been expended, since Mr. Jesup's decease in 1908, from the income from the Morris K. Jesup Fund, which by the terms of the will is devoted to purely scientific purposes. The research product of the Museum has grown accordingly; the volume of publications has increased several fold; the popular publications, based on the pure researches of their authors, have spread the educational influence of the Museum all over the world. It is interesting to observe that certain branches of science relinquished by many of our universities are taken up by our museums.

The sales of popular publications have reflected the character of the public attendance and interest, being greater than ever, particularly of the *Guide,* which was exhausted much sooner than expected and "out of print" for four months. All together there were sold at the attendants' desks 3,005

Guides, 1,886 *Handbooks,* 3,087 *Leaflets* and 1,044 *Reprints,* a total of 9,022 copies.

The publications of The American Museum of Natural History for the current year include the *Annual Report;* the *Bulletin;* the *Anthropological Papers; Natural History,* the Journal of The American Museum of Natural History; the *Guide Leaflets,* and the *Handbooks.* During 1919 Volume XLI. of the *Bulletin* was published, which contained three articles on mammalogy, one on ichthyology, nine on invertebrate zoology, three on vertebrate palæontology, two on herpetology, one on ornithology and one on invertebrate palæontology. Also two volumes relating to the Belgian Congo were published: Volume XXXIX., containing a monograph by Bequaert on "A Revision of the Vespidæ of the Belgian Congo" and a monograph by Schmidt on "Contributions to the Herpetology of the Belgian Congo"; and Volume XI., which is devoted entirely to Pilsbry's paper on "A Review of the Land Mollusks of the Belgian Congo." The collection of papers on the Belgian Congo has steadily increased; a "List of Reports on the Results of The American Museum Congo Expediton" published this year contains a short description of fifteen such papers.

For the most part the members of the anthropological staff gave their time to the data obtained on former field expeditions. Problems of racial distinction and origins were developed by Assistant Curator Sullivan and Dr. Bruno Oetteking. Mr. Sullivan, with the cooperation of the department of physiology, made a series of microphotographs of racial hair cuttings for study and exhibition. His main investigation, however, concerned itself with a series of measurements upon full and mixed-blood Indians made some years ago under the direction of Professor Franz Boas. These data have been thoroughly compiled and correlated to show the results of race mixture. Among some of the significant conclusions are the constancy of degrees of correlation between bodily proportions even in mixed-bloods and the apparent inheritance of specific correlations between face width and breadth of head. Dr. Oetteking completed the measurement and description of the skulls for northeastern America and eastern Siberia, for a report upon the physical anthropology of the Jesup North Pacific Expedition.

Facilities for promoting research in human biology have been greatly improved during the year. A room adjoining the physiological laboratory has been equipped as an anthropometric laboratory and office for Assistant Curator Sullivan. By special arrangement the equipment of the physiological laboratory is now available for the work of this department. The Galton Society has organized a special laboratory for the study of racial characters, which, for the present, is housed in this department, the curator being the chairman of its governing committee and Assistant Curator Sullivan its director.

Assistant Curator Spinden discovered a correlation between the calendars of the Aztec and Maya that promises to give an unbroken historical record for the New World from the beginning of the Christian era. Mr. Leslie Spier has completed an exhaustive study of the sun dance of the Plains Indians, revealing some interesting culture movements among these tribes. Dr. Elsie Clews Parsons has nearly completed a detailed analysis of the social organization of the Rio Grande Pueblo Indians.

