SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, JULY 3, 1908

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THE TEACHING OF MATHEMATICS[1]

As mathematical pedagogy is receiving increasingly marked attention in this country, a brief account of the reforms recently proposed by Professor Felix Klein, of Germany, may be of general interest.[2]

The three types of German higher schools leading up to the university are the Gymnasium, the Real Gymnasium and the Ober Real Schule, corresponding roughly to the classical, Latin scientific and scientific courses in American high schools. Until recently, the university could only be entered through the portals of the gymnasium. This exclusive privilege might be termed the gymnasial monopoly, and even yet the gymnasium is the school of the aristocrat.

However, as a result of the Berlin Conference of 1900 and the emperor's decree of the same year, the three schools were placed on an equal footing and each per-

[1] Prepared by the author in connection with a course on the History and Teaching of Mathematics, given by Professor S. E. Slocum at the University of Cincinnati. For reports prepared by other members of the class see article soon to appear in the *Educational Review.*

[2] "Uber eine zeitgemässe Umgestaltung des mathematischen Unterrichts an den höheren Schulen," F. Klein. "Bermerkungen im Anschluss an die Schulkonferenz von 1900," F. Klein. "Hundert Jahre mathematischer Unterricht an den höheren preussischen Schulen," F. Klein. "Uber das Lehrziel im mathematischen Unterricht der höheren Lehranstalten," E. Götting. Collected in "Neue Beiträge zur Frage des mathematischen und physikalischen Unterrichts an den Höheren Schulen," Klein u. Riecke, Teubner, 1904.

mitted to work out its ideal along its own particular line, provided that the aim is to produce cultured citizens. Graduates of the Real Gymnasium and the Ober Real Schule, however, are debarred from the study of theology, and graduates of the latter are further debarred from the profession of medicine. In addition to the exclusive rights possessed by these three schools as feeders to the university, they also have the privilege of furnishing candidates for a majority of civil service positions.

After a three years' course in a Vorschule, or equivalent work done with private tutors, the average boy enters these schools at the age of nine, and may accomplish the work in nine years, being eighteen years of age when ready to enter the university; but so extensive is their study, and so closely are they held to their work, that the graduate of these schools is considered by many to be prepared to enter the junior year of our colleges.

This thoroughness of instruction is due to the fact that in Germany teaching is a profession, and is invested with all the dignity of custom and authority. The teacher must be a university graduate and a specialist in those subjects which he expects to teach. After having completed a three to five years' university course, a year is taken for the teachers' examinations. The applicant must qualify in at least four subjects (two major and two minor), and may teach only those subjects in which he has qualified.

His examination consists of two parts: written and oral. In the first he is assigned topics upon which to prepare theses, and is given six weeks to prepare each topic. His doctor's dissertation may be offered as one of these. If the written examination is satisfactory he is orally tested to determine his readiness in commanding his specialties. If successful, he is given a certificate from the examining board, which is composed of university professors.

After securing this certificate, a year's course in theoretical pedagogy must be taken at some seminar. Then follows the Probe-jahr, or year of trial teaching under criticism. If he is finally declared proficient, his name is placed on the service list, and he ultimately secures a position, sometimes waiting six or seven years for an appointment.

Adding the year of army service, the candidate is at least twenty-five years old (most of them are thirty) when placed on the list. Considering the thoroughness of preparation, and the depth of German scholarship, the statement that Germany has the best trained teachers in the world is, therefore, not surprising.

It should also be noted that all schools must come up to a certain definite standard. The government has a thorough system of inspection (as a matter of fact, too much bureaucracy), so that for a given type of school certain courses are uniform throughout.

For comparison the following outline of the course in mathematics in the Cassel Real Gymnasium is given. The period chosen corresponds most closely to that of the average American high school course.[3]

OBERSECUNDA (age, 15–16 years)

I. *Geometry and Trigonometry,* 3 hours.[4] Plane geometry and trigonometry re-

[3] The nine years of the German high school course, beginning at the lowest, are called, respectively, Sexta, Quinta, Quarta, Untertertia, Obertertia, Untersecunda, Obersecunda, Unterprima and Oberprima. See Russell's "German Higher Schools."

[4] Since 1901, forty-two week-hours are devoted to mathematics in the Real Gymnasium, a week-hour being one hour per week throughout the year.

viewed and concluded; solid geometry; practical applications.

II. *Arithmetic and Algebra,* 2 hours.

Arithmetical and geometrical series; compound interest and annuities; quadratic equations; permutations and combinations; binomial theorem applied to positive integral exponents.

UNTERPRIMA (age, 16–17 years)

I. *Geometry and Trigonometry,* 3 hours.

Solid geometry continued; theory of plane and spherical angles; spherical trigonometry and its applications to mathematical geography; conic sections.

II. *Arithmetic and Algebra,* 2 hours.

Continued fractions and applications; arithmetical series of second order; cubic equations; problems in maxima and minima.

OBERPRIMA (age, 17–18 years)

I. *Geometry,* 3 hours.

Solid geometry reviewed and concluded; analytic geometry; problems in mathematical geography; geometrical drawing.

II. *Arithmetic and Algebra,* 2 hours.

Functions and applications to higher equations, especially those of the third degree; exponential, logarithmic, sine and cosine series; practical applications.

At the beginning of the nineteenth century those subjects whose development had been going on through the seventeenth and eighteenth centuries occupied the foreground in Germany, namely, Euclidean geometry; calculation with letters (Buchstabenrechnung); the theory of logarithms; the decimal system and the elements of analytic geometry. The elements of differential and integral calculus, although new, were also studied. The general tendency was toward the practical. Mensuration, elementary mechanics and those portions of descriptive geometry which dealt with fortifications occupied an important place. It is also noteworthy that a certain amount of mathematical knowledge was considered a prerequisite for philosophical learning, as witness the cases of Leibnitz and Kant.

Klein divides the nineteenth century into three periods. In the first period, extending from 1800 to 1870, mathematical instruction was a mixture of the pure and applied. Ideals were high, efforts were directed toward developing individual ability, and attempts were made to teach more than is now required. The candidate for the position of teacher of mathematics must be one who had gone as far as possible into the field, and was himself capable of original research. As the result we find such names as Grassmann, Kummer, Plücker, Weierstrass and Schellbach.

The second period, extending from 1870 to 1890, opened with the victory over France, and the assumption by Germany of a more important international position. This period seemed to be marked by the separation of pure, or abstract, and applied mathematics. In the schools the feeling prevailed that the development of the especially gifted pupil was not so much to be sought as that of the average pupil, and, consequently, greater interest was manifested in methods of instruction. A desire was expressed to replace the early system by a systematic graded course in mathematics, which should keep in view the ability of the constantly developing pupil. Drawings and models were demanded; problems were so stated and aids so given that pupils might see space relations, and not depend so largely upon the logic of the ancient Greeks. This was a direct result of the teachings of Pestalozzi and Herbart. In this period the teaching standard was lowered, as the teacher was only required to possess a knowledge sufficient to work out problems of moderate difficulty.

The third period, beginning with 1890, seems to be characterized by a tendency to again associate pure and applied mathematics; that is to say, the idea prevails that while a teacher should be thoroughly familiar with pure mathematics, his knowledge of its applications in the various fields should also be extensive. This is perhaps one result of the new order of things which puts the *real* schools on an equality as to privileges with the older gymnasium. There is also a tendency to allow the teacher greater freedom from the dictation of a centralized bureaucracy, and in this freedom lies an opportunity for future development.

For many decades, under the rule of the new humanism, the value of mathematical training was thought to lie in its formal discipline. Before the revival of learning it was the utilitarian factor which received emphasis, but in the last decades the majority have reached a more comprehensive view. Briefly stated, the modern view is that mathematical thought should be cherished in the schools in its fullest independence, its content being regulated in a measure by the other problems of the school; that is to say, its content should be such as to establish the liveliest possible connection with the various parts of the general culture which is typical of the school in question. Here, then, it is not a question of methods of teaching, but rather of the selection of material from the great mass furnished by elementary mathematics.

In the conference of 1900, it was agreed that each type of school should determine what form of culture its particular course should produce. It seems that the Gymnasium was asserting its claim to be considered preeminently the culture school, not hesitating to stigmatize the others as mere technical schools, while the friends of the Real schools apparently made no efforts at defense. Klein emphasized the fact that he considers the three schools of equal importance, and whatever he has to say concerns all three types.

Much of the material of instruction, although interesting in itself, lacks connection and is partially isolated. In fact, the topics seem for the most part to be the result of chance selection, and afford only a faulty and indirect preparation for a clear understanding of the mathematical element of modern culture. This element clearly rests on the idea of function and its form, both geometrical and analytical, and this idea should, therefore, be made the center of mathematical instruction. Klein's chief thesis is, in fact, that beginning with the Untersecunda and proceeding in regular, methodical steps, the geometrical concept of a function should permeate all mathematical instruction. In this is included a certain consideration of analytic geometry, and the elements of differential and integral calculus. He refers in this connection to two French publications which to a certain extent carry out his ideas.[5]

To accomplish this purpose, the graphical representation of the simplest elements, such as $y = ax + b$ and $y = 1/x$, should be begun in the Untersecunda. Trigonometry and the theory of algebraic equations furnish ample material for more complicated work, while in this connection related illustrations can be obtained from applications of mathematics, particularly from the domain of physics. Also the idea should be especially inculcated that a function can be developed empirically, perhaps by means of apparatus. In the Prima the general fundamental principles of both differential and integral calculus should be given, based upon the ideas which the pupil has acquired in the Secunda.

[5] "Notions de mathématique," Jules Tannery; "Algebra," E. Borel.

The ground to be covered depends largely upon the ideals of the school. Although the formal side must not be neglected and a thorough knowledge of processes must be obtained, the principal aim is to give a clear conception of the fundamental ideas and their meaning.

Much confusion often results from the fact that a word possesses several meanings. Thus a purist might define elementary mathematics as those parts of the subject in which the conception of a limit is avoided. The more commonly accepted definition of elementary mathematics, however, admits the idea of limits but excludes the special forms represented by the symbols dy/dx and $\int ydx$. Neither definition can be made to agree with the practise of the schools. For example, the first definition would exclude the consideration of such irrationals as $\sqrt{2}$, and π used in determining the area of a circle as the limit approached by a polygon. On the other hand, the second definition might be made to include much which does not belong in the schools, as, for example, the so-called "elementary" theory of analytic functions of the complex variable. The first definition might also be made to include much of the most difficult nature, such as advanced portions of the theory of numbers. In geometry there is also a new use of the word elementary. That portion of geometry is now styled elementary which is based on the Euclidean or ancient Greek geometry, the simplest conceptions of the newer geometry being of too severe a nature for the schools.

The only definition which will hold within the schools is a very practical one, namely, that shall be called elementary in the various branches of mathematics which can be grasped by the average pupil without extraordinary effort of long duration.

The material which constitutes elementary mathematics varies with time; that is to say, it is subject to the law of historical delay. Subjects which formerly were not considered elementary have, by improved processes of instruction, been made so, as is shown, for instance, in the geometry of the ancients. If, in consequence of the above definition, the extent of the field of elementary mathematics becomes too great and indeterminate, it comes within the province of the schools to choose those parts which best serve their purpose.

Mathematical instruction, on the level at which it is at present carried on in the upper classes of the higher schools, has existed in Germany since about the beginning of the eighteenth century. Christian Wolf, who was professor at Halle and one of the foremost schoolmen of this period, included in his list of elementary mathematics, in addition to the geometry of the ancients, a great many of what were at that time modern achievements, such as calculations with letters, negative numbers, algebraic equations and logarithms; in fact, practically everything which was known to mathematicians in 1700. It is evident that calculus was not included, for at that time the knowledge of calculus was the possession of only a few investigators of the highest type, whose efforts were not so much directed toward the clearing up of fundamental principles as toward the solution of new and difficult problems. To the layman, calculus seemed a sort of witchcraft. Cauchy's great work on differential and integral calculus appeared in 1821, but the schools had already been led into certain channels, and it was not possible to divert then toward a subject which was only in process of formation.

Moreover, it is true in general that mathematics is more susceptible than any other subject to hysteresis. A new idea finds its way into the schools through the lectures of university professors. A new generation of teachers is thus trained who give the idea shape in their class work, until finally it becomes the common possession of all. In accordance with this process of development, Klein expresses his belief that it is now time to make the fundamentals of calculus a necessary part of elementary instruction. To illustrate the historical development of the subject, he quotes the words of his teacher of mathematics, who said in the fall of 1865, "In elementary mathematics we can prove things, but in the higher mathematics it is different. They resemble a philosophical system, which we may or may not believe." It is remarkable that this idea has completely disappeared in such a short interval.

For a long time calculus was regarded with distrust, but as it received recognition in the official course of study of 1900, Klein believes that it is time to take advantage of this favorable attitude to put that which has taken centuries for preparation upon a general and recognized basis. As a matter of fact the fundamental ideas underlying the calculus are actually taught in many schools. In a few Ober-Real schools they are regularly taught as calculus, but in the majority of the schools they are given in a very roundabout manner. It amounts to this, that students are actually taught to differentiate and integrate as soon as occasion for the same arises, but the terms differential and integral are avoided.

An inspection of the text-books in current use in the higher schools shows conclusively that many of the simpler ideas of calculus are in use, but are rendered more or less difficult of comprehension by the avoidance of symbols and operations, which, if understood, would render the work comparatively easy. If the field of physics were examined, instances of this kind would be greatly multiplied, especially in the fundamentals of mechanics and electrodynamics. Evidently, then, calculus occupies a more extensive field than is commonly supposed, but it is taught unsystematically, and is merely tacked on here and there to the general content of mathematical instruction. Klein is of the opinion that instead of making instruction in calculus in those grades whose work demands its employment merely incidental, desultory and generally unsatisfactory, it should be made the central idea of all instruction, and the other ideas and work grouped around it.

At present calculus is made the beginning of higher mathematics and is accompanied by a revolution in thinking. This revolution furnishes good evidence of the aimlessness of the earlier instruction as contrasted with the ideas with which the pupil later comes in contact. Klein's suggestion aims to spare the pupil this sudden change, by gradually accustoming him to the methods of thinking which prevail in his later work.

The traditional methods of teaching will readily accommodate themselves to this new idea, and in fact will be much simplified thereby. This statement is borne out by a comparison of the cumbrous algebraic method of solving problems with the methods of calculus. On the other hand, no harm is done if certain portions of mathematics which supposedly have merely a formal training value, such as artificial equations solved by quadratic roots, and trigonometric analysis, are pushed to the rear, for the new material gives ample opportunity for formal work.

The inadequacy of the present system is clearly shown in the education of the lawyer, physician or chemist. As regards the first two, it is, of course, understood at the outset that their work in mathematics must necessarily be brief, as their major subject allows little time for it. Hence these students take up their major subject without preparation in calculus, with the result that some of the most important phases of their subject, depending upon higher mathematics, always remain obscure to them. This is true with lawyers, for instance, as regards questions of statistics, insurance, etc. With physicians the lack is felt at the very beginning of experimental physics, by reason of which instruction in the subject is necessarily placed on a much lower plane and the most important principles are only understood in a hazy way. It is still worse in chemistry, where quantitative determinations require the use of comparatively complicated formulas.

The text-books in these various subjects try to meet this situation with short prefaces on calculus, which the students are supposed to acquire in this condensed form. How then can the statement that calculus is too difficult for the higher schools be reconciled with the fact that students just released from the higher schools are expected to acquire this important subject from such condensed materials. Evidently conditions in the university emphasize the haziness of the aims of higher school mathematics.

Klein seems especially anxious to have it thoroughly understood that his plan is perfectly feasible, and comes well within the pedagogical possibilities of the case. In the first place, no more time is required than at present given to the mathematical curriculum. Moreover, he is not demanding a change in the course of study, but rather is urging that advantage be taken of the present leaning toward calculus, and carried out to its logical sequence. This, of course, can not be the work of a university professor, but must be that of the practical schoolmaster. The chief difficulty at present is that there are no text-books which fully meet the situation. Again, it is necessary to proceed with care and circumspection so as not to arouse the antagonism of the gymnasial leaders, but rather secure their friendly cooperation. There can be little opposition from the physicist if he is assured that there is no intention of invading his province, and it is pointed out to him that the pupils are being given tools for a far more complete mastery of his specialty. Neither should opposition be encountered from the representatives of the language and history departments if it is fully impressed upon their minds that the guiding principle of instruction should be the study of special subjects not as isolated from the rest of the curriculum, but with reference to the general culture which his particular type of school aims to produce.

The two main objections which are always urged when a university professor discusses educational problems of a general nature are that too little heed is given to pedagogical possibilities, and that university professors are only concerned about those pupils who will later come under their instruction. Concerning these objections, Klein answers the first by stating that he is keenly alive to the difficulty of the task of raising a large number of pupils, not especially gifted with mathematical ability, to a certain established level, and that his aim is not to raise this level, but rather to move it in what might be termed a horizontal direction.