The *Anthropological Papers* deal entirely with the work of the department of anthropology. These papers are now in their twenty-ninth volume. The nine parts which appeared during 1919 include articles on various phases of the history of the Crow, Aztec, White Mountain Apache, Eskimo and Philippine tribes, and make a total of 713 pages, 125 text-figures and 3 maps. Among these articles are "Kinship in the Philippines," by A. L. Kroeber, Vol. XIX., Part III.; "Myths and Tales from the White Mountain Apache," by P. E. Goddard, Vol. XXIV., Part II.; and "The Aztec Ruin," by Earl H. Morris, Vol. XXVI., Part I. An important *Guide Leaflet* on "Indian Beadwork" was prepared by Dr. Wissler. The *Handbook* on the "Peoples of the Philippines," by A. L. Kroeber, has just appeared. It gives an interesting account of the ethnology and culture of the peoples of these islands.

Henry Fairfield Osborn

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE EFFECT OF SNOW UPON THE GROWTH OF WINTER WHEAT

It has long been believed that a snow cover is a beneficial factor in the growth of winter wheat; but some doubt has recently been cast upon this view, at least with respect to Ohio and Illinois, for which the question has been studied. Two short papers, one by Mr. Clarence J. Root[1] and the other by Professor J. Warren Smith,[2] have served as introductory to a longer discussion by Mr. T. A. Blair.[3] Professor Smith draws a clear distinction between the quantity of snowfall with its subsequent effect and the effect of a snow covering, for it may well be that a very heavy snow will melt quickly and leave the ground bare for a considerable time, or that a very light snow will remain for a long time unmelted on the ground. Thus, the question of the relation of snow and winter wheat is divided into two distinct aspects.

The first aspect has been discussed by Mr. Blair. His method of treating the problem is two-fold: first, by the well-known method of partial correlation, and second, by expressing the yield in linear regression equations of the form $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots$, in which Y is the yield; $x_1, x_2, x_3, \ldots$ are the various weather elements, such as mean temperature, total precipitation, sunshine, etc.; and $b_1, b_2, b_3, \ldots$ are constants for a given equation depending upon the data. In expressing such relationships, the author has had to assume that there is a linear relation between the weather and yield, which, as he says, "is doubtful in cases of extreme weather conditions," and also that the most important weather influences have been included in his equations. Of the latter, perhaps the most important are temperature and precipitation, although there are many other factors which are not considered owing to lack of data, but which are more or less directly related to the weather, namely, hessian fly and other insects, severe storms, hail, and loss of crop by storm after it is cut.

Taking the state of Ohio as a whole, Mr. Blair finds that there is little evidence that there are monthly values of weather elements which exert a profound influence upon the yield of wheat. After obtaining this negative result, he proceeds to treat smaller areas of the state and shorter periods than the month. First, confining his area to Fulton county, and his period to 10 days, he finds that there are certain conditions of temperature and precipitation—the former more than the latter—operative over short periods, and these are the dominant factors in determining the final yield.

His conclusions, which seem to cast doubt upon the validity of the practise of the Bureau of Crop Estimates in publishing crop estimates as early as December 1, show that for the state as a whole, a warm March and June and a cool, dry May are favorable for a high yield. There are certain critical stages in the development of the plant, in which the conditions during certain 10-day periods may exert an important influence, especially in northern Ohio. It is found that the weather should be cool during the jointing stage, dry during the development of the boot, warm while the head is filling, and warm during the last ten days of stooling. As to the quantity of snowfall, it appears that a heavy fall of snow in March is detrimental. Forecasts of yield, earlier than May or June, believes Mr. Blair, can be of little value, because of the great influence of temperature during those months.

The second aspect of the distinction drawn by Professor Smith, was investigated by Mr.

1 "The Relation of Snowfall to the Yield of Winter Wheat," *Mo. Weather Rev.*, October, 1919, Vol. 47: 700, 4 figs.

2 "The Effect of Snow on Winter Wheat in Ohio," *ibid.*, pp. 701–702, fig.

3 "A Statistical Study of Weather Factors Affecting the Yield of Winter Wheat in Ohio," *ibid.*, December, 1919, Vol. 47: 841–847, 2 figs.

Root in Illinois. He attempted to correlate the number of days with snow on the ground between December and March inclusive, or the number of days in March with freezing weather while the ground was bare, or even the number of days throughout the whole winter when the temperature was below 20° F. with the ground bare, with the yield of wheat in central Illinois, and in every case, he obtained a correlation coefficient so small as to cast great doubt upon the importance of the snow cover in determining the yield of wheat. More specifically, he found that there is reason to believe that wheat has a better prospect when the ground is not covered in January. The best years have been those with less than normal snowfall and with the temperature above normal for the winter. The years of poorest yield were those in which the winters had heavy snow and the temperatures were below normal. The companionship of warm winters and subnormal snowfall, and of cold winters and above-normal snowfall, is doubtless attributable to the fact that in a warm winter much of the precipitation falls as rain and that a snow cover tends to lower surface temperatures.

Studies of this type are important. It is true, however, that they are, through the complexity of weather factors and the pitfalls of the correlation coefficient, not always final in their result. Nevertheless, each serves a useful purpose in drawing the attention of agriculturists and others to the possibilities of relations or aspects of a subject which are either new or are opposed, as in this case, by a less scientific belief.

C. LeRoy Meisinger

SPECIAL ARTICLES

TRANSFERENCE OF NEMATODES (MONONCHS) FROM PLACE TO PLACE FOR ECONOMIC PURPOSES

Speaking generally, it is now beyond question that many soil-inhabiting mononchs feed more particularly on other nemas. However, they never follow these latter into plant roots, except in the case of open root cavities fairly readily accessible. They do not enter living plant tissues in pursuit of their prey. It follows that the good they do is in devouring the larvæ and young of injurious nemas at such times as the latter are accessible either in the soil or in open cavaties in the roots of plants.

In transferring mononchs from place to place with a view to making use of them in combating injurious nemas, the first requisite is a supply of mononchs. Such a supply may be obtained from soils in which the mononchs are numerous, and although we have comparatively little experience to guide us, yet it is now demonstrated that supplies of mononchs existing under these conditions are available. Thus far these supplies have been discovered more or less by accident; the cases, however, are numerous enough to establish the belief that special search will lead to the discovery of a sufficient number of these original sources of mononchs to furnish an adequate supply for trial.

The methods of collecting the mononchs, and transferring them, once they have been found, have been sufficiently elaborated for practical purposes, and published.

In transferring the mononchs to new situations, it is of course best to pay careful attention to the relative physical and biological conditions of the two habitats—the soil from which they are transferred and that to which they are transferred. The physical and biological conditions of the two habitats should be such as to insure the persistence of the mononchs after they have been transferred from the old to the new habitat. If the climatic and soil conditions of the new habitat closely resemble those of the old habitat, there is every reason to suppose that the mononchs will survive and flourish if there is a supply of suitable food.

The practical details may be illustrated by a hypothetical example. Suppose a region in Holland having a sandy soil has distributed in it as a plant pest the devastating nema, *Tylenchus dipsaci*, which, though more or less prevalent, is not doing very serious damage because held in check by mononchs. Suppose the existence of another region, like that in the vicinity of Bellingham, State of Washington, U. S. A., having a soil and climate similar to that of the district in Holland just mentioned, and suffering more or less severely from the ravages of *Tylenchus dipsaci* because this nema is not sufficiently held in check by any natural force. We may suppose that in this latter case *dipsaci* has been introduced at Bellingham without the enemies and parasites that hold it in check in the first-mentioned place. The mononchs found in the soil of the Holland district feeding upon *Tylenchus dipsaci* are collected and transported to Bellingham and introduced into the soil. There is good reason to suppose that under the new conditions, finding their food abundant, including the larvæ and young of *Tylenchus dipsaci,* the mononchs will flourish *Tylenchus dipsaci* in check.