As regards the second objection, he says that those pupils who take mathematics at the university are precisely the ones about whom he is not concerned, but that it is the future chemist, physician or lawyer whose mathematical training needs to be improved in order to bring about the best results.

Charles Ottermann
Woodward High School,
Cincinnati

THE IDEAL UNIVERSITY ADMINISTRATION

The recent controversy in Syracuse University is one that is of far more importance to the educational interests of this country than a mere quarrel between two individuals. It is a symptom of a disease which to some extent is common in many universities, that is, the government of a university by a single autocrat, supported in power by a body of absentee trustees who are not educational experts. The time is ripe for a general study of the subject of university administration.

A university is primarily a congregation of students and teachers. The corporation responsible for the administration of the university may or may not be constituted wholly or partially of either students or teachers. The earliest university in Europe, that of Bologna, Italy, founded in the year 1119, was a corporation of students. The University of Paris, founded in 1200, was a corporation of teachers. Given a body of students of legal age, they might under our laws form a corporation, and it might hire a body of teachers, frame a set of by-laws, erect and furnish buildings and equipment, and so form a university. Or another body composed exclusively of teachers might form an organization, elect themselves as officers, issue stock, rent or erect buildings and furnish them, and advertise for students just as a mercantile house advertises for customers. A third method of making a university would be for a single rich man to furnish money, form a corporation with four dummy stockholders, giving them one share of stock each, erect buildings, provide the necessary equipment, hire teachers, advertise for students, and begin the business of furnishing education in exchange for tuition fees.

These three different corporations might each organize and carry on a university of the highest rank. These three universities may differ in many things; in age and reputation, in wealth, in numbers of professors and students, in social standing and in fame in athletics, in methods of teaching and in number of subjects taught, in systems of government and administration. One may have a magnificent campus and marble palaces, another no campus at all, but a lot of rented brick buildings in a city block, converted from old residences. They may differ in all these things, but in one thing they must agree, the possession of a corps of professors of the first rank. Given such a corps of professors and the students will come as a matter of course. The real university is the body of professors and students. The real work of the university is teaching. The buildings, the equipment, the system of administration, are the possessions, the appendages of the university, not the university itself. As the body is more than the raiment, as the inhabitants of a house are more than the house, as a man is more than his possessions, so is a university more than its mere equipment.

Given a real university, a body of capable, cultured gentlemen, able and willing to teach, a body of carefully selected students, able and willing to learn, a roof to cover them, the necessary equipment of furniture, apparatus and other material that modern methods of teaching require, what else does a university need to enable it to carry on its work?

First, money to keep it from going into bankruptcy. This may be furnished by the state, as is done in the west. The students may contribute a great deal of it, as in most eastern colleges. The professors contribute some by working for small salaries, getting the remainder of their income from interest on their investments or from doing outside work, and some is presented in the shape of contributions or legacies from philanthropic citizens. The money is a mere detail. Good beggars may be hired on commission or salary to get enough of it to make up the annual deficits.

The next thing is a proper organization of departments. This the professors themselves, being educational experts, can easily provide.

Then there has to be provided a system of government. This will depend at first on the ideas of the originators of the university. We have assumed three universities, one started by students, one by teachers and one by a single rich man. They may all eventually by evolution reach the same best governmental system, or by degeneration the worst. The fittest may survive at last, but the unfit survives a long time. The United States has a splendid system of government, divided into legislative, executive and judicial departments, with mutual checks on one another, the result of the brains of Hamilton, Jefferson, Franklin and Washington. Old New England had an excellent system in its town meetings, but many of our states and cities are now suffering from bad government, the results of boss rule. So universities have not all reached the best type of government, and the existing type varies all the way from that of the chaos of mob rule to the rule of a czar. Mob rule is unstable, and never lasts very long. The boss soon appears and the rest of the mob become his puppets. The czar system is stable; it may last a thousand years, but it has fallen even in Persia, it is on the verge of falling in Russia, and it may fall within ten years in Turkey. The rule of the boss and that of the czar are not very different in results, although the czar rules by military force and the boss by the power of money.

The best system for a university is neither the boss nor the czar system, but the democratic system; not mob rule, but a carefully planned system of representative government, of which that of the United States is a model. It is founded on the principles of the Magna Charta and the Declaration of Independence. It involves the privileges of free speech, freedom of the press and trial by a jury of one's peers.

The object of a system of government, it has been said, is "to get things done." In organizing a good system of government there should be a carefully prepared list of the different things that are to be done and the best way of doing each should be considered. A mere suggestion of such a list is the following:

1. Determine the general policy of the university as to what departments of education it shall engage in.

2. Determine who shall have the appointing power of the executive officers of the government and who shall appoint professors and instructors.

3. Who shall be charged with the responsibility of raising money and who with the responsibility of spending it?

4. Who shall frame the constitution and by-laws and how and by whom shall they be amended?

5. The government of a university being like that of a nation, legislative, executive and judicial, where shall these different governmental powers be placed?

6. What procedure shall be followed in case any one has to make a complaint against a professor or instructor or other person holding office?

7. How shall a jury be constituted for his trial?

8. If the university is composed of several colleges, shall the general government of the university be managed by representatives from the colleges, or shall each college exercise only such power as may be allowed it from time to time by a central governing body or by an autocrat?

9. What rules shall be enacted concerning the discipline of students and who shall be entrusted with the enforcing of these rules?

10. What provision, if any, shall be made for calling in outside experts to advise in regard to improvements in educational methods, or what facilities shall be given to the professors to travel and study such methods?

The above list is not intended as a complete list, but is merely a suggestion as to the kind of questions that may arise in forming a university government.

The following is suggested as a form of organization which will best secure the desired result:

A board of trustees, the legal corporation, responsible for the financial management and for the enactment of broad legislation as to matters of general policy. It should contain men of wealth and social standing, to give it the prestige that such men can bring; men skilled in business and the law, to look after its invested funds; experienced educators, whose counsel may be valuable on matters of educational policy; representatives of each of the learned professions that has a college in the university; and representatives of the alumni of each college. Such a body of men under a proper system of government will not need to meet oftener than twice a year except in cases of emergency, nor will it need to take any active part in the details of management, but it would establish a set of rules delegating specific powers to another body of men better qualified than the trustees are to exercise them.

Such other body is a university senate or council, and it might be composed of, say, three trustees, who are willing to devote some time to university matters, of the deans of each college, ex-officio, of one professor from each college, elected for a definite period by its faculty, and of one alumnus of each college, not a trustee or holding any other position in the university, elected by the alumni association of each college.

This university council should be granted all powers not especially reserved by the board of trustees, and it may delegate such minor powers as it sees fit to the several deans or faculties.

The president or chancellor of the university should properly be elected by the trustees. He should represent the university on all public occasions. If he is an orator and money-getter, all the better; but whatever he is, it is not wise to give him autocratic power over the faculties nor over the council.

There might be a vice-chancellor, elected by the trustees on nomination of the council. It should be his duty to preside over the council, and to have a general oversight over educational matters, and he therefore should be an experienced educator.

Given two such bodies, each composed of strong men, and they could be trusted to discover the best system of university government and to frame it in a constitution and by-laws. Under such a government strong men could be obtained to fill the professors' chairs; they would be secure in their positions as long as they did their duty, and such a disgraceful proceeding as the one that has just taken place at Syracuse would be impossible.

William Kent
601 Comstock Ave.,
Syracuse, N. Y.,
June 9, 1908

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE

In a paper entitled "Cooperation in Scientific Bibliography" which appeared in Science, April 3, 1908, no mention was made of the work being done by the International Catalogue of Scientific Literature. As the

International Catalogue is undoubtedly the greatest of all cooperative bibliographical enterprises, it would not seem out of place to here briefly outline its present condition, its history having been sufficiently recorded in several papers by Dr. Cyrus Adler published in Science, August 6, 1897, June 2, 9, 1899, and August 28, 1903.

The first volumes of the International Catalogue dealt with the literature of 1901; since that date seventeen volumes have appeared annually, covering the whole field of science, classified under the following heads, each subject being the title of an annual volume: Mathematics, Mechanics, Physics, Chemistry, Astronomy, Meteorology (including Terrestrial Magnetism), Mineralogy (including Petrology and Crystallography), Geology, Geography (Mathematical and Physical), Paleontology, General Biology, Botany, Zoology, Anatomy, Anthropology, Physiology (including Experimental Psychology, Pharmacology and Experimental Pathology) and Bacteriology.

The aim of the International Catalogue is not only to cite the title of each scientific paper published since January 1, 1901; but to briefly supply an analytical digest of the subject of each paper. This is accomplished by means of classification schedules arranged to include in systematic order each minute subdivision or subject of all of the sciences named above. Not only was it necessary to provide in the schedules for the subjects of all previous scientific activities, but also to make ample and elastic provision for the present trend of scientific thought and investigation, and so far as possible to anticipate future need. It will be seen that such a broad system of classification must, to prevent its becoming unwieldy, be provided with some shorthand method of classifying the subject contents of scientific papers, not only for convenience in preparation, but for convenience in use. This has been successfully accomplished in the following manner: To each one of the sciences is assigned one of the letters of the alphabet, and to each of the subheadings in these sciences is assigned a number; in classifying the subject contents of any scientific paper instead of writing an abstract of the contents a letter and a number for each important subject treated is added to the citation, thus not only analyzing but classifying the author's work. The printed volumes are arranged first as author catalogues and second as subject catalogues. In the subject catalogues the classified references are assembled and grouped under each of the common heads to which they appertain, furnishing thereby a ready means of learning at a glance all that has been written on a given subject of scientific investigation. It will be seen that it is necessary for each paper to be examined by some one competent to appreciate its contents and note the salient points and principal subjects by means of the combined alphabetical and numerical method noted above.

The International Catalogue of Scientific Literature is more than an index, it is a condensed digest of the world's scientific literature.

As the editing and publishing of the International Catalogue is paid for entirely by the funds received from the subscribers, it has been necessary to charge $85 per annum for the complete set of seventeen annual volumes, although this sum has, up to the present time, barely been sufficient for the purpose intended. It is felt that the comparatively high price has greatly limited the sale of the catalogue and therefore limited its general usefulness, although no way can at present be seen to reduce the cost. Should a large endowment at any time be made for this work the general usefulness of the index could be extended by materially reducing the price of the volumes.

The organization of the catalogue is cooperative to the fullest extent; all of the nations of the world taking part in the work through the agencies of regional bureaus established in central locations in all of the principal countries of the world. These bureaus are supported by the countries in which they are established; in no case is any part of the subscription receipts used for their maintenance.

The Smithsonian Institution is and has

been, since the beginning of the undertaking, acting as the regional bureau for the United States and is, through the aid of a small governmental grant, collecting, indexing and classifying the scientific works published in this country. At the present time about thirty thousand classified references are being sent by the Smithsonian Institution each year to the London Central Bureau, and as the small congressional allotment only justifies the employment of a limited force to carry on the work this number represents practically the limit of the output of the bureau as at present constituted. The literature of each year since 1901 is gradually being filled in and when done will constitute a complete and permanent record of scientific work. That no paper of any importance might be omitted a most systematic routine is carried on of which a complete and permanent record is kept. For the regularly appearing periodicals a list of titles is kept and as soon as a number or part is indexed records are made of the fact, first under the title of the publication, then in an author's record, together with a complete copy of all data abstracted. By regularly going over these records any omission in a volume or part of a volume is apparent and the omission made good. For collecting books, pamphlets and separately appearing publications a variety of methods are resorted to; all the principal bibliographical lists are consulted, the *Publishers' Weekly* is regularly checked up, as are the following works: The Catalogue of Public Documents, proof sheets of the Library of Congress catalogue cards, the Experiment Station Record and various list of publications, such as those of the Carnegie Institution, the various colleges, the bureaus of the United States government.

The Smithsonian Institution is supposed to receive all scientific periodicals published in this country and its daily mail furnishes a great part of the material indexed. By means of these methods every published paper, coming within the scope of the catalogue, is almost certain at some time to come to the notice of the indexers for the catalogue. As similar or equivalent systems are used in the other regional bureaus in dealing with foreign scientific literature, it would appear difficult for any paper worthy of notice to escape this international drag-net now so systematically used to provide for the needs of the modern scientific investigator.

Leonard C. Gunnell,
Smithsonian Institution,
Washington, D. C.,
June 11, 1908

THE INDIAN INSTITUTE OF SCIENCE[1]

After negotiations and preparations extending over several years, the Indian Institute of Science is about to come into existence. Intelligence received by the last Indian mail states that Lord Minto, as patron of the institute, has appointed a provisional committee to conduct its affairs until the properties with which the institute is endowed can be vested in the constituted authorities. The committee has already met, and the construction of the institute buildings is to be commenced at once.

The institute owes its inception to the munificence of the late Mr. Jamsetji Nusserwanji Tata, a Parsi merchant and mill-owner of Bombay, who did much for the development of various Indian industries and started the scheme for the great iron and steel works now in course of erection at Sini. He wished to encourage the pursuit of science among young Indians, with special reference to the utilization of the country's resources, and thought the best plan would be the establishment of a large and well-equipped institution for post-graduate work. To this end he decided to allot a considerable portion of his ample fortune, in the shape of property at first calculated to produce Rs.125,000 (about £8,333) annually, though it is believed to have since appreciated in value. Unexpected difficulties were, however, experienced at the outset. Institutions of the kind in various parts of the world were first studied by special representatives, and it was sought to adapt their principal features to Indian requirements. Then the selection of a suitable site was a matter that took years

[1] From the London *Times*.

to decide. The city of Bombay was anxious to have the institute in its midst, or on the adjacent heights of Trombay, but experts advised that the climate was not suitable for delicate scientific work. Sir William Ramsay visited India, on the invitation of Mr. Tata, to assist him in his decision, and to advise concerning the character of the scheme. Professor Masson, of Melbourne, and Colonel Clibborn, Principal of Rurki College, prepared tentative plans and estimates. Ultimately, owing largely to the generosity of his Highness the Maharajah of Mysore, it was decided to build the institute at Bangalore, which has an agreeable and temperate climate. The Maharajah, on the advice of his late enlightened Dewan, Sir Seshadri Iyer, not only offered free a valuable site half a mile square for the institute and its grounds, but agreed to make an annual grant of Rs.50,000 (about £3,333) towards its maintenance. The cooperation of the government of India was an essential feature of the scheme. It was always recognized that the liberal provision offered by Mr. Tata would not, even with the aid of the Mysore grant, suffice for the cost of upkeep. The government was therefore asked to make an annual contribution. So long has the scheme been under consideration that almost the first duty undertaken by Lord Curzon on his arrival in India as Viceroy was a discussion of the matter with an influential deputation. Eventually the annual grant of the government of India was fixed at Rs.87,500 (about £5,833). Before the transfer of the property was completed Mr. Tata died somewhat suddenly at Nauheim. His two sons, who were his heirs, immediately announced their decision to carry out their father's wishes. As the property was in real estate, there were interminable legal delays, but these are now at an end. The cost of the buildings and equipment had, however, still to be provided. Towards this purpose the government of India has contributed Rs.250,000 (about £16,666), and the Maharajah of Mysore Rs.500,000 (about £33,333). The building is expected to cost Rs.1,100,000 (about £73,333), and the balance will be obtained from the surplus income already accumulated. By the late Mr. Tata's express wish, his name will not be associated with the institute.

On the advice of Sir William Ramsay, Dr. Morris W. Travers, F.R.S., who was formerly on the staff of University College, Bristol, was appointed director of the institute, and arrived in India about eighteen months ago. He has since been busily engaged in work connected with the undertaking, which is now primarily under his control. Sir Herbert Risley, on behalf of the government of India, has been closely associated with the various stages of development. Some members of the staff have been already appointed and have taken up residence at Bangalore. The site of the institute is about three miles from the center of the station, and is 3,080 feet above sea-level. It commands a view of one of the most beautiful pieces of undulating country in southern India, and the Maharajah has ceded jurisdiction over the site to the imperial government. The architect selected is Mr. Charles F. Stevens, whose father designed the Victoria terminus at Bombay and many other famous buildings in India.

The chief work of the institute will be the establishment of departments of pure and applied science, and students who have passed through the Indian universities will be trained so that they may apply science to the Indian arts and industries. It will be in no sense a "trade school." Though there will be no undergraduate side at present, it is expected that this may ultimately become a necessity, as has been the case with some post-graduate institutions in America. Even as it is, most of the Indian students entering the institute will first have to go through a course of practical instruction before commencing research. Private workers requiring accommodation for the purpose of investigating new products or processes, or actuated by a desire to carry out scientific research, will be received. Six departments are to be established, each with a professor and assistant professors. The director will occupy the chair of pure chemistry, and a professor of applied chemistry has already been selected. In view of the importance of vegetable products in India, there will also be a chair of organic chemistry. The nearness of the great Cauvery power works, from which a supply of electricity at high tension will be obtained, has led to the decision to open a department of electrical technology. There will also be a chair of bacteriology, and, though the sixth department has not yet been finally decided on, it may be a chair of metallurgy or electro-metallurgy. A large sum is being allotted for the creation of a library. Probably sixty students will be admitted to the institute in the first two or three years, and a few students in chemistry may be at work by the end of the present year, when temporary laboratories will become available.

The question of suitable openings for students of the institute causes no anxiety among those responsible for its direction. It is believed that the supply of well-trained scientific men will create a demand. There is already a certain demand in India for chemists in sugar works and similar concerns, and also for analysts in metallurgical enterprises. The demand for electrical engineers is growing rapidly. Dr. Travers states, however, that "it is not so much in industries which are already flourishing, but in nascent industries."

THE ORDER OF THE CONTENTS OF "SCIENCE"

With the present issue of Science, which opens the twenty-eighth volume of the new series and the fifty-first volume of the journal, a change is made in the arrangement of the contents. It may be explained that this is done in order that the number may be paged more quickly and conveniently. To fill the pages exactly certain of the items under "Scientific Notes and News" must be adjusted to fit. When these notes are at the end of the number, it must be paged until they are reached. Placing them in the middle of the number permits making up the forms by starting at the same time from the beginning and the end. The proceedings of Scientific Societies and Academies, which will hereafter be placed at the close of the number, will be printed in smaller type, in order that this department may represent as completely as possible the increasing activity of the scientific societies of the country. Finally, this opportunity may be used to remind subscribers that those who wish to receive their copies of Science with the pages trimmed should write to the publishers to that effect.

SCIENTIFIC NOTES AND NEWS

Dr. Adolf Meyer, director of the Pathological Institute of the New York State Hospitals, has accepted a professorship of psychiatry in the medical department of the Johns Hopkins University, and the directorship of the Psychiatric Hospital and Clinic, recently founded by Mr. Henry Phipps.

Harvard University has conferred its doctorate of laws on Dr. Charles R. Van Hise, president of the University of Wisconsin, and its doctorate of science on Dr. W. C. Gorgas, member of the Isthmian Canal Commission and this year president of the American Medical Association.

The University of Wisconsin has conferred its doctorate of laws on Professor Calvin M. Woodward, dean of the School of Engineering of Washington University, St. Louis, and on Dr. Frederick Belding Power, director of the Wellcome Research Laboratory, London, and formerly professor of pharmacology in the University of Wisconsin.

Yale University has conferred its doctorate of science on Dr. Graham Lusk, professor of physiology in the University and Bellevue Hospital Medical School, New York, and formerly professor in Yale University.

Amherst College has conferred its doctorate of laws on William Bullock Clark, professor of geology in the Johns Hopkins University.

Trinity College has conferred its doctorate of laws on Dr. James Ewing Mears, professor in the Jefferson Medical College, Philadelphia, and its doctorate of science on Dr. Andrew Ellicott Douglass, professor of physics and astronomy in the University of Arizona, and on

Dr. C. C. Trowbridge, instructor in physics in Columbia University.

The Albert medal of the Royal Society of Arts has been awarded to Sir James Dewar.

Sir William Ramsay succeeds Lord Kelvin as a member of the Dutch Academy at Amsterdam.

Dr. Wilhelm Pfeffer, professor of botany at Berlin, has been made a knight, and Dr. H. Lorentz, professor of physics at the University of Leyden, a foreign knight, of the Prussian order of merit.

President David Starr Jordan, of Stanford University, has been appointed United States representative on the international commission to investigate the fishery laws governing the American-Canadian border waters. He has gone to Eastport, Me., to meet the British commissioner.

At the May meeting of the American Academy of Arts and Sciences, held at Boston, Professor John Trowbridge was elected president, and Professor Edward H. Hall, corresponding secretary.

Dr. William H. Howell, dean of the medical faculty of the Johns Hopkins University, delivered the address to the graduating class of Jefferson Medical College, Philadelphia, at the annual commencement.

Professor Armin O. Leuschner, director of the Students' Observatory of the University of California, has been granted his sabbatical leave for the next academic year. He leaves Berkeley in June to visit some of the eastern observatories before going abroad. His time will be divided principally between Berlin and Paris. For the year of his absence the Berkeley astronomical department will be in charge of Assistant Professor R. T. Crawford as acting director.

Dr. J. Culver Hartzell, professor of chemical geology, University of the Pacific, will spend six weeks in a study of the metamorphic rocks of the Santa Lucia Range about the Big Sur region.

The University of Chicago will send a paleontological expedition to the Permian of Texas during the present season under the charge of Mr. Paul Miller.

The death is announced of Dr. Chamberland, sub-director of the Pasteur Institute, author of papers on anthrax, drinking water and epidemic diseases and other subjects.

Dr. Ostwald Seeliger, professor of zoology at Rostock, has died at the age of fifty years.

Dr. A. A. Baer, medical superintendent of Prisons, Berlin, and author of numerous writings on the hygiene of prisons, on criminals, on alcohol in relation to crime, etc., has died, aged 74.

The minister for agriculture of New South Wales, Australia, desires applications for the position of pathologist in his department. The salary will be six hundred pounds with yearly increments of twenty pounds, until the sum of seven hundred pounds is reached. The position is that formerly held by Dr. N. A. Cobb. Further information may be had by applying to Dr. Cobb, whose present address is Department of Agriculture, Washington, D. C. The applications are due in Sydney, New South Wales, on August 4, 1908.

The Everhart Museum of Science and Natural History, a gift of Dr. Isaiah F. Everhart, was dedicated and presented to the city of Scranton with fitting ceremonies on May 30. Dr. Everhart has endowed the institution with a fund of $100,000.

The New England Federation of Natural History Societies will hold a field meeting on the summit of Mount Washington during the week from July 1 to 8. The gathering will include representatives of about twenty societies and will be particularly strong in botanical members. The members of the geological section of the American Association will join the party at the summit at the conclusion of the meeting at Hanover.

The Council of the Association of American Geographers has decided to hold its next annual meeting at Baltimore, in affiliation with the American Association for the Advancement of Science. The exact dates of the meeting will be announced later.

The semi-annual meeting of the American Society of Mechanical Engineers was held in Detroit, Mich., from June 23 to 26. A session was devoted to papers on the conveyance of materials, hoisting and conveying machinery including belt conveyors, the use of conveying machinery in cement plants, etc., being discussed. The Gas Power Section of the society held a session, and the Society for the Promotion of Engineering Education and the Society of Automobile Engineers held a meeting in Detroit at the same time.

The twenty-fourth Congress of the Royal Sanitary Institute will be held at Cardiff on July 13 to 18, under the presidency of the Earl of Plymouth.

The results of a poll taken by the Geological Society, London, to ascertain the opinion of the fellows resident in the United Kingdom as to the admission of women to the society have been announced. The number of voting papers sent out was 870, and 477 replies were received. Two hundred and forty-eight fellows were in favor of the admission of women as fellows and 217 against their admission, but of this number 84 were in favor of their admission as associates.

On June 1 the Grand Duke Michael opened the International Congress on Navigation, which is being held for the first time in St. Petersburg.

The Second International Anatomical Congress will be held at Brussels, Belgium, in 1910, in accordance with a decision reached by the international committee at a meeting held during the session of the *Anatomische Gesellschaft* at Berlin. The exact date of the congress has not yet been fixed, but the probable date is the latter part of August or early in September. Brussels offers many advantages for such a congress, and the city has an established reputation for its hospitality towards scientific guests. It is hoped that there will be a considerable attendance from America, and early notice of the proposed congress is therefore issued that American anatomists may plan so as to be able to participate in it. The development of anatomical science in this country has been so rapid that we now have a large number of persons actively engaged in scientific research, and there ought to be a large American delegation in attendance at the congress.

The steam-yacht *Nimrod,* which took Lieutenant Shackleton's party to the Antarctic, and which returned to New Zealand some months ago, is lying at Lyttleton, the expedition's headquarters. Captain England, who took the *Nimrod* down to King Edward the Seventh Land, has resigned from his command, and has gone to the United Kingdom. The arrangement was that the *Nimrod* should make a magnetic survey of New Zealand waters until she was ready to go to the Antarctic again in December, 1908, to bring back Lieutenant Shackleton and his comrades, but as no commander has yet been appointed in Captain England's place, that arrangement has been abandoned. Professor David, of Sydney, at the last moment, decided to accompany Lieutenant Shackelton. In a private letter, sent by the *Nimrod,* after leaving the party at its headquarters near Mount Erebus, Professor David states that he expects to be back in New Zealand by April, 1909, when the whole party will return.

The Danish explorer, Captain Ejnar Mikkelsen, has returned to Copenhagen after his two years' sojourn in the regions north of Alaska. According to his statements in the Copenhagen papers, as summarized in the London *Times,* the expedition proved a success, and the scientific investigations were of value. He hopes to be able to continue the work next year. The chief object of the expedition was to decide whether there is land to the north of Alaska or a deep sea. Captain Mikkelsen's ship, the *Duchess of Bedford,* arrived on September 17, 1906, at Flaxman Island, where she was soon frozen in. The whole of that autumn was spent in mapping the surrounding country and observing the tide. About 40 miles from the coast the party found mountains from 10,000 feet to 12,000 feet in height, hitherto not marked on any map, and Mr. Leffingwell, the companion of Mr. Mikkelsen, undertook some geological researches. In March, 1907, Captain Mikkelsen, Mr. Leffingwell, and the mate of the Duchess of Bedford, a Norwegian named

Storkersen, started in three sledges with 18 dogs on a trip over the ice towards the north. The thermometer showed 56 degrees Centigrade below zero; nevertheless, they often came across big crevices among the ice floes. About 50 miles from shore they found water which they sounded with a newly-invented machine to the depth of 800 meters without reaching bottom. Sixty miles farther on no change was recorded, until at last, turning towards the southeast, they found bottom. They followed this edge of the continental shelf towards the east, but had soon to return owing to the strong current. Captain Mikkelsen was thus able to prove that deep water exists north of Alaska to a great distance. On the return journey the ice had started drifting and thick fogs enveloped everything, but on May 13, after 55 days of sledge journey, the explorers reached land again, only to find that the ship had been lost in the meantime. The ice pressure had proved too much for her, but the crew had saved all the instruments, food and utensils.

UNIVERSITY AND EDUCATIONAL NEWS

THE class of '83 of Harvard University will present to the university for its general endowment a fund of more than $100,000.

BY the will of George Bliss Griggs, who graduated from Yale University in 1872 and who died on May 22, Yale is bequeathed a fund of $75,000, to be used to found scholarships for worthy students in the academic department.

BY the will of Colonel C. S. Barrett, of Cleveland, O., a member of the class of '63 of Norwich University, the institution receives an unrestricted endowment of $100,000.

THE contract has been let for a new agricultural building for the University of Missouri which will cost $100,000. This building will contain the administrative offices of the College of Agriculture and Experiment Station, and will house also the departments of animal husbandry and agronomy and the State Soil Survey. It will likewise house the State Board of Agriculture, including the offices of the state veterinarian, the state highway commissioner and the pure food and dairy commissioner. The building is to be of native limestone, two stories and a high basement, with an extreme length of 266 feet. It will be thoroughly fireproof, and is to be completed by the middle of the next school year.

THE trustees of the Massachusetts College of Agriculture and the Mechanic Arts at Amherst have voted to establish a graduate school with Professor Charles H. Fernald as its head. It will confer the degrees of master of science and doctor of philosophy.

PROFESSOR C. H. BEACH, of the University of Vermont, has been elected president of the Connecticut College of Agriculture and Mechanic Arts. Professor Beach is succeeded in the chair of animal husbandry at Vermont by Mr. Robert M. Washburn, state dairy and food commissioner of Missouri.

THE following appointments, to take effect in August, 1908, have been made in Stanford University: John Andrew Bergström, of Indiana University, to be professor of education; Burt Estes Howard, of Los Angeles, to be professor of political science; J. E. McClelland, to be assistant professor of mining; John Kester Bonnell, to be instructor in English; F. O. Ellenwood, to be instructor in mechanical engineering; Robert E. Richardson, to be instructor in bionomics; L. Lance Burlingame, to be instructor in botany. The following promotions have been made: Allyn Abbott Young, from associate professor to be professor of economics; Frederick John Rogers, from assistant professor to associate professor of physics; Wesley Newcomb Hohfeld, from assistant professor to associate professor of law; Henry Waldgrave Stuart, from assistant professor to associate professor of philosophy; Charles Andrew Huston, from instructor to be assistant professor of law; Edwin Chapin Starks, from curator to be assistant professor of zoology; Samuel B. Charters, Jr., from instructor to be assistant professor of electrical engineering; Everett P. Lesley, from instructor to be assistant professor of mechanical engineering; George Holland Sabine, from instructor to be assistant professor of philosophy; Robert B. Harshe, from instructor to be assistant professor of graphic arts.

The following promotions have been made at Lehigh University: L. D. Conkling becomes assistant professor of civil engineering; S. S. Seyfert, assistant professor of electrical engineering; A. W. Klein, assistant professor of mechanical engineering; Joseph Daniels, assistant professor of mining engineering; J. W. Miller, assistant professor of mathematics; J. E. Stocker, assistant professor of mathematics and astronomy; F. R. Ingalsbe, assistant professor of geology; C. S. Fox, assistant professor of modern languages. In the department of chemistry D. J. McAdam, Jr., has been promoted from assistant in chemistry to instructor in physical chemistry and qualitative analysis; F. S. Beattie from instructor in chemistry to instructor in industrial chemistry and qualitative analysis.

DISCUSSION AND CORRESPONDENCE

THE AMERICAN SOCIETY OF NATURALISTS

To the Editor of Science: As secretary of the American Society of Naturalists it has recently been necessary for me to become more familiar with the organization and relations of this society and to face its problems from a new point of view, especially in connection with arrangements for a program for the next meeting in December.

Some of my suggestions will probably be benefitted by discussion and, hence, should be published in advance of the meeting. I am aware that this matter was brought up in Chicago some years ago, but as action is still delayed I shall try to formulate the problem concisely in the hope of securing the attention of the society.

The recent publication of the program of the American Association for the Advancement of Science for a Darwin celebration shows most clearly how urgent this problem is. Here arrangements, peculiarly the province of the naturalists, have been perfected without consulting their official representatives! Speakers have been engaged and dates set which may conflict seriously with the plans of the Society of Naturalists now maturing. Yet the American Association evidently desires to foster biological interests in undertaking such an extensive and appropriate program. The difficulty lies in the faulty organization of the naturalists! I have accidentally learned of a Darwinian celebration to be held about the same time under the auspices of the botanists. Other affiliated societies have not been heard from. Such lack of an organized cooperation between these societies must generally bring about diffuse results with more or less duplication or conflict. In this case, though each of the three or more Darwinian celebrations will probably prove to be well worth while, a proper recognition of the Society of Naturalists, as a primary natural division of the American Association, would have secured immediately a well-balanced correlation of effort resulting in a single celebration, even more effectively organized and representative. If, however, the society is to be thought of as a division of the American Association, it must be conceded the power of initiating and controlling action relating to the Naturalists.

The plan of organization for the Society of Naturalists, suggested below, would not merge it with any other society nor destroy its individuality, as has been feared at times would happen; on the contrary, it should gain a more dignified position, and its usefulness would be more generally recognized.

The following is my idea:

1. The Society of Naturalists is largely made up of members of affiliated societies, and still represents a real cooperation between these related special interests which have developed since its foundation. This cooperation should be maintained and extended by an effective organization.

2. The activity of this society, however, is now practically restricted to an annual dinner and to an annual discussion, though it makes occasional and irregular attempts at united effort when some common cause must be advanced, as, for instance, cooperation in biological investigation and teaching, or the dealing with educational, sociological or health problems, involving a national effort of the biological societies.

3. The group of societies forming the naturalists constitutes a great natural subdivision of the American Association for the Advancement of Science, representing a definite phase of the work and aims of this general society, but in no sense subordinate to it. The American Association should act for the Naturalists where its aid is demanded, but the relations of the two societies must be so adjusted that there shall be no danger of encroachment on the dignity, powers or functions of the Naturalists. The broader society can obtain good results only by a generous attitude of service to its coordinated sections.

4. The Society of Naturalists should then be preserved as an important group, but in a modified form.

5. The organization of the society should be made more representative and efficient by including all of the members of all affiliated societies. It should not then be restricted, from chiefly accidental causes, to a special list of names. As a matter of fact all naturalists are welcomed and actually take part in its dinners, discussions, etc. They should then be recognized as members. At present even a few of the officers of some of the affiliated societies are not rated as members of the naturalists.