If it be asked why injurious nemas are transferred from place to place without their enemies being transferred at the same time, the answer is that nemas injurious to plants are often transferred in the interior parts of plants imported in a living condition, and, as already indicated, the mononchs and other predatory nemas are less common in these situations than they are in the adjacent soil, which latter in the course of commerce often is removed from the roots and not shipped. One need only instance the case of bulbs and similar importations to see how much better chance the injurious parasitic nemas have of being imported than have those nemas which feed upon them. There is also reason to believe that sometimes the parasitic nemas infesting crops are more resistant to untoward conditions, *e. g.,* dryness, than are the predaceous nemas.

We have at the present time arrived at a stage where logically the next step is to try out the introduction of promising species of mononchs. Efforts of this kind will necessarily be somewhat expensive, probably more expensive than the corresponding early efforts to introduce beneficial insects. There can be no doubt, however, that the enormous losses due to plant-infesting nemas fully justify the expenditure of even large sums of money in an effort to apply this remedy, more particularly because the remedy, when successful, bids fair to be permanent and self-sustaining.

After long-continued and intensive studies I am thoroughly convinced that many of the practises evolved in the transfer of beneficial insects can, with appropriate modification, be applied to the nemas. At the present time the greatest drawback in the case of the nemas is the small number of people who are technically competent to make the necessary biological examinations. It is in this respect principally that their introduction will differ from that of the introduction of useful insects, for the nema problem is essentially a microscopic one. Though the collection of the nemas from the soil differs entirely from the collection of beneficial insects, the methods have already been brought to such a state that there are no insuperable obstacles.

The percentage of mononchs in miscellaneous collections of soil-inhabiting nemas taken from various situations is roughly indicated by the following figures based on the writer's examinations—in each case of from one thousand to several thousand specimens:

1. Miscellaneous collection from very small quantity of soil taken from the roots of 14 species of plants imported from Brazil, 6.5 per cent. mononchs.
2. Sandy soil about the roots of astilbe and peony, Holland, 11.6 per cent. mononchs.
3. Soil from cornfield in New Jersey in autumn, the prevailing genus was *Mononchus.*
4. Sand from Washington filter beds, 96 per cent. mononchs.

N. A. COBB
U. S. DEPARTMENT OF AGRICULTURE

THE INTERACTION OF ETHYLENE AND SULPHURYL CHLORIDE

SOME time ago,[1] while treating suphuryl chloride (SO_2Cl_2) with ethylene gas (C_2H_4) at room temperature, the writer discovered a reaction quite different from any other which has come under his observation. It was noted that when a fairly strong, steady stream

[1] First observed on February 28, 1918.

of ethylene is passed into sulphuryl chloride at room temperature no apparent change occurs until the gas has bubbled through for quite a long while. Under certain conditions, however, the colorless liquid suddenly turns greenish-yellow, accompanied by rather a sharp rise in temperature, which during the first two or three hours of the run amounts on the average to approximately 10° C. As the temperature rises, the liquid loses its color, soon to be followed by a gradual fall in temperature, which in the course of a few minutes reaches approximately that of the room. When the gas is passed steadily through the liquid, this remarkable cycle returns again and again uniformly and continually in the same order. At the minimum temperature the liquid invariably turns greenish-yellow (about the color of chlorine), which is a sure signal that the temperature will rise. At the maximum temperature, which is usually in the neighborhood of 35° to 40°, the liquid is colorless. A complete cycle ordinarily requires from 10 to 20 minutes, depending upon conditions, and these cycles may be observed for several hours. In the course of time, however, the cycles become longer and the differences in temperature less pronounced. This is what one would expect. A number of different runs has been made, with the same general results. The accompanying diagram shows very clearly some of the cycles observed when one of the experiments was carried out. An explanation of this interesting phenomenon has not been fully worked out, but the mechanism of the reaction is under investigation. It appears that sulphur dioxide and ethylene chloride (Dutch liquid) are among the products of the reaction. It may be that ethylene and sulphuryl chloride first unite to form an unstable compound which then dissociates into ethylene chloride and sulphur dioxide, or it may be that these products are formed by the interaction of the factors as represented by the following chemical equation:

$$SO_2Cl_2 + C_2H_4 \rightarrow C_2H_4Cl_2 + SO_2$$

William Foster

Princeton University

THE AMERICAN PHILOSOPHICAL SOCIETY. IV

SATURDAY, APRIL 24

Afternoon Session—2 o'clock

William B. Scott, D.Sc., LL.D., president, in the chair

Presentation of a portrait of the late Edward C. Pickering, LL.D., vice-president of the society, 1909–1917, by Vice-president Hale.

Animal luminescence and stimulation: E. Newton Harvey, Ph.D., professor of physiology, Princeton University. (Introduced by Dr. H. H. Donaldson.) The production of light by animals is due to the burning or oxidation of a substance called luciferin in the presence of an enzyme or catalyst called luciferase. It resembles the ordinary artificial methods of illumination by burning in that oxygen is as necessary for animal luminescence as it is for the light of a lamp or tallow candle. It differs in that water is absolutely essential for the light production and no carbon dioxide or heat is produced—at least no carbon dioxide or heat is produced at all comparable to that formed during the burning of such substances as tallow, either in the form of a candle or as food, to supply heat and energy for the body. Light production by animals differs also from light produced by combustion in that the oxidation product of luciferin, oxyluciferin, can be easily reduced to luciferin, which will again oxidize with light production. The reaction is reversible and appears to be of this nature—luciferin + 0 $\rightleftarrows$ oxyluciferin + H_2O. The difference between luciferin and oxyluciferin lies probably in this, that the luciferin possesses two atoms of hydrogen which is removed to form H_2O when the luciferin is oxidized. The H_2 must be added to reform luciferin. Whether the reaction goes in one direction or to the other depends, among other things, on the concentration of oxygen and the presence of a reducing agent. In a mixture of luciferin, luciferase, reducing agent and an abundant supply of oxygen, the reaction goes from left to right (with production of light) to an equilibrium. On removal of oxygen the reaction goes in the right to left direction with reformation of luciferin. Thus, while a firefly is flashing, oxyluciferin is produced and between the flashes oxyluciferin is reduced and is now ready to be again oxidized with light production. We may figuratively describe the firefly as a most extraordinary kind of lamp which is able to make its oil from the products of its own combustion. Not only is it most efficient so far as the radiation (being all light) it produces is concerned but also most economical so far as its chemical processes are concerned. The above reactions can be demonstrated in a test tube with a mixture of oxyluciferin, luciferase and ammonium sulphide. The ammonium sulphide is probably represented in living cells by reducing enzymes or reductases. If such a test-tube is allowed to stand, oxyluciferin is reduced to luciferin which will luminesce only at the surface of the fluid in the test-tube in contact with air. When the tube is agitated so as to dissolve more oxygen of the air the liquid glows throughout. Even a gentle knock or "stimulus" to the tube is sufficient to cause enough oxygen to dissolve to give a momentary flash of light which is strikingly similar to the flash of light given by luminous animals themselves on stimulation. This suggests that when we agitate a luminous animal or when the luminous gland cells of a firefly are stimulated through nerves with the resultant flash of light, in each case the stimulus acts by increasing the permeability of the surface layer of the cells to oxygen. This then upsets an equilibrium involving the luciferin, luciferase, oxyluciferin, oxygen and reductase within the cell, with the production of light and formation of more oxyluciferin. So long as the luminous cell is resting and unstimulated the tendency is for reduction processes to occur and luciferin to be formed. It must be pointed out that not all sorts of stimulation can be explained in this way, as the stimulation of muscles or nerve fibers may take place in the complete absence of oxygen.