6. The naturalists should appoint a committee to bring about a new coordination between their affiliated societies and also to secure a proper adjustment with the American Association for the Advancement of Science.

7. As soon as the affiliated societies will take this necessary action to place the Society of Naturalists on the footing it should occupy, the membership should be as follows: The membership of the society should still be published, but, since identical with that of its affiliated societies, by simply giving the titles of these societies, and referring to their lists and that of the American Association for addresses, etc. A few who are members of the naturalists, but not of the affiliated societies, should, of course, be added. In addition there should be a statement of the constitution, aims and acts of the society and its function of organizing cooperation in biological undertakings where combined action is desirable, should be clearly formulated and recognized.

8. The Society of Naturalists should no longer be obliged to collect dues, except from members not belonging to the affiliated societies. Even with its annual fee of one dollar it does not now receive the amount which should come to it under a different organization.

9. The affiliated societies should collect a small annual fee in addition to their own, to be devoted to the purposes of the Society of Naturalists, thus recognizing its usefulness. This would probably give a larger annual total than is now collected from its restricted membership.

10. The society should make the *American Naturalist* its official organ, and this journal should set aside special sections for the publication of articles and discussions bearing on the problems of the society. Dr. McMurrich, the late president of the society, has recently (see SCIENCE, March 5, 1908), pointed out in an able manner advisable lines for future development. He has also well expressed the feeling of many members that this society is an important factor in the scientific and educational development of this country, and the above suggestions are not intended to conflict in any way with the common desire that the society shall continue to remain independent, even though a readjustment of its external relations shall permit a more effective cooperation.

H. MCE. KNOWER
Secretary to the American Society of Naturalists

NEWS FROM KILAUEA

THIS volcano is now in action. Since 1894 there has been no exhibition at all comparable with that now apparent. Hon. L. A. Thurston, than whom there is no better judge of the conditions, writes as follows to the *Advertiser* issued May 29:

> Within the last few weeks the central pit has filled up by the rising of molten lava within its walls until its floor is now only about 200 feet below the floor of the main crater.
>
> At this level, 200 feet below the spectator,

there is a lake of molten lava, in the shape of the figure eight, approximately 800 feet long by 400 feet wide. Near the center of the northern lobe of the lake is an island some 78 feet in length, in the shape of a half moon. Within the little bay formed by the points of this island there is an almost constant boiling of the molten lava, with explosive bursts of gas every minute or so, which throws masses of the molten fluid into the air some 30 to 40 feet, and scatters it over an area of approximately 100 feet in diameter. Immediately after each outburst of gas a tremendous suction draws the lava from a radius of 100 feet of the bay into a vortex like that of a maelstrom, great cakes of lava 15 or 20 feet in diameter being turned up on edge, sucked in and disappearing like chips down a whirlpool.

Immediately north of the island, at a distance of not more than 100 feet therefrom, there is a gigantic outpouring of lava from beneath, without any bubbles or explosions. It looks like an enormous spring, the lava simply welling up and flowing off in all directions. The current is so rapid that the surface of the lake does not have time to cool, except in spots, and these spots are at frequent intervals upheaved by convulsions from beneath, and the black crust engulfed in the liquid lava beneath. The crusts striking the banks of the lake, which are from four to six feet high, are either shoved bodily upon the banks, like ice cakes in the Arctic, or upturned on edge and swallowed up in the fiery depths below. At intervals boiling spots appear at various points on the lake; engulfing the black cakes of lava floating thereon. The outpouring of the lava from the great spring is so great that the level of the liquid lava is raised faster than the surrounding banks can retain it, and at frequent intervals the banks give way and torrents of lava flow out into the surrounding territory in the pit, until that portion of the pit is raised to a level that stems the flood.

This action has been going on now for several weeks, the lake constantly enlarging and the floor of the pit being raised by the overflows of lava.

The brilliancy of action can be judged from the fact that a lantern is not needed in crossing the rough floor of the crater, the light from the lake being more than sufficient to show the trail in its details. The glare of the lake can also be seen any clear night from Hilo and Honuapo, at distances of 31 and 35 miles, respectively.

The probability is that this brilliant display can be seen for several weeks or months yet; but it would be well for visitors to lose no time in starting for the volcano for fear of disappointment. It will be many years before another equally good opportunity is likely to present itself.

C. H. Hitchcock

Hanover, N. H.,
June 10, 1908

SCIENTIFIC BOOKS

Air-ships, Past and Present. By A. Hildebrandt. Translated by W. H. Story. Pp. 364; 222 illustrations. New York, D. Van Nostrand & Co. Price, $3.50 net.

There have been hitherto few satisfactory books in English upon aerial navigation and information in newspapers has not always proved accurate. We now have, however, a book by a thorough expert, Captain Hildebrandt, instructor in the Prussian Balloon Corps, who wrote the work in 1906, and it was found so good as to warrant translating into English by Mr. W. H. Story. There are twenty-six chapters and profuse illustrations.

The greater portion of the book is naturally devoted to balloons. These vessels have now been developed to almost adequate speed and efficiency in the "dirigible air-ships" of the present day and the European nations are providing themselves with war aerial navies which are described and illustrated by Captain Hildebrandt, in a popular way so as not to repel untechnical readers.

He begins with the early history of the art, this referring chiefly to flying machines, and then gives two chapters to the hot-air balloon and its subsequent supersession by the hydrogen balloon. In the fourth chapter the theory of its flotation is taken up and formulæ are given for calculating the "lift" at different heights, or with different atmospheric pressures. Also for the effects of temperature upon the enclosed gas. Then four chapters contain the history of the dirigible halloon, with copious illustrations of the vessels which have marked the gradual increase in speed. This was twenty-two miles an hour for the French "Lebaudy" in 1906. Since then it has been increased by increased sizes to about thirty miles an hour, which must be very near the limit and will probably enable such craft to cruise about three quarters of the days of the year. A misprint on page 63 states the length of the German "Zeppelin" as 85 feet instead of 414 feet.

A rather scant chapter follows on flying machines, but it can be profitably studied to ascertain the various steps which have led to the success of the last two years.

After devoting one chapter to kites and another to parachutes, both of which are fairly well written, the author passes to military ballooning, in which he is evidently thoroughly proficient. He takes up its development, describes its uses in the Franco-Prussian war, and then devotes two chapters, the ablest in the book, to the modern organization of military ballooning in some fourteen different countries. This brings us to chapter XVI., Balloon Construction and the Preparation of the Gas, followed by one on Instruments, and then follows Ballooning as a Sport, in which the author is evidently an adept, having made many such expeditions and relating them in an entertaining way.

Chapter XIX., on Scientific Ballooning describes the various journeys (in some of which the scientists lost their lives) made to ascertain the laws of decrease of air pressure, of temperature changes, of saturation, of the composition of the air, of its electrical and its acoustical properties. The greatest authentic height attained by man has been 35,500 feet, while kites have been flown to 21,100 feet and unmounted balloons with recording instruments (ballons-sondes), have reached 85,000 feet (16.1 miles) and have furnished data which will presently be utilized in foretelling the weather.

The next six chapters treat of balloon photography, of the outfit required, of the interpretation of photographs, of the uses of kites and of the methods for interpreting the bird's-eye views obtained for topographical purposes, in all of which the author is evidently an expert. He has also had much experience with carrier pigeons and devotes a chapter to them. The reader may be surprised at the statement quoted that the mean speed of these birds is only about 26 miles an hour; feats mentioned in sporting books having been probably accomplished by the aid of the wind. Swallows fly faster than pigeons, but efforts to train them have failed so far.

The last chapter is on Balloon Law. The author states that such law can hardly be said to exist, but "that some sort of international regulation will be necessary in the future, seeing that balloons are now much more common than they were and that the dirigible air-ship is a practicable possibility."

The book is well written and well translated. Its perusal will enable the reader to follow understandingly the great advances since 1906 which are now in process of evolution.

O. Chanute

Chicago, Ill.

Laboratory Exercises in Physical Chemistry. By Frederick H. Getman, Ph.D. Second Edition. Pp. x + 285. New York, John Wiley & Sons. 1908.

The first edition of this laboratory manual was issued in 1904. Its author had set for himself the task of selecting for American students only such exercises as are typical, describing these in the clearest way possible, giving all reasonable discussion of theory and directions for work, and saving the student the labor of searching out his needs in such volumes as Ostwald's "Physiko-Chemische Messungen" and Traube's "Physikalisch-Chemische Methode." These must continue to be standard authorities, but with such wealth of detail and so many references to the German literature of the subject as to be often discouraging to the student who is not already well advanced.

While physical chemistry is now fairly differentiated as an individual branch of physical science, a laboratory manual on this subject is necessarily restricted in range, and the demand for it can never be large. Dr. Getman's aptness in clear statement and good arrangement is manifest, even without more than a cursory examination of the book. The best evidence that he was successful in giving satisfaction to students of his favorite subject is the unexpected discovery that a new edition is demanded within less than four years. This edition is slightly enlarged to the extent of about forty pages. A short chapter on thermostats has been inserted, devoted chiefly to the toluene regulator for temperatures both above and below the ordinary laboratory temperature. The chapters on electric conductivity and electromotive force have been enlarged, as are also those on solubility and chemical dynamics. The former short chapter on measurement of dielectric constants has been expanded to include that of radioactivity by use of the microelectroscope and the electrometer. Among the reference tables at the end of the book has been now included one for the calculation of the dissociation constant.

The volume is to be commended to students of physical chemistry and will be quite sure to maintain its character for usefulness that has been already well established.

W. Le Conte Stevens
Washington and Lee University

Mosquito Life: The habits and life cycle of the known mosquitoes of the United States; methods for their control; and keys for easy identification of the species in their various stages. An account based on the investigations of the late James William Dupree, M.D., surgeon general of Louisiana, and upon original observations by the writer. By Evelyn Groesbeck Mitchell, A.B., M.S. (Illustrated.) Pp. xxii + 281; 54 figures, 10 half-tone plates. New York and London, G. P. Putnam's Sons, The Knickerbocker Press. 1907.

The title is long—too long, too comprehensive, and not entirely accurate; for by her own showing a goodly portion of Miss Mitchell's book is based upon the observations of others than Dr. Dupree and herself. A brief and altogether appreciative biographical sketch of Dr. Dupree forms the major portion of the introduction and throughout the book are quotations from Dr. Dupree's notes; the text sometimes forced so as to bring them in fittingly. Indeed the book suffers from too much quotation, and in her anxiety to do justice to authors Miss Mitchell has sometimes lost in continuity of statement.

Nevertheless the book is interesting, on the whole very accurate and as nearly complete as a work on a living topic on which many persons are engaged can ever be. Miss Mitchell has a somewhat racy style, which prevents the book from becoming dull, wherever she herself speaks. For example, in dealing with the "buzzing" she says:

> There is, to the writer, nothing on earth so irritating as the shrill piping and shrieking right in one's ear just as one is comfortably drifting off into peaceful slumber. It rouses one up like a fire alarm. The victim snatches wildly at the air, thinking unutterableness, with the general result of a self-inflicted thumped head and the escape of the tiny offender.

For a book which makes a popular appeal the writer gives a surprising amount of strictly technical information. The chapters are arranged so as to bring out even the details of structure in all stages and the habits of the insects are elaborated at considerable length. In the life histories there is much detail and some of it, in the nature of breeding records, seems rather out of place.

In dealing with structures the author is at her best and speaks from personal knowledge; her drawings in illustration are good, and her comments on the bearing and importance of the structures are usually justified. As to the classification, that is in so chaotic a condition at the present time that no criticism is justifiable. Miss Mitchell follows Coquillett in general, and Mr. Coquillett is at least good authority.

An important feature in a book of this kind is the discussion of the relation of mosquitoes to disease and that is up-to-date and in a general way adequate. There is nothing new or original, the quotations from Dr. Dupree adding little, if at all, to our knowledge, though they do bring out the close connection of the Doctor's work with the yellow-fever investigations. The discussion, in the appendix, on Mosquitoes and Leprosy is inconclusive, and might have been omitted without loss.

The chapter on collecting and laboratory methods is good and contains suggestions that are most useful to all who have to do with these little pests. The discussion of mosquito remedies and enemies brings together the usual recommendations in concise form, and nothing is added by the author from personal experience.

Chapter XI., containing identification keys and a systematic list, covers sixty pages and is a most useful and ingenious production. The differences in habits and life cycle between the species of mosquitoes are so great and so radical that before practical work can be intelligently done it is absolutely necessary to know what species is really in fault. Many hundreds of dollars have, in the past, been wasted and many a mosquito campaign has in the past ended in failure, simply because the measures adopted failed to reach the species really in fault. These tables will at least help in the attempt to identify the pestiferous types.

For health inspectors, for those interested in sanitation generally and for physicians this book will be especially useful.

There is a rather scanty bibliography and a satisfactory index, in which the illustrations are separately referred to. As to the illustrations, those of the adults are rather disappointing. It seems to be exceedingly difficult to get a really characteristic representation of an adult mosquito and Miss Mitchell has not succeeded any better than others. Some of the illustrations of eggs and of structural details are excellent.

On the whole this is a very useful book: with plenty of faults and an abundance of points that might be criticized if criticism is fault finding; but altogether considered it is commendable.

JOHN B. SMITH

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for May opens with an article by A. E. Verrill on "Geographical Distribution; Origin of the Bermuda Decapod Fauna," which is considered an offshoot, mainly by accidental migration, from the West Indian fauna. Incidentally is suggested the desirability of introducing new species of crustacea to serve as food for fishes. Charles T. Brues discusses "The Interpretation of Certain Tropisms of Insects," concluding that we can not make satisfactory progress in interpreting the behavior of insects studied in the laboratory without careful reference to their behavior in nature. The third paper, on "The Evolution of Tertiary Mammals, and the Importance of their Migrations," deals with the Miocene Epoch. J. F. McClendon considers "Xerophytic Adaptations of Leaf Structure in Yuccas, Agaves and Nolinas." Francis B. Sumner gives a summary of the work of the season of 1907, at the Biological Laboratory of the Bureau of Fisheries at Woods Hole, Mass. Finally, Gertrude C. and Charles B. Davenport treat of the "Heredity of Hair-form in Man," showing what, under various conditions, are the chances of children having straight, curly or wavy hair. There is a detailed review of half a score of papers on crinoids by A. H. Clark, and a capital summary, by H. S. Jennings, of recent works on animal behavior.

Bird-Lore for May–June has articles on "A Family of Barred Owls," by W. C. Clarke; "The Brown Thrasher," by Charles E. Heil; "A Bittern Study," by Agnes M. Learned; "The Nesting Habits of Henslow's Sparrow," by E. S. Woodruff, and the fourth paper on "The Migration of Flycatchers," by W. W. Cooke. There are many illustrations and many notes. The report of the Audubon Societies shows continued progress and notes two new bird reservations, at Tortugas Keys and Fort Niabrara.

THE *Bulletin of the Charleston Museum* for May contains articles on the "Preparation of Museum Exhibits" and on "The Snowy Heron in South Carolina." This species, as the result of protection, has begun to reestablish itself on the South Carolina coast, and one rookery contained about one hundred birds, another at least two hundred, besides many of other species.

A RECENT number of Smithsonian Miscellaneous Collections is devoted to a paper by C. W. Gilmore on "Smithsonian Explorations in Alaska in 1907 in Search of Pleistocene

Vertebrates" and especially of the mammoth. Mr. Gilmore notes the conditions under which the fossils occur and presents an extremely clear and convincing suggestion as to how the Siberian mammoths became imbedded in ice, a suggestion that calls for no sudden and widespread glaciation and no great beds or ponds of ice. Mr. Gilmore gives a summary of our knowledge of the Pleistocene mammals of Alaska and the localities where they were found, and gives the particulars of the finding of two teeth of the mastodon near Dawson.

In *The Museums Journal* of Great Britain for May, Professor Geddes discusses "The Museum and the City—A Practical Proposal," to interest the public by devoting special attention to illustrating by maps, models and documents the past history of a city and suggest plans for its future improvement. W. B. Barton has "Thoughts on the Equipment of an Art Gallery and Museum" and S. L. Moseley has some notes on "Preserving Plants in Natural Form."

NOTES ON ENTOMOLOGY

The recent parts of Wytsman's "Genera Insectorum" include the hymenopterous family Trigonaloidæ (fascicle 61) by W. A. Schulz, 24 pp., 3 pls. The author has been fortunate in examining nearly all of the available material in this small family, so that all but three species are placed in the system. A number of new genera are established, mostly at the expense of *Trigonalys*. Fascicle 62 is by Dr. Schmiedeknecht on the parasitic Hymenoptera of the subfamily Pimplinæ, 120 pp., 2 pls. The author adopts the usual tribes, but the arrangement of genera is quite different from that of Ashmead. He makes no new genera, but accepts most of those of Ashmead; however he drops many of Förster's genera. Over 1,500 species are catalogued, of which 340 are in the genus *Pimpla*. Fascicle 63 is on a small group of tropical butterflies, the subfamily Dioninæ of the family Nymphalidæ. H. Stichel is the author, 38 pp., 3 pls. Fascicle 64, a ponderous volume of 487 pages, treats of the tiny beetles of the family Pselaphidæ. The author is A. Raffray, who has devoted his whole attention for many years to these insects. Over 3,000 species are arranged in the 452 genera. There are nine plates, three exhibiting the structural details, and the others show about 80 species, drawn by the author. M. Raffray considers that the 3,000 known species are not one third of the existing forms.

The British Museum has long been considered the greatest in the world. Recently it has published an account of its collection.[1] There are lists of the accessions for each year, the number of species and specimens in each order, and the number of boxes for each family. The number of types in each accession is often mentioned, and the persons who revised and arranged each group. The entire number of insects (1904) was 1,018,000 specimens. By orders as follows:

	Specimens	Named Species
Lepidoptera	355,767	41,210
Coleoptera	398,000	67,300
Hymenoptera	132,000	19,600
Hemiptera	57,650	11,700
Diptera	46,900	7,377
Orthoptera	18,800	3,900
Neuroptera	9,056	1,864
Aptera	140	21

The largest collection ever received was the famous Bowring collection of Coleoptera, 230,000 specimens; the next, Stephens general collection, 90,000 specimens; the third, 51,130 Lepidoptera of the Leech collection; the fourth, 45,000 Coleoptera, with over 3,000 types from the Pascoe collection.

Meigen's first work, a classification of flies, has been one of the rarest of entomological publications. Owing to this and to the fact that Meigen himself abandoned them, the genera there presented have rarely been accepted, but recourse was taken to later and more extensive works of this author. Dr. F. Hendel has now republished the paper, with numerous commentaries and references under

[1] "The History of the Collections contained in the Natural History Departments of the British Museum," 2 vols., 1905–7. Insecta, Vol. II., pp. 550–653.

each genus to its equivalent in Meigen's paper in Illiger's Magazine of 1803.[2] Now being available to all, the paper will doubtless kindle many nomenclatorial controversies. According to Hendel, there will be changes in 47 generic names. It would be of great advantage to entomologists, if others, who have access to rare papers, would follow the example of Dr. Hendel and republish them.

MR. R. SHELFORD has described a strange new genus of Diptera,[3] which shows still more than its allies a deceptive resemblance to the cockroaches. The creature is wingless, with deflected head, small eyes, no ocelli, an enlarged globular basal antennal joint, reduced mouth parts, flattened femora, no tarsal pulvilli, and the venter of the abdomen shows no segmentation. It comes from Africa, but nothing further is known about its occurrence.

THE third and concluding part of the Monograph of the Phasmidæ or stick insects has been issued.[4] This part contains the tribes Phibalosomini, Acrophyllini and Necrosciini, and is all by Redtenbacher. There are a great many new species described from his own collection, or from continental museums. Unfortunately he has omitted many species described in the last few years by American writers. The plates, by the author, well represent the remarkable structures of these marvels of insect life.

MR. V. E. SHELFORD, who for several years has been gathering ethologic material on the tiger beetles, has published the first of a series of articles upon this attractive group of insects.[5] There are notes on the habits of various species occurring in the vicinity of Chicago. The life history is given of *C. purpurea*, and more or less completely for *C. cuprascens*, *C. lepida*, *C. punctulata*, *C. sexguttata*, *C. hirticollis*, *C. scutellaris*, *C. tranquebarica*, *C. duodecimguttata*, *C. repanda*, *C. generosa* and *C. limbalis*. The plates show the larvæ, their burrows, the pupal cell, and the head and prothorax of the larvæ of the species; the position of the bristles on these parts furnish good distinguishing characters.

OF all our families of Homoptera the Fulgoridæ are perhaps the least known. Several years ago Mr. E. P. Van Duzee studied one group of them, and lately he has taken up some of the larger forms.[6] Descriptions are given of many new species from various parts of the United States, and tables to the subfamilies, several genera and some of the species. The same author, as the result of a brief trip to the island of Jamaica, has published a list of the Hemiptera of that island.[7] Nearly fifty species are described as new in the list of over 230 collected on the trip. Dr. O. M. Reuter has elsewhere described some of the Capsidæ taken by Mr. Van Duzee in Jamaica. And in the same society Mr. Van Duzee has published a comprehensive review of our tree-hoppers.[8] Synoptic tables are given to the genera and usually to the species. The author has placed more reliance upon the shape of the prothorax than many writers. It is hoped that the paper will lead to a monographic treatment in the near future.

DR. W. M. WHEELER has contributed two more articles to the ant fauna of our country. One, a revision of the Myrmecocysti[9] or

[2] "Nouvelle classification des mouches à deux ailes (Diptera L.) d'apres un plan tout nouveau," par J. G. Meigen, Paris, an VIII. (1800). Mit einem Kommentar herausgeben von F. Hendel, *Verh. zool.-bot. Ges. Wien*, 1908, pp. 43–69.

[3] "*Ænigmatistes africanus*, a New Genus and Species of Diptera," *Journ. Linn. Soc. Lond. Zool.*, XXX., 150–155, 1 pl., 1908.

[4] "Die Insektenfamilie der Phasmiden," Leipzig, 1908, pp. 341–589; 12 pls., folio; by K. Brunner v. Wattenwyl and J. Redtenbacher.

[5] "Life Histories and Larval Habits of the Tiger-beetles (Cicindelidæ)," *Journ. Linn. Soc. Lond. Zool.*, XXX., pp. 157–184, 4 pls., 1908.

[6] "Studies in North American Fulgoridæ," *Proc. Acad. Nat. Sci. Phil.*, f. 1907, pp. 467–498, 1908.

[7] "Notes on Jamaican Hemiptera," *Bull. Buffalo Soc. Nat. Sci.*, VIII. (No. 5), 79 pp., 1907.

[8] "Studies in North American Membracidæ," *Bull. Buffalo Soc. Nat. Sci.*, IX., pp. 29–129, 2 pls., 1908.

[9] "Honey Ants, with a Revision of the American Myrmecocysti," *Bull. Amer. Mus. Nat. Hist.*, XXIV., pp. 345–397, 1908, 28 figs.

"honey ants," is especially attractive because of the accounts of the habits of all the known honey ants of the world. These honey ants have one form in which the abdomen is swollen by stored honey. Such forms occur in six widely separated genera. Our *Myrmecocystus* belong to two species, each with several subspecies and varieties; they inhabit the arid regions of Mexico and the south-western United States. The other paper is an annotated list of the ants of Texas, New Mexico, and Arizona.[10] More ants occur in this region than in all the rest of the United States; 101 species being recorded in this first paper, 41 of which are in the genus *Pheidole.* There are many notes on the habits of the various species, and descriptions of several new forms.

Col. T. L. Casey has again published on the darkling beetles.[11] This time on the Coniontinæ, a group of moderate-sized insects found in the western states. About two hundred species are treated in synoptic form, more than half are described as new, and almost all are recorded from but one locality. Several new genera are based on species closely allied to *Eusattus* and *Coniontis.*

Making its initial appearance in the familiar garb of the French society comes the *Bulletin de la Société Entomologique d'Egypte.* It is published at Cairo in French, and under French auspices. Fascicle 1 has forty pages, and among other articles is one on the beetles found in the Egyptian mummies.

Nathan Banks

[10] "The Ants of Texas, New Mexico and Arizona," *Bull. Amer. Mus. Nat. Hist.*, XXIV., pp. 399–485, 1908, 2 pls., Part I.

[11] "A Revision of the Tenebrionid Subfamily Coniontinæ," *Proc. Wash. Acad. Sci.*, X., pp. 51–166, 1908.

SPECIAL ARTICLES

REGIONS OF MAXIMUM IONIZATION DUE TO GAMMA RADIATION

1. I have recently standardized the fog chamber by the aid of Thomson's electron. The method (as will be shown elsewhere) is not only expeditious, but leads by inversion, when my old values of the nucleations of the coronas are inserted, to values of e which agree with Thomson's and other estimates. This affords an incidental check on the broader bearings of the work. Thus a series of rough tests made in this way showed $e \times 10^{10}$ to lie between 3 and 4 els. units, agreeing closely enough with the accepted values to prove that both the positive and the negative ions are captured in my fog chambers, even at very high nucleations (500,000 per cu. cm.).

2. The experiments themselves run smoothly and take but a few minutes each; but there is an *inherent* difficulty involved in the interpretation of the distributions of ionization observed in the fog chamber. The radium (10 mg., 100,000, contained in a small thin sealed glass tube) is introduced into the inside of a cylindrical fog chamber, by aid of an aluminum tube (walls 1 mm. thick and about one quarter of an inch in diameter), thrust axially from one end to the other of the horizontal chamber. The inner end of the aluminum tube is thoroughly sealed; the other end lies quite outside the fog chamber, is open, and serves for the introduction of the radium tube. In this way the latter may be moved axially from the glass end of the fog chamber on the right of the observer, to the metal cap which closes the fog chamber on the left.

When the radium is successively placed at distances of about 11 cm. apart within the available 45 cm. the length of the fog chamber, the maximum nucleation (ionization) coincides with the position of the radium when both are near the glass end of the chamber (12 cm. in diameter). The nucleation then falls off rapidly and at first uniformly from the glass end to the metal end, where the coronas are strikingly smaller and the nucleation less than one half of that observed at the glass end. Considered alone, this would appear like the natural effect of an increasing distance from the source, except that the coronas near the distant end approach a constant diameter.

When the radium is moved about 12 cm.

(one quarter of the length of the fog chamber) from the glass end toward the metal end, the maximum nucleation, moving at a greater rate toward the brass end, has already outstripped the position of the radium and now lies near the middle of the chamber. The coronas and the corresponding nucleations, therefore, fall off rapidly toward both ends. In other words, the *maximum nucleation is seen where there is no radium.*

On moving the radium to the middle of the chamber, the position of the maximum nucleation coincides with the brass end, over 20 cm. beyond the radium. The coronas now fall off from left to right, to a uniform size near the glass end of the chamber, the ratio of the extreme nucleations being at least 200,000 to 100,000 per cubic centimeter in the cases examined. Finally, when the radium is placed in the brass cap of the chamber, the maximum still lies there and the nucleation falls off toward the glass end; but all nucleations are reduced throughout about one half.

It is clear that the two ends of the chamber behave differently. There must, therefore, be some sort of conflict (to use a word that has not been preempted) between the primary and secondary radiations which issue from the ends and other parts of the chamber. The solid walls both contribute nucleation; the glass wall most when close (a few cm.) to the radium, the metal wall at a greater distance (20 cm.) from the radium; but no simple hypothesis of the known properties of the rays will account for the occurrence and location of regions of maximum nucleation, nor for the high nucleation ratios specified. Moreover, plates of lead placed outside over the glass end of the chamber to modify the secondary radiation are quite without effect. Covering the aluminum tube with a thick lead pipe, the phenomenon is slightly reduced in magnitude, but not in character. It follows that the gamma rays are chiefly concerned.

In a region of maximum nucleation there must either be a larger rate of production or a smaller coefficient of decay. The latter may be expected if in the region of maximum nucleation the ions have largely the same sign. The best conception of the phenomenon which I can form at present is thus an explanation in terms of Bragg's[1] theory of neutral pairs for the gamma rays. As such, a region of primary rays may be regarded as devoid of nucleation. On impact, however, these paired rays separate into secondary cathode rays and alpha rays, returning with unequal swiftness from both ends of the fog chamber. In order to exist as separate condensation nuclei, they must, therefore, travel over a certain distance to be recognized as distinct particles by the fog chamber, the distance depending on the intensity of the impact of the gamma rays; depending, therefore, on the buffer, on the strength and distance of the radium from the buffer. In the above experiment this function is performed by the ends of the fog chamber. In case of very weak radium, a minimum of nucleation in the middle of the chamber, and coinciding in position with the radium, was actually obtained, in contrast with the central maxima for the strong radiations, as described above. Possibly the frequent occurrence of the ratio of 2 to 1 between the maximum and minimum nucleations may be similarly interpreted; but much further work is necessary before any definite conclusions can be reached. I am now constructing a chamber about 1 meter long, with the object of ascertaining whether more than one maximum of nucleation is producible; in other words, to interpret the stationary wave resemblances of the phenomenon.

3. A final element of interest is the behavior of the axial aluminum tube after the radium (in small sealed glass or aluminum tubes) has been removed. The internally sealed aluminum tube is distinctly radioactive for several hours, even though gamma rays alone have passed through it. The activity vanishes gradually, and more quickly if the ions are continually precipitated by exhaustion. The behavior of this residual nucleation is very peculiar; if the aluminum tube is pushed into the fog chamber, axially, from the glass end as far as the middle, the

[1] See *Phil. Mag.*, May, 1908.

part of the chamber around the tube shows strong coronas on exhaustion while the other half (toward the brass cap) is blank. Something, consisting of very slow-moving particles, gradually diffuses radially out of the aluminum tube. Of course it is difficult to deny with assurance that merest traces of emanation decaying within the aluminum tube may not possibly account for the activity; but what is remarkable in any case is the existence side by side of a region with nucleation and a region without it, in the absence of anything like a partition. The fog chamber itself must at all times be scrupulously free from infection such as an emanation would produce, and anything of this kind is at once detected.

Carl Barus
Brown University,
Providence, R. I.

A NEW METHOD OF ENUMERATING BACTERIA IN AIR

The development of accurate bacteriological methods for the examination of air has not attracted wide attention in recent years; and this branch of bacteriology is far behind the related subject of water bacteriology in its technique and interpretation.

Bacteriological examinations of air have been carried out by most observers in one of two ways, without much attempt at critical control. The most primitive method consists in the simple exposure of plates of nutrient gelatin or agar for a more or less indefinite period. The colonies developing, correspond in a rough way to the bacterial flora of the air above. The method, however, can not be considered a quantitative one, since the number of bacteria which fall on the plate is not related to any particular volume of air and must vary with all sorts of environmental conditions. Nevertheless, this method is still used in many investigations in which quantitative results would be valuable; as in the important work of Major Horrocks on the presence of bacteria derived from sewage in ventilating pipes, drains, inspection chambers and sewers.[1]

[1] *Proceedings of the Royal Society*, Series B, Vol. 79, No. 531, p. 255.

The other method in common use is a modification of the sand-filter method of Pasteur and Petri. It involves the filtration through asbestos, sand, sugar, etc., of a measured volume of air; the washing of the filtering material with sterile water; and the plating of aliquot portions of the wash water in the usual way. Pasteur used asbestos for his filtering material; Sedgwick and Tucker recommended finely powdered sugar; and Petri and most recent observers have used sand. Petri pointed out that the sand should be of such fineness as to pass a .5-mm. mesh. In a recent important study of the air of the New York Subway Soper used both the plate method and the sand-filter method. The sand grains used were "about half a millimeter in diameter" and the sand layer 5 cm. deep.[2] In discussing these methods, in another paper, this author said, "as is well known, there is no precise way to determine the numbers of bacteria in air."[3]

I have been engaged for about a year in a study of bacteria in sewer air; and relied at first upon the sand-filter method. The remarkable results, reported by Major Horrocks in the paper to which reference has been made, led me to revise the detail of my technique with considerable care. In the course of the investigation a modified method of air examination was developed which is here reported in the hope that it may be of assistance to others at work on similar lines.

My aim was to combine the quantitative results of sand filtration with the directness and simplicity of the plate method. Hesse did this after a fashion by slowly aspirating air through a long roll-tube the walls of which were covered with melted gelatin. There was, however, a possibility in such an apparatus that bacteria might be drawn through, without settling out on the walls. My method is really a modification of Hesse's with an increase in the size of the culture vessel relative to the sample of air. I use two liter-and-a-half bottles arranged as shown in Fig. 1. On the

[2] *Technology Quarterly*, XX., 58.

[3] *Journal of Infectious Diseases*, Supplement No. 3, 1907, p. 82.

bottom of each is a layer of nutrient gelatin; and the tubing is adjusted so that a measured volume of air may be drawn through the two bottles in succession, by the action of a water-suction bottle, shown inverted on the right of the figure. In practise I place any desired amount of water, generally one liter, in the suction bottle and by slowly inverting it draw a corresponding volume of air from the bottom of the second culture bottle. The same volume of air passes from the bottom of the first bottle into the top of the second and from the outer air into the top of the first bottle. A known amount of air is thus drawn into the first bottle and the bacteria present settle out and form colonies on the gelatin. The volume of air examined being less than the capacity of either bottle, most of the bacteria remain in the first. A few, which are carried down by direct short currents, are caught in the second bottle. The results of a few examinations made by this method are shown in the table below.