The phosphorescence of Renilla: George H. Parker, S.D., professor of zoology, Harvard University. The common sea-pansy, *Renilla,* is found in most southern waters and has long been noted for its phosphorescence. It is a dice-shaped colony of polyps whose upper surface is covered with numerous small whitish patches, the phosphorescent organs. During the day *Renilla* can not be excited to phosphoresce, but at night on stimulation it can be made to glow with a beautiful golden green light. The light is produced in wavelike ripples that spread out from the spot stimulated and run over the upper surface of the animal. They travel at a relatively slow rate that agrees with that at which the nervous impulses of the animal travel. Hence it is concluded that the phosphorescence of *Renilla* is under the control of the nerve-net of the animal which apparently pervades the whole colony.

Feeding habits of pseudomyrmine ants: W. M. Wheeler, Ph.D., Sc.D., professor of economic entomology, Bussey Institution, Harvard University, and Irving W. Bailey, assistant professor of forestry, Harvard University. In 1918 the senior author described and figured various stages of the larvæ of *Pachysima* and *Viticola,* two genera of Pseudomyrmine ants from the Congo. Except in their earliest stages these larvæ have the ventral portion of the first abdominal segment much swollen and hollowed out as a peculiar pocket, opening just behind the head. The pocket was called the trophothylax (Wheeler, 1920), because the food, in the form of a subspherical or lenticular, usually dark-colored pellet is placed in it by the worker nurses, so that it is within easy reach of the larva's mouth-parts. As early as 1918 the pellet was known to consist of triturated pieces of insects, but subsequent careful analysis shows that the pellet not only in *Pachysima* and *Viticicola* but also in the two other genera of the subfamily, *Tetraponera* and *Pseudomyrma,* is merely the small pellet ("corpuscle enroulé" or "corpuscle de nettoyage" of Janet), which the worker ant first moulds in its own infrabuccal pocket and which consists of the solid food-particles collected by the ant with the strigils of the fore tibiæ from the surfaces of the antennæ and other parts of the body and carried into the infrabuccal pocket after being wiped off by the tongue and maxillæ. Other ants eventually spit out the pellet, which is commonly a moulded, subspherical conglomerate of diverse particles, such as small pieces of insects, fragments of plant-tissue, fungus spores and hyphæ, pollen grains, etc., and cast it away as refuse, but the worker nurses of the Pseudomyrminæ place it as food in the trophothylax of the larva. Even this, however, is not the whole story. Examination of the mouth of the larva reveals a singular, hitherto undescribed organ, evidently used for reducing the food-pellet to such a finely divided state that it can, when acted on by the digestive juices of the stomach, yield a certain amount of nutriment which the worker ant could not extract from it while it was in the infrabuccal pocket. This larval organ, which may be called the trophorhinium, consists of two flat, opposable plates, corresponding to the dorsal and ventral walls of the buccal cavity, each furnished with very fine, parallel, transverse welts or ridges, which, under a high magnification, are seen to be beset with very delicate chitinous projections or spinules. The ventral usually has more numerous rows of these structures than the dorsal surface. The two surfaces are evidently rubbed on one another and thus triturate the substance of the food pellet, only small portions of which are ingested at a time from the trophothylax. In all Pseudomyrmine larvæ and in many larvæ of the other subfamilies, except the Dorylinæ and Cerapachyinæ, the trophorhinium is beautifully developed, although in many ants (Ponerinæ) it must be used for comminuting parts of insects given directly to the larvæ by the workers. In its development the trophorhinium bears a strange resemblance to the stridulatory organs of the petiole and postpetiole of many adult ants. It may, in fact, function also as a stridulatory organ, when the food supply is exhausted, and thus apprise the worker nurses of the larva's hunger. Many ant-larvæ, notably those of the Ectatommiine Ponerinæ and of most genera of Formicinæ, also have elaborate but coarser stridulatory surfaces on the mandibles, so that the larva may be able to produce a variety of sounds and therefore communicate to the nurses more than one need or craving.