The number of bacteria reaching the second bottle is evidently small, in most cases less than 10 per cent., and the number lost by being drawn through the second bottle must be negligible. With the exception of the possibility that bacteria may settle on the walls of the bottles, the method should give a complete account of all bacteria present which will grow under ordinary conditions of cultivation.

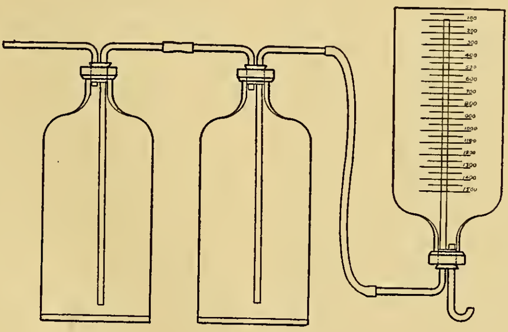

Fig. 1.

AIR EXAMINATION BY CULTURE BOTTLE METHOD

Air	Sample, c.c.	Colonies, First Bottle	Colonies, Second Bottle	Bacteria per Liter
Normal street air.	1,500	4	0	3
Air above foaming soapy emulsion of *B. prodigiosus.*	1,000	1	0	1
	1,000	1	1	2
	1,000	1	0	1
	1,000	3	0	3
	1,000	1	0	1
Air sprayed with suspension of *B. coli.*	100	73	1	740
	100	984	91	10,750
	100	394	69	4,630
Air sprayed with suspension of *B. prodigiosus.*	100	492	3	4,950
	100	320	34	3,540
	100	1,188	120	13,080

The culture-bottle method was devised primarily as a check on the sand filter method; and two types of sand filters were used for comparison. The first was the classic Sedgwick-Tucker apparatus, which consists of a glass tube 15 cm. long and 4 cm. in diameter, opening at one end into a smaller tube 10 cm. long and .5 cm. in diameter. A layer of 5 cm. of sand was supported in the small tube by wire gauze. A measured amount of air was drawn through, entering the larger tube and passing out through the sand. The sand, with the bacteria filtered out, was shaken down into the large tube, melted gelatin was added, and

Fig. 2.

by rolling the tube on ice the gelatin with the sand and bacteria was cooled on its inner surface. The sand used in this filter was between .5 mm. and 1 mm. in diameter.

The other type of filter tested consisted of two short tubes, 1.5 cm. in diameter, arranged in tandem, each containing 2.5 cm. of fine sand, between .1 mm. and .3 mm. in diameter. The sand in each tube was supported by bolting cloth on a perforated rubber stopper and the tubes were connected by rubber tubing. The apparatus is shown in Fig. 2. After drawing air through this filter, the sand from each tube was shaken out into ten cubic centimeters of sterile water and, after thorough agitation, aliquot portions of the water were plated. This method is essentially the one used by Soper and by most recent observers.

Each of these filter methods is open to possibilities of error. Bacteria may be drawn completely through the filtering layer in either case; and in the second method there is danger that bacteria filtered out may not be separated from the sand or bolting cloth. My object was to find out the magnitude of these errors by direct comparison with the culture-bottle method. For this purpose a number of examinations were made, of normal air, and of air artificially infected with bacteria by spraying with emulsified cultures. With the filtration method samples of 750 c.c. to 1,500 c.c. were slowly drawn through the sand, the filtration occupying from two to three minutes. With the culture bottles, samples of 100 c.c. were generally used and the air was drawn in more rapidly. The general results obtained may be shown best by quoting a few typical experiments in detail.

Experiment III.—Examinations of air of a city street on a winter day. Four successive samples taken at intervals of fifteen minutes showed: (1) 3 bacteria per liter, by culture-bottle method; (2) 17 bacteria per liter by filtration method (fine sand); (3) 23 bacteria per liter by filtration method (fine sand); (4) 94 bacteria per liter by filtration method (fine sand). Apparently the number of bacteria in the air was increasing during this experiment; but the results by the two methods are concordant.

Experiment IV.—A suspension of a culture of *B. coli* was sprayed into a box and five samples taken at intervals of about ten minutes. The results were as follows: (1) 2,640 per liter by filtration method (fine sand); (2) 100 by filtration method (fine sand); (3) 740 by culture-bottle method; (4) 40 by culture-bottle method; (5) 0 by sand-filter method (fine sand). Evidently the bacteria were settling out rapidly. With the exception of the low sand-filter count in No. 2 the results of the two methods check fairly well.

Experiment V.—*B. coli* was sprayed into a box four times, at intervals of about ten minutes, a sample of the air being examined after each spraying. The results were as follows: (1) 175 bacteria per liter, by sand filtration (coarse sand); (2) 4,300 per liter by sand filtration (fine sand); (3) 4,000 per liter by sand filtration (fine sand); (4) 10,750 per liter by culture-bottle method. Very probably the repeated spraying more than balanced the settling out and the number of bacteria in the air of the box actually increased. The first result with the coarse sand seems low, however.

Experiment VI.—*B. prodigiosus* was sprayed into a box three times. The first two samples were examined after the first spraying, the third and fourth samples after the second and third sprayings, respectively. Results: (1) 15,000 bacteria per liter, by sand filtration (fine sand); (2) 14,000 per liter by culture bottle method; (3) 5,300 per liter by sand filtration (coarse sand); (4) 14,000 per liter by sand filtration (fine sand). Again the filtration method checked with the culture bottle method when fine sand was used, but gave low results with the coarse sand.

These experiments, and others of the same sort, seemed to indicate that sand filtration gives reasonably accurate results if the sand used be as fine as .3 mm. The crucial test of this point, however, must be made by drawing a given sample of air through sand filters and a culture bottle, so arranged in tandem that the bacteria which pass the sand shall be collected in the bottle. The table below shows a series of such experiments and makes it clear that the efficiency of the filtration method depends upon the size of sand grain employed.

RELATIVE NUMBER OF BACTERIA PASSING THROUGH SAND FILTERS; AND RETAINED IN THEM

Air Examined	Bacteria per Liter Retained in Filter: Two 2.5 cm. Layers of .1–.3 mm. Sand	Bacteria per Liter Retained in Filter: One 5 cm. Layer of .5–1 mm. Sand	Bacteria per Liter Passing Filter
Suspension, *B. prodigiosus.*	100		2
Street air.	94		1
Suspension, *B. coli.*	2,640		12
" "		175	304
" "	4,000		37
Suspension, *B. prodigiosus.*		1,700	3,500
Suspension, *B. prodigiosus.*	14,000		2,400
Suspension, *B. coli.*	40		12
" "	90		15
" "		165	105

In seven tests with tandem sand filters, each containing 2.5 cm. of sand, with grains between .1 and .3 in diameter, the bacteria passing the sand were—once 30 per cent. of the number retained by the sand, twice 17 per cent., once 2 per cent. and three times 1 per cent. or less. On the other hand, in three tests with the Sedgwick-Tucker apparatus holding a single layer of sand, 2 cm. deep with grains between .5 mm. and 1.0 mm., nearly half the bacteria present passed the sand in one case and about two thirds escaped in the other two instances.

It seems clear that sand over .5 mm. in diameter is inadequate for filtering out bacteria. On the other hand, a sand finer than .3 mm. is generally efficient though not wholly reliable, since at times it allows a considerable proportion of bacteria to pass. This is not remarkable when the relative size of sand and bacteria is considered.

It is, of course, obvious that sand can not operate in the removal of bacteria by any process which can properly be called straining. In an editorial discussion of the removal of fine particles from water the *Engineering News* (LIX., 344) has described the phenomenon as "adhesion"; and the term deserves general acceptance in this connection. The size of the sand must affect the removal of fine particles in two ways. First, in a given depth, the number of surface contacts, which permit adhesion, must vary inversely with the size of the particles. Second, the velocity of flow, which tends to tear off adhering particles, must, under given conditions, increase with the size of the particles. Coarse sand might, therefore, be used with success by filtering through a deeper layer and by cutting down the rate of flow. It is simpler, however, to use sand sufficiently fine to regulate the rate of filtration automatically.

On the whole, the culture-bottle method seems to offer a more accurate procedure for bacterial examination of air than any yet available. The sand-filter method is fairly accurate as a rule, but occasionally gives low results. The filter method is more convenient than the culture bottle method for examinations outside the laboratory, since for the latter it is necessary to carry two 1,500 c.c. bottles for each examination. Aside from this difficulty of transportation, however, the technique of the culture-bottle method is to be preferred. Bottles are easier to prepare and to sterilize than sand filters and the actual examination is simplified by the omission of sand washing and subsequent plating.

C.-E. A. Winslow
Massachusetts Institute of Technology

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES, SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY

A meeting of the Section of Astronomy, Physics and Chemistry was held at the Museum of Natural History on Monday, January 20, at 8:15 P.M., Professor D. W. Hering in the chair. Professors Lamb, Rosanoff and Breithut read a paper on "A New Method of Measuring Partial Vapor Pressures in Binary Mixtures."

On Monday, March 16, Professor W. Campbell read some "Notes on Metallography applied to Engineering." The methods of preparing specimens, development of structure, microscopic examination and photographing the specimen were briefly reviewed. The structure of metals, ingotism and grain structure, the effects of strain and of annealing were demonstrated and the constitution of alloys, mattes, speisses, etc., taken up. The carbon-iron series, the graphite-austenite and cementite-austenite groups were discussed and illustrated. Examples of structure were given; wrought iron *vs.* low carbon steel, good and bad material; working and annealing of medium carbon steel; rails and examples of their failure; steel tyres and shelling out; the structure of hypereutectic steels and their change with heat treatment; cast iron, gray, mottled, white, spiegeleisen; cementation and blister steel; malleabilizing and the formation of temper carbon.

The application of metallography to economic geology was shown by demonstrating the paragenesis of certain mixed sulphide ores, of silver ores from Cobalt, Ont., of the Butte copper ores, of typical "enrichment zones." The constitution of so-called nickeliferous pyrrhotites and of certain complex opaque minerals was shown. Many lantern slides were used to illustrate the paper.

A sectional meeting was held on Monday, May 18. Dr. J. P. Simmons presented a "Note on a Curious Effect produced by the Explosion of Detonating Gas." When a mixture of oxygen and hydrogen is exploded in a tube, the inside of which is coated with a thin layer of water, perfect rings are formed. The same phenomenon has been noticed when the same kind of a gas mixture is exploded in a tube, the inside of which is coated with a thin layer of wax. This is a heating effect, since the rings formed in the tube covered with wax are made apparent by the melting of the latter substance. This periodic heating is probably due to compressions arising from either sound or explosion waves.

W. Campbell and R. F. Böhler read a paper on the heat treatment of carbon tool steels. The various constituents of unhardened and hardened high carbon steels were first classified, cementite, pearlite, ferrite, graphite, austenite, martensite, troostite, osmondite and sorbite, and the views of the different authorities on their constitution given in tabular form. The plan of study embraced (1) heating to various temperatures and (*a*) slow cooling, (*b*) quenching, (*c*) tempering; (2) the effects of forging temperature and quenching temperature, to see whether the structure gave any evidence whether overheating had taken place during forging at the works of the manufacturer or during reheating for hardening at the user's, in the case of faulty material; also whether this persisted after tempering. Only the maximum forging temperature left any traces after quenching and this was much above that used in practise. Tables and curves showing variation of physical properties with heat-treatment were given, and the various structures illustrated by numerous lantern slides.

Professor Charles L. Poor presented two papers by title, (1) "An Investigation on the Figure of the Sun and of Possible Variations in its Size and Shape," (2) "The Photoheliometer."

William Campbell,
Secretary

Columbia University

THE CHEMICAL SOCIETY OF WASHINGTON

At the 183d meeting of the Chemical Society of Washington, held at the Cosmos Club, May 14, 1908, the following papers were presented: "Influence of Fine Grinding on the Water and Ferrous Iron Content of Minerals and Rocks," by W. F. Hillebrand, and "Technical Value of Wood Turpentine," by F. P. Veitch.

Mr. Bailey Willis, of the Washington Academy of Science, addressed the society in regard to a proposed scientific weekly. The following resolution was then adopted:

Resolved, That it is the sense of the society that the new journal is desirable and, further, that it will be welcomed by this society.

The meeting was presided over by President Joseph S. Chamberlain, and the attendance was 48. President Bogert also addressed the society on problems of general interest to the members of the Chemical Society.

A special meeting of the society was held at the George Washington University Lecture Hall on May 9, 1908. President Chamberlain introduced Dr. C. A. Ernst, the speaker of the evening, who gave an address on "Viscose and Artificial Silk." The lecturer showed many samples of artificial silk, and explained the process carried on at the Genasco Silk Works of Lansdowne, Pa. The attendance was 65.

J. A. LeClerc,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FRIDAY, JULY 10, 1908

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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., or during the present summer to Wood's Hole, Mass.

PHYSICAL ANTHROPOLOGY AND ITS AIMS[1]

THE phenomena of the universe, brought within the range of human understanding and preserved in memory or writing, constitute knowledge; and systematic search for knowledge, on the basis of the highest standards of learning, is science. This in its application being of the utmost utility, constitutes the most important function of mankind. A branch of science is a portion of systematic research that extends to closely related phenomena and has become the special function of a definite class of qualified observers.

One of these branches is anthropology, described by its principal promoter, Broca, as "the natural history of the genus *homo*," or, more in detail, as "that science which has for its object the study of mankind as a whole, in its parts, and in its relation with the rest of nature."[2] In the light of to-day, it may be defined more strictly as that portion of systematic research which deals with the differences

[1] Annual address of the president of the Anthropological Society of Washington, given under the auspices of the Washington Academy of Sciences, February 11, 1908.

[2] Article "Anthropologie" in the Diction. encyclop. d. sc's. méd., Vol. V., p. 276—Paris, 1866; also in Broca's "Mémoires d'anthropologie," Paris, 1871, Vol. I., p. 1. References to numerous definitions in R. Martin, "System d. (physischen) Anthropologie, etc.," *Korr.-Bl. d. deutsch. Anthrop. Ges.*, 1907, Nr. 9/12. See also L. Manouvrier, *Rev. de l'École d'Anthrop.*, 1904, pp. 397–410, and F. Boas, "Anthropology," 8°, pp. 1–28, The Columbia University Press, N. Y., 1908.

in structure, in function, and in all other manifestations of mankind, according to time, variety, place and condition. It is the science of structural, functional and cultural differences in mankind in its epochs and its groups. That part of the science which occupies itself with the body and its functions, investigating their differences, causes, modes of development and tendencies, from man's beginning, and among his present multiple groups—the research, in brief, into man's organic and functional variations—is physical anthropology.

The comparative element is the fundamental characteristic of anthropology and that which distinguishes it from allied branches of research. It shows clearly the position of physical anthropology in relation to general human anatomy and physiology, and towards general biology. The main objects of general human anatomy and physiology are the completion of knowledge regarding structure, and its inseparable functions, in the average man of the present day; while the chief aims of general biology are to trace the structural and functional relations of the different species of living beings to one another, and search for the causes and processes of organic variation and evolution. Physical anthropology is a continuation, an extension, of all these, to the epochal, racial, other natural, social and even pathological groupings of mankind, and reaches with its investigations beyond man only so far as is necessary for understanding the phenomena which it encounters. If it had not its present designation it could well be called "advanced human anatomy and biology."

Physical anthropology is still a young branch of science, though its roots lie far back in the development of human reflection. It is interesting to know that the discovery of America, with its new race of people, was one of the main incentives to research in this line. This was followed by discoveries of other lands and peoples in the Pacific and by slowly increasing knowledge of organized beings in general, including the anthropoid apes. All this aroused new thoughts in scientific men and doubts as to the correctness of the old theories of creation; and the fermentation in minds, though greatly impeded by the power of dogma, progressed until it finally began to pierce the cloud and manifest itself in publications. Peyrere's "Preadamites" appeared in 1655, and, notwithstanding prohibitions and the small real worth of the book, was received with eagerness and read very extensively. In 1699 was published Tyson's "Comparative Anatomy of Man and Monkey." And in 1735 we see the actual foundation stone of modern anthropology laid by Linnæus. It was in Linnæus's "Systema Naturæ" that man for the first time was placed in, instead of outside, the line of living beings in general, and that his close organic relation with the rest of the primates was authoritatively expressed. Then came Buffon, with whom the new branch of the natural science of man takes a more definite form, and thence the progress towards anthropology, as differentiated to-day, is continuous. The men who contributed towards its development are too numerous to mention; they include all the prominent naturalists and anatomists of the latter half of the eighteenth and the first half of the nineteenth century, such as Camper, Lamarck, Blumenbach, Soemmering, Lacépède, Cuvier, Retzius, the brothers Geoffroy, Morton, Lawrence, Edwards, Serres, Pritchard and many others.[3] Even the teachings of

[3] For details concerning the history of anthropology see T. Bendyshe, *Mem. Anthrop. Soc. London*, Vol. I., 1863–4, pp. 335–458; P. Topinard's "Elements d'Anthropologie générale," Paris, 1885, pp. 1–148; L. Niederle, *Athenæum*, Prague,

Gall, however erroneous in application, have assisted its growth, for they stimulated research regarding the variations of the head, skull and brain, and were the main incentive to Morton's remarkable work "Crania Americana." And the discussions of the mono- and polygenists, particularly those of the nineteenth century, were of great importance in this connection.

The first effort at some organization of forces in the new line was made as early as 1800, when a small body of scientific men formed themselves, in Paris, into a Society of Students of Man (Société des observateurs de l'homme). It was in this little circle that the term anthropology (used previously as a title for some works on man of philosophical and in a few instances of simple anatomical nature) was employed in something like its present significance. This attempt at organization was, however, premature and had to be given up two years later (1803), after but little had been accomplished. In 1832 the Paris Museum of Natural History, under the influence of Professor William Edwards, transformed its chair of anatomy into that of natural history of man, and to this Serres, in 1839, added anthropology; but the time was still not ripe for the subject to assume much importance. From 1839 to 1848 Paris had a Society of Ethnology, which included the physical branch, again with but little result. It was not until the commencement of the second half of the nineteenth century, with the advent of Paul Broca and his collaborators, and the foundation of the Paris "Société d'anthropologie" (1859), that the actual birth of the new branch of science took place. This is less than fifty years ago; and how difficult the beginnings were even then will be appreciated from the following recently published[4] details. When permission to establish the society was sought, the minister of public instruction, notwithstanding the rank and fame of the men who with Broca applied for the sanction, refused to have anything to do with the matter. He sent the petition to the prefect of police, but the prefect was equally unwilling and returned the document to the ministry as he received it. It was not until after the influential intervention of Ambroise Tardieu, that one of the chiefs of the police department was persuaded the scientific gentlemen in question were not quite as dangerous to the welfare of the empire or society as was suspected, and not finding, besides, any law that forbade the gathering of less than twenty persons, he informed the eighteen future anthropologists that their meetings would be tolerated. But Broca was made responsible for anything that might be said at the meetings against the government or religion, and every meeting was to be attended by a plainly dressed officer.

From the establishment of the Société d'anthropologie the progress of the new branch of research was more rapid. Before long similar societies were organized in England, Germany and other countries; the publication of anthropological journals was commenced; an efficient system of anthropometry, with the required instruments, was devised, principally by Broca, and detailed instructions in the system were published by the same author; collections and important lines of research were begun in different parts of Europe and also in the United States; and in 1876 was founded the Paris School of

1889 (repr. pp. 1–19); F. Boas, Science, Oct. 21, 1904, pp. 513–524; references to more or less direct contributions to the subject in R. Martin, o. c.; and the "Recent Progress in American Anthropology," *Am. Anthrop.*, Vol. 8, No. 3, 1906, pp. 441–556.

[4] "L'Ecole d'Anthropologie de Paris," 1876–1906, 8vo, Paris (F. Alcan), 1907.

Anthropology, for academic instruction and training in the new branch of science. Finally, in 1885, appeared Paul Topinard's great text-book on anthropology, the "Éléments d'anthropologie générale," which to this day is an indispensable volume in our laboratories. A long step was made during this time in the differentiation of anthropology as a whole into its main subdivisions, namely, physical anthropology, ethnology and archeology.

But this period of the first twenty-five years of anthropology as a separate branch of learning, a period of the greatest activity, the detailed and still unwritten history of which is of absorbing interest, was not one of uninterrupted progress. There was encountered, above all, a crisis which affected especially physical anthropology and from the effects of which it is only now beginning to recover. This crisis was the result of what may be called a schism in anthropometry, begun in 1874 by Ihering and completed in 1882 by the German anthropologists at Frankfurt. This is not the place for a discussion of the causes or details of the case; it suffices to say that at the present time a commission, composed of the foremost physical anthropologists of Europe—French, German and from other countries—is endeavoring, and with much success, to select the best from the existing methods in anthropometry and bring about a much-needed uniformity.[5] A complete agreement on this subject will be of the greatest importance and mark an epoch in our branch of learning.

This chapter, necessarily superficial, will be appropriately concluded with a few words concerning the actual status of physical anthropology. The subject, like the whole history of this science, calls for a thorough presentation, but such is out of the question in an address of this nature.

Physical anthropology counts distinguished followers wherever science progresses; it has already an extensive bibliography of its own; it maintains a number of well-equipped laboratories, where students are trained; it possesses a large series of important collections of material for investigation; it contributes the bulk of original matter to well-established anthropological journals of high standing, such as the *Bulletins et Mémoires de la Société d'anthropologie de Paris,* the *Archiv für Anthropologie,* the *Zeitschrift für Morphologie und Anthropologie, Biometrica, Man,* etc., while numerous other results of investigation are being disseminated through periodicals devoted to anatomy, general biology, and to other subdivisions of anthropology; finally, it is a subject or a part of instruction in the École d'anthropologie, in the Anthropological Institute of Zurich University, in several large museums, and in one or more of the principal universities in almost all civilized countries.[6] It is still struggling with numerous difficulties which retard it, but, unless development in science stops, it has before it a wide and useful future.

II

The questions are often asked by those

[5] For what has been accomplished see F. v. Luschan, "Die Konferenz von Monaco," *Korr.-Bl. d. d. Ges. f. Anthrop., etc.*, Juli, 1906, pp. 53 et seq.—in *Arch. f. Anthrop.*, 1906, H. 1–2; and "Entente internationale pour l'unification des mesures craniométriques et céphalométriques," *L'Anthropologie*, 1906, pp. 559–572.

[6] For information regarding instruction in anthropology see J. Ranke, in Lexis, 1896, p. 117; W. Waldeyer, *Korr.-Bl. d. d. Ges. f. Anthrop., etc.*, 1896, p. 70; G. G. MacCurdy, Science, Dec. 22, 1899, and Feb. 7, 1902; "Recent Progress in Anthropology" (a review of the activities of American institutions and individuals from 1902 to 1906), *Amer. Anthropol.*, Vol. 8, No. 3, 1906; R. Verneau, *Bull. et Mém. Soc. d'Anthrop. de Paris,* 1902, p. 12, and *l'Anthropologie*, 1904, pp. 113, 252 and 483.

whose preoccupations have not permitted closer following of this branch of research, what has physical anthropology accomplished, and what are its aims for the future. Both of these are weighty questions and deserve to be answered.

The amount of work actually done must be considered, together with the obstacles that have stood in the way of fruitful investigation. The greatest of these obstacles has been the imperfect state of anatomical knowledge, which is the starting point of physical anthropology. It is obvious that structural comparison, extending to various groups of humanity, can properly be carried on only on the basis of a thorough knowledge of structure in some one type of man, preferably the white race. Had anatomy been able to furnish such a foundation to physical anthropology, the progress of the latter would have been immeasurably easier and more rapid. As it was, the new branch began to differentiate itself while general human anatomy was yet very imperfect, and in consequence it was confronted with the tedious task of establishing or improving the basis for its future comparisons. Thus a large portion of the work of anthropologists became and still is purely anatomical. It is safe to say that fifty years ago, when the Paris society of anthropology was founded, there was not one point in any part of the human organism that was well known and understood. Even at this day, with all the excellent work accomplished, there is not yet a single bone in the body, and perhaps no other organ, the knowledge of which together with that of its total range of variation is perfect, and that even in the white race alone, which has been most studied. The splendid anatomical text-books of the day give little more than generalities. The specialized literature is much richer; but when one comes to details, there are innumerable lacunæ. Yet details are to-day the essentials of all research, and they are indispensable in anthropological comparisons. It would almost seem from this that the birth of physical anthropology had been premature; but if one stops to consider the deep interest its problems have for humanity, it is seen that its early rise, even on the but partly prepared soil, was natural.

The second great obstacle to the progress of physical anthropology has been the defects in collections of needed material. The third was the dearth of properly trained men, and in the fourth place should be named the difficulties, based on various prejudices or want of comprehension, attending the collection of accurate anthropological data in many parts of the uncivilized and even the civilized world. Still further impediments, attending this more than other branches of natural science, were those accompanying the elaboration of the necessarily extensive series of data and especially their publication.

With regard to material, what collections of value for physical anthropology were there half a century ago? Fair beginnings had been made by that time in a number of the European cities, and one particularly interesting one on this continent—that of Morton in Philadelphia; but all this was limited to crania and was useful in awakening suggestions rather than leading to definite conclusions. It required years of assiduous collection and excavation before actual scientific work of any extent could anywhere be attempted. Such collection has been going on, and there are now several great and many minor gatherings of identified material, including those in the National and other American museums. Yet even now we are far from the ideal in this direction, or from collections which would include at least the bones of the whole skeleton, and the brain, and enable us to determine the complete range of variation in these parts of special importance in at least the most significant groups of humanity. What is required in this line will be clearer when it is appreciated that, to determine the total range of variation in a single long bone, such as, for instance, the humerus, in any particular group to be studied, there are needed the remains of hundreds of individuals of one sex from that group. As it is, even the greatest collections fall still far short of the requirements, and the investigations carried on with them can be seldom perfect or final.

The dearth of properly trained men has been a great hindrance in physical anthropology. The cause of this is simple enough. The branch demands extensive preparation and arduous work, for which it offers at best only moderate pecuniary reward. It has not yet reached the stage of its ultimate public utility and in consequence receives much less public recognition than the so-called applied sciences. Under these circumstances the recruiting of regular workers of the right class is precarious, a new physical anthropologist is almost an accident and the supply of students is far short of what is needed.

The difficulties of gathering the requisite material, and even the data alone, have been infinite and are still very great; in fact they are sometimes quite insurmountable. Religious beliefs and superstition, but also love, cover the dead body everywhere with a sacredness or awe, which no man is willingly permitted to disturb. It is not appreciated that the secured remains are guarded in the laboratory with the utmost care and for the most worthy ends, including the benefit of the living. The minds of the friends are only apprehensive of mutilation and sacrilege, or simply fear the disturbance. These conditions extend with small exceptions to the civilized and savage alike, and to collect, in their presence, large supplies of material indispensable to physical anthropology is often very arduous and unsatisfactory. The impediment that this constitutes to the advance of the science is beyond computation. And the difficulties extend even to the data on the living. The stumbling blocks due to ignorance and superstition are particularly numerous in the way of measuring, and are met with even among the otherwise most enlightened. Compare with this the facilities of the zoologist or botanist!

Notwithstanding these and other obstacles, among others those placed in its way by the ill-fitted or fool investigator, physical anthropology has already accomplished considerable useful work. It has established a system of precise measuring of man and his remains, and has furnished the needed instruments; it has directly advanced general anatomy, particularly that of the skeletal system and brain of man and other primates, and contributed to zoology, general biology and other natural sciences; it has established the physical knowledge of the races and many of their subdivisions, and has aided through its activities the advance of its sister branches, ethnology and archeology; it has given a far-reaching impetus to search for the remains of early man, and has determined the physical characteristics of the finds made; it has actuated and to a large extent carried out the study of man's development from his inception onward; it has brought about physical investigation and through this a vast improvement in our knowledge of the criminal and other defective classes; it has led directly to the practical systems of identification of criminals; it has taken part in and promoted the studies in human heredity, variation, degeneration and hybridity; it has added to knowledge of the functions and pathology of the human body and especially of the brain; it has furthered vital statistics; and it has already begun to assist other branches in pointing out, on the basis of gained knowledge, ways towards the safeguarding and improving of the human race. This outline is necessarily defective, yet it will show that physical anthropology, notwithstanding the many and great obstacles in its road, has justified its separate existence, and the decrees by which the French government pronounced it, in 1864 and again in 1889, as a science of public utility.

III

The object of the final chapter of this address is to outline in a brief way, and yet not too generally, the future field and aims, in a word the future program—as it appears to the speaker—of physical anthropology. Could such a program be perfected, it would itself mean an important step forward.[7]

The future activities of physical anthropology must extend to its own body and means, as well as to further research work proper; the more extensive and efficient the former, the more important and prompt will be the scientific results.

The main needs—which logically become the aims—of the anthropologists themselves, include more regular and extended recruiting of their ranks; a closer general unity and cooperation; definite unification and perfection of anthropometry in its whole range; systematization of the methods of treating and recording of data; the supply of fresh text-books, and advance towards strictly specialized periodicals; the compilation of a complete bibliography relating to this branch of research, and its continuation; the generalizing of information concerning collections of material; and the augmentation and improvement of collections.

Recruiting with the right kind of men is very urgent. It conditions further development of academic instruction and laboratory training; it makes very desirable the extension of lectures on physical anthropology to medical colleges; but, above all, it necessitates financial resources from which scholarships could be offered to men to be trained in the laboratory and in the field, and an improvement in the prospects of their employment with fair compensation after their preparatory studies and training have been completed. The time required for the proper training of the physical anthropologist, coupled with that needed for the acquisition of indispensable experience, extends over several years of post-graduate activity, and as the men who are best prepared for such training and most likely to be interested are those who have completed a medical course, these years of specialized training and work mean a real pecuniary loss, which ought to be at least partly indemnified. Until provision is made in this point it can not be expected that the requisite numbers of students will be attracted to and will specialize in physical anthropology. And this applies particularly to this country, where the prospects of the graduate in medicine—as well as in other sciences—are brighter than in many parts of the old world. The most suitable means of compensation during the preparatory years would be scholarships, continued with the right kind of men until they find positions. The opportunities of employment for well-trained anthropologists are not so few as one might be led to believe; the principal problem is to augment the compensation, so that it may correspond better to the needed preparation and with the prospects of a man as well trained, had he followed

[7] See in this connection, and for further references to literature on this subject, R. Martin's above cited paper on the "System of Physical Anthropology and Anthropological Bibliography."

another vocation, such as that of the physician.

Closer unity and cooperation among physical anthropologists of different countries must always be one of our cherished aims, and the same is true of the unification and perfection of anthropometrical processes and standards, as well as the methods of dealing with anthropometric data and their recording. Concerning the latter, the establishment of definite rules is still distant, the whole subject being in the process of evolution. One of the main questions, accentuated especially since the establishment of the journal *Biometrica*, relates to the employment and utility of higher mathematics in the analysis and presentation of the data. A simple exposition of facts, intelligible to every educated person, carries with it so great an advantage to every branch of investigation and to the public as well, that the matter of the extensive use of algebraic formulæ in publication can not be passed over lightly. It would be folly to oppose the legitimate use of higher mathematics, which in special cases excel all other methods, and may, in fact, be the only means by which to arrive at a solution of a given problem; but when it comes to the presentation of the results arrived at, it can not be denied that the high-mathematical method, while finding special favor with some, abstracts the subject from critical perusal by a large percentage of scientific men, not to speak of others. The whole matter demands very careful attention.

A supply of up-to-date text-books is a pressing need. It was twenty years ago that Topinard's great handbook appeared and nothing has been produced since that would bring it up to date or replace it. Yet a considerable advance has been made in every direction and the need of a thorough presentation of the accumulated facts and changes is acute. There is hope that the unification and precision of anthropometric methods, inaugurated two years ago at the Congress of Monaco, will stimulate efforts in this direction.

An advance towards strictly specialized periodicals, to be devoted exclusively to physical anthropology, is merely an aim at a further step in differentiation, such as is manifested in all other branches of research, after they have reached a certain stage of development. It depends upon the strengthening of the ranks of the physical anthropologists.

The importance of complete and continued bibliographical record is evident enough to every student and author and is an aim calling for the earliest possible realization. Beginnings in this line have already been made, particularly with current literature, and more is promised, but the movement calls for definite organization and extension to the older publications.

Improvement in and generalization of information concerning collections in physical anthropology are highly desirable. Such information, furnished through periodically supplemented registers of material by and to all institutions, would greatly promote collaboration as well as the extent of research. An additional procedure of much consequence would be the deposit of smaller collections in larger centers in each country, where they could be better cared for and be more available.

Finally, a matter of vital concern to physical anthropology is the augmentation and improvement of its collections. It is necessary that these be supplemented in a more systematic manner than has been done hitherto, and in all particulars. There are needed much additional osseous material, including all parts of the skeleton, for racial and other group studies; ample developmental series, on which could be determined racial and other peculiarities in all stages of growth; the largest possible acquisitions of skeletal remains from all the periods of peoples known the longest to history, such as the Egyptians, the Semites, the Chinese, for the ascertainment of physical variations in different localities in known time; large collections of brains, preserved by uniform methods, for the study of gross, minute and chemical differences in that organ, in definite groups of humanity; and substantial series of at least the skeletal parts and brains of the anthropoid and other apes, for purposes of comparison. The existing material, as well as that to be added, should be held in the best possible condition regarding identification, cleaning, repairs and preservation. All these are conditions, on the fulfilment of which further advance in physical anthropology depends directly. Other objects needed, at least in our great museums, are series of specimens fit for exhibition, for illustrating to the public the most interesting human variations; and large gatherings of good photographs, as well as accurate casts, fit for both study and exhibition.

The above by no means exhausts what may be termed the internal wants and therefore aims of physical anthropology. There still remain the very important objects, of the virile development and advance of teaching; the highest of our hopes, namely, the foundation of separate central institutes of physical anthropology, like the École d'anthropologie; the forming of a special, international association; the conservation of original, detailed data, etc. But these are largely matters of development of the branch, dependent on progress realized in the points before specified, and their discussion can be postponed.

This leads to the scientific aims proper of physical anthropology, and these are innumerable. They extend from questions of pure science and natural philosophy to those of high practical utility, and from those of local interests to those of all humanity. I shall pass briefly over those of a more general nature and conclude with those that are more specially American.

The most urgent and important scientific object before physical anthropology is the gradual completion—in collaboration with anatomists, physiologists, and even the chemists—of the study of the normal white man living under average conditions, and of the complete range of his variations—these facts to form a solid and sufficient basis for all comparisons. This goal is still very distant, notwithstanding the mass of work already accomplished. It is necessary to renew and extend the investigations on every feature, every organ, every function of the medium white man, until these are known in every detail. The facility and value of all comparative work will increase in direct proportion to the degree of the consummation of efforts in this direction. The choice of the white man for the standard is merely a matter of convenience; the yellow-brown or black man would do equally as well, if not better, were he available.

The second task of physical anthropology is to perfect, or aid in perfecting, detailed knowledge of the structure, function and chemical composition—with their variations—in the primates. This field of investigation may be regarded as the vestibule to the space occupied by man's natural history and is indispensable to the understanding of man's past and continued evolution, collectively and in every particular. The fossil forms of the primates must naturally be comprised with the living.

The third great duty of our science is the determination of development and variation in man's structure, and also as far as possible in other organic qualities—particularly those of chemical nature—in relation to time. This comprises a delicate and thorough study of every specimen of man of geological, and ample series of those of historical, antiquity. Research as to the bones of the geologically early man has been painstaking, but the specimens themselves are still very limited in number and imperfect; while the study of man's variations within the time of which there is closer and finally historical knowledge, is still in its infancy. The investigations here mentioned relate principally to the important phase of man's evolution as man.

The fourth leading object of physical anthropology is the study of the human races and their subdivisions. This subject has attracted attention since the earliest time, and contributions to the theme are numerous as well as important; yet the road to go is still much longer than that already traveled. The very term "race" awaits as yet a definition that would be universally adopted. There are still immense territories in Asia, Africa, Oceania and America, concerning the populations of which our knowledge is very rudimentary, or wholly deficient; and the subdivisions of the white race still offer a vast field for further investigation. The appreciation of what remains to be done on the races and tribes of man impresses one forcibly with the fact that we are still only in the beginnings of this study and barely emerging from empiricism. The future work in this special field must be more extensive, systematized and critical.

Directly connected with racial studies, but of more serious concern to many nations, are investigations into the effects on the progeny, physical and potential, of racial mixtures. Mixture of races is a matter which can be brought largely under control through law and through general enlightenment. In view of this, a precise knowledge on the subject is a necessity, and to furnish it must be one of the main aims of anthropology.

Next in sequence, but not in importance, are studies concerning the numerous environmental groups of humanity—of groups developed and continuing under extremes of elevation, climate and nourishment; or under the greatest specializations in clothing, food, occupation or habits that are liable to permanently affect the body or its functions. All such conditions are followed by functional and structural accommodations of the system, and it is to be determined how they eventually affect the progeny. Learning the exact facts in these lines is beset with great difficulties, but the results are bound to be of much practical, as well as scientific, utility.

A still further extension of the studies takes up the pathological groups of mankind, including the alcoholics, epileptics, insane, idiots, perverts and other defectives or degenerates, and also criminals. This part of anthropological research is already well advanced and has, with the help of medical men, accomplished much of immediate benefit to society. But the aims of scientific work in this direction, a complete knowledge of these classes, are yet far from having been attained. Their realization depends to a very large extent upon the perfect understanding of the normal contingent of the human family.

Somewhat separate from all the preceding are studies in human ontogeny, or the development of the individual from birth onward, in all divisions of mankind and under all specific conditions. The contributions to knowledge in this line have already been substantial, though almost restricted to the whites. One of the most interesting parts of this study will be that of man's decline in the different races and under various definite conditions.

Finally, the ultimate aim of physical anthropology is to show, on the basis of accumulated knowledge, and together with other branches of research, the tendencies of the future evolution of man and lay down indications for its possible regulation or improvement.

A few words in conclusion regarding the duties of physical anthropology in this country and in America in general. American students ought to contribute, as much as lies in their power, to knowledge concerning the white race at large and of other peoples outside of this continent with its dependencies. They have already added in no small degree to the study of child growth and should not stop in this direction; they should also cooperate in all investigations concerning special, environmental and pathological, groups of humanity. But there are several problems which will be to them of especial importance and demand the bulk of their labor. These are: (1) The appearance of man in America; (2) the composition and detailed characteristics, with their complete range of variation, and the affinities, of the indigenous race, including the Eskimo; (3) the crystallization of the new contingents of the white race in America, particularly in the United States; (4) the development of the negro element, especially in this country; and (5) the effects of the mixture of the white with the negro and the Indian. Beside these range themselves parallel problems affecting the insular possessions of the United States. All these are scientifically, as well as practically, serious questions, and research into them deserves to be generally promoted. There is no other branch of natural science which can occupy itself with them and define them; they are the rôle of physical anthropology in this country and demand its development.

Aleš Hrdlička

U. S. National Museum

THE HANOVER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The special summer meeting of the American Association for the Advancement of Science held at Hanover, N. H., on the invitation of Dartmouth College, from June 29 to July 2, took place in accordance with the program that has already been printed in Science. The local committee, with Dean Robert Fletcher as chairman and Professor H. H. Horne as secretary, had made admirable arrangements for the reception and entertainment of members, and the college campus and buildings and the beautiful surrounding country were of even greater interest than had been anticipated.

The meeting was called to order at 8 p.m. on June 29 in the auditorium of Dartmouth Hall, and an address of welcome was given by the acting president of the college, Dr. John King Lord, who drew attention to the large place science now has in the college curriculum as compared with the conditions when the college was founded some one hundred and forty years ago. The president of the association, Dr. T. C. Chamberlin, of the University of Chicago, responded on behalf of the association and the visiting members. He laid stress on the increasing use of the scientific method in all subjects included in the college course and the importance of this movement for the future of society.

On Tuesday and Wednesday, June 30 and July 1, Section B and Section E of the association held sessions for the reading of scientific papers in conjunction with the American Physical Society and the Geological Society of America. Reports of the proceedings will be published subsequently in this journal. On the evening of June 30, Professor J. W. Spencer gave a public lecture entitled "The Spoliation of Niagara," and on July 1 Mr. J. S. Palmer lectured on "The American

Bison.'' On the following day, there was a general excursion to the Blue Mountain Forest Park, established by the late Mr. Austin Corbin to preserve the buffalo, moose, elk and other large animals of the American wilderness now threatened with extinction. Before, during and after the meeting there were excursions of much interest, arranged by the sections of geology and geography. An account of these will be published later.

The committee on policy of the association held a meeting with Messrs. Woodward, Chamberlin, Britton, Cattell, Nichols and Howard in attendance. In view of the facts that only two sections met at Hanover and that the attendance was small, it was decided that all business for the council should be postponed to the Baltimore meeting. It was announced, however, that Professor John Dewey, of Columbia University, had been elected chairman of the Section of Education; that the American Medical Association, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers will hereafter be represented on the council of the association; that the membership of the association now exceeds 6,000, and that progress had been made in the arrangements for a meeting in Hawaii in the summer of 1910. As the permanent secretary wishes to know who is likely to attend this meeting, the letter from the Hawaiian committee is printed here.

Hawaii Committee
1910 Convention
American Association
For the Advancement of Science.
Governor W. F. Frear, *Chairman.*
A. F. Griffiths, *Vice-Chairman.*
A. F. Judd, *Secretary.*

Honolulu, T. H.,
June 12, 08.

Dr. L. O. Howard, *Secretary,*
American Association for the
Advancement of Science.
Hanover, N. H.

Dear Sir: At a meeting called by Acting Governor E. A. Mott-Smith at the Governor's office to consider your letter in reference to the invitation of the American Association for the Advancement of Science to hold its convention, summer meeting, in 1910 in Hawaii, the invitation was cordially endorsed. The expressions of opinion left no doubt that the Association would receive a hearty welcome in Hawaii.

The following resolutions were adopted:

Resolved, That it is the sense of this meeting that a reply to the letter of Dr. L. O. Howard, Permanent Secretary of the American Association for the Advancement of Science, dated May 12, 1908, stating that an invitation had been received for the Association to hold a meeting in Hawaii in the summer of 1910, which invitation had been tentatively accepted, "provided suitable arrangements can be made," and wherein he asks certain questions, be replied to, as follows:

First. That the invitation to the Association to come to Hawaii is one which the people of the Islands generally and heartily approve.

Second. That the Association will be more than welcome.

Third. That the committees on reception and arrangements can and will be formed, consisting of the leading people of the Territory; that it is our belief that special expressions to this effect will be formally adopted at an early date by all the leading scientific, educational, commercial, political and social organizations in Hawaii.

Fourth. That entertainment at Honolulu will be furnished free to a large proportion of the members of the Association, and at greatly reduced rates to the remainder of them.

Fifth. That the question of transportation offers the greatest problem in connection with the invitation. As to this point, it is the belief of this meeting that the problem can be solved satisfactorily.

An organization was at once effected which will do everything possible to bring the Association to Hawaii and to provide for the entertainment of members who come. The list of the members of this representative organization follows:

W. F. Frear, Governor of Hawaii, *Chairman.*

A. F. Griffiths, President of the Trustees of the Oahu College, *Vice-Chairman.*

A. F. Judd, lawyer, *Secretary.*

E. A. Mott-Smith, Secretary of Hawaii.

Jared G. Smith, Director Hawaii Experiment Station.

F. L. Waldron, commission merchant, Chairman Hawaii Promotion Committee.

C. S. Holloway, Engineer, President and Executive Officer, Board of Commissioners of Agriculture and Forestry.

P. L. Horne, President, Kamehameha Schools.

D. L. Van Dine, Entomologist, Hawaii Experiment Station.

C. F. Eckhart, Chemist, Hawaiian Sugar Planters' Experiment Station.

S. B. Dole, U. S. District Judge, Ex-Governor, etc.

R. A. Duncan, Territorial Food Commissioner.

W. T. Brigham, Director Bernice P. Bishop Museum.

W. R. Brinkerhoff, U. S. Public Health and Marine Hospital Service.

H. R. Trent, President, Trent Trust Company.

L. A. Thurston, lawyer.

W. A. Bryan, President, Pacific Scientific Institute.

J. E. Higgins, Hawaii Experiment Station.

F. G. Krauss, Hawaii Experiment Station.

L. Lewton-Brain, Hawaii Sugar Planters' Experiment Station.

R. S. Hosmer, Territorial Forester.

A. Gartley, Manager, Hawaiian Electric Company, Regent College of Hawaii, etc.

This organization will include later many others who will join in the welcome and entertainment of the Association.

The officers are Governor Walter F. Frear, Chairman; A. F. Griffiths, Vice-Chairman; A. F. Judd, Secretary.

I send you herewith copies of resolutions and letters from practically all the scientific, educational, social and commercial organizations in the city whose assurances of good-will and support fairly voice the unanimous feelings of the community.

The generous offer of the Trustees of the Oahu College of the free use of the College Halls for the meetings of the Association and its sections assure the Committee of satisfactory and adequate places in which to hold the meetings of the convention. The satisfactory entertainment of the members is certain. Many will receive invitations to be guests in private homes. Many may prefer to live in the College Dormitories. The hotel accommodations of the city in addition are admirable.

The question of cheap transportation has already been taken up by the Committee. In this matter, we shall wish and shall need your cooperation as well as that of the other officers and members of the Association. The Committee is sanguine that a fairly good rate can be secured.

We hope that the advantages as well as the pleasure of holding the convention in Hawaii will be brought out in both the Hanover and Baltimore meetings. We are now preparing a statement of the unusual opportunities for scientific study that Hawaii offers. We shall have this ready for your use at an early date.

Assuring you that Hawaii will royally welcome and entertain as many members as can come to the 1910 convention, we remain,

Very truly yours,

(Sgd.) A. F. Judd,
Secretary

A. F. Griffiths,
Vice-Chairman

SCIENTIFIC NOTES AND NEWS

At the centenary celebration of the founding of the Vienna Physico-Medical Society on June 27, Dr. Charles Sedgwick Minot, Stillman professor of comparative anatomy in the medical school of Harvard University, and Dr. Jacques Loeb, professor of physiology in the University of California, were elected corresponding members.

On commencement day at Mount Union College, Alliance, Ohio, the degree of doctor of laws was conferred on President Charles Sumner Howe, of the Case School of Applied Science.

On the occasion of the installation of Lord Rayleigh as chancellor of the University of Cambridge, the degree of doctor of laws was conferred on the following men of science: The Hon. C. A. Parsons, Sir Andrew Noble, Sir William Crookes, Professor H. Lamb and Professor George Downing Liveing.

Professor Grassi, eminent for his work on malaria and other subjects, has been created a senator of the kingdom of Italy.

Dr. Johann Gottfried Galle, from 1851 to 1895 professor of astronomy and director of the observatory at Breslau, has celebrated his ninety-sixth birthday.

Sir James Dewar, F.R.S., has been elected an associate of the Belgian Academy.

Dr. J. W. L. Glaisher, F.R.S., has been awarded the De Morgan medal of the London Mathematical Society.

The Bunsen medal of the German Bunsen Society for Applied Chemistry has been awarded to Professor F. Kohlrausch, of Marburg.

The Munich Academy of Sciences has awarded the gold Liebig medal for services to agriculture to Professor Joseph König, of Munster, Professor Carl Kraus, of Munich, and Professor Max Rubner, of Berlin.

Professor Henry Fairfield Osborn, president of the American Museum of Natural History, has returned to New York after spending several weeks visiting the various natural history museums of Europe.

At the invitation of Dr. W. E. Hoyle, president of the Museums Association of Great Britain, Mrs. Agnes L. Roesler will speak to the members of the society at its meeting to be held at Ipswich, England, during the week commencing July 13, on the educational work of the American Museum of Natural History, in which institution she holds the position of instructor.

The officers of the Anthropological Society of Washington, elected at the annual meeting of the society, Tuesday, May 26, for the current year are as follows: *President,* Dr. Walter Hough; *Vice-president,* Mr. James Mooney; *Secretary,* Dr. John R. Swanton; *Treasurer,* Mr. George C. Maynard; *Additional Members of the Board of Managers,* Dr. I. M. Casanowicz, Mr. J. N. B. Hewitt, Mr. F. W. Hodge, Mr. C. H. Robinson, Mr. W. E. Safford.

At the luncheon on the occasion of the installation of Lord Rayleigh as chancellor of the University of Cambridge, an announcement was made by Sir Andrew Noble that it had occurred to several of Lord Rayleigh's friends, who are not resident members of the university, that some mode of expression should be afforded to the gratification of the scientific world on his election to the high office of chancellor of the University of Cambridge, which would at the same time serve as a mark of recognition of the great obligations to his example and influence under which British science had rested for many years. They had, therefore, arranged to offer to the university a fund large enough to provide an annual award, in such manner as he may select, to be associated with the name of the chancellor in those branches of knowledge in which Lord Rayleigh is preeminent.

As has already been noted here, the Linnean Society of London will celebrate the fiftieth anniversary of the reading of the joint essay by Charles Robert Darwin and Alfred Russel Wallace, entitled: "On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection," which was presented to the society on July 1, 1858, and preceded by sixteen months the issue of the classical "Origin of Species." The program of the celebration is as follows: (1) An afternoon meeting at which appropriate addresses will be given by eminent biologists, and copies of a special medal, to be called the Darwin-Wallace medal, will be presented. It is proposed that from time to time a copy of this medal in gold or silver may be awarded, and that fellows may purchase copies of the same in bronze. (2) An evening reception in the rooms of the society. (3) A volume to be published containing the full account of the memorable meeting of July 1, 1858, and an account of the jubilee proceedings, including the addresses delivered at the afternoon meeting.

Mr. Henry Lomb, one of the founders of the Bausch and Lomb