On correlation of shape and station in fresh water mussels: A. E. Ortmann, Ph.D., Sc.D., curator of invertebrate zoology, Carnegie Museum, Pittsburgh. Various observers have noticed that freshwater mussels differ in shape according to the localities from which they come, and that, generally speaking, flat or compressed shells are found in the smaller streams, more swollen shells in the larger ones. But these observations have been rather vague and indefinite. The present paper is devoted to the demonstration of this fact by careful measurements and their tabulation on the hand of abundant material from a great number of localities, and it has been found, indeed, that for certain species, such a law does exist, according to which more swollen specimens are found downstream, in the larger rivers, more compressed specimens more upstream, and that in the intermediate stretches of a river, these extremes are connected by gradual transitions.

Evolution principles deduced from a study of the even-toed Ungulates, known as Titanotheres: Henry Fairfield Osborn, Sc.D., LL.D., research professor of zoology, Columbia University.

The Astropotheria: William B. Scott, Sc.D., LL.D., professor of geology, Princeton University.

The middle Cambrian beds at Manuels, Newfoundland, and their relations: B. F. Howell, Jr., B.S., instructor in geology, Princeton University. (Introduced by Professor W. B. Scott.) The beds of Middle Cambrian age at Manuels, near St. Johns, southeastern Newfoundland, are part of a once widespread sheet of marine sediments, deposited millions of years ago off the shore of an ancient continent, which probably stretched across what is now the North Atlantic Ocean and for hundreds of thousands of years formed a land bridge between such parts of North America and Europe as were then above the sea. These beds are of special scientific interest because they contain large numbers of unusually well-preserved fossils, which prove that the creatures that swarmed in the waters then covering much of what is now New England, southeastern Canada and southeastern Newfoundland were of practically the same sort as those living in the seas which at the same period washed over many parts of Scandinavia and the British Isles. North America has probably been joined to Europe in this way several times in the geologic past, so that the animals living in the coastal waters could spread from the one hemisphere to the other; but it is seldom that geologists discover such clear evidence of one of these old connections as that which is presented by the Manuels fossils.

The Michigan meteor of November 26, 1919. Also *the glacial anticyclone and the blizzard in relation to the domed surface of continental glaciers:* William H. Hobbs, D.Sc., Ph.D., professor of geology, University of Michigan.

On Saturday evening the annual dinner of the society was held at the Bellevue Stratford Hotel and was largely attended, the following toasts being responded to:

The memory of Franklin: Hon. Oscar S. Straus.

Our universities: Dr. John M. Clarke.

Our sister societies: Dr. Harvey W. Wiley.

The American Philosophical Society: Professor Leslie W. Miller.

Arthur W. Goodspeed

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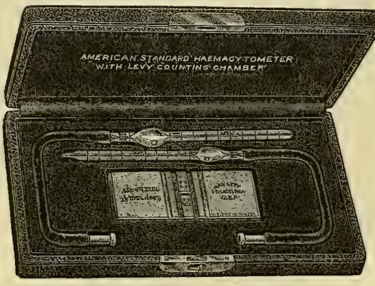

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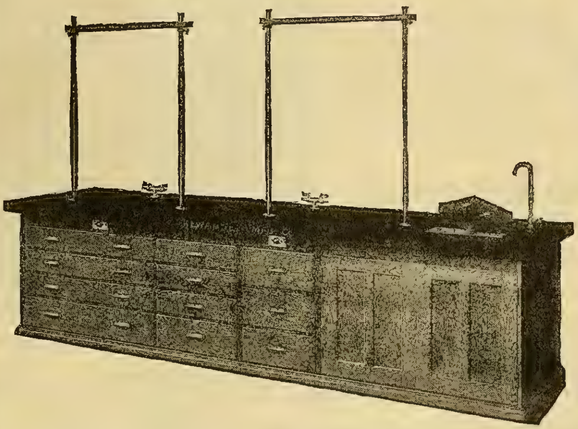

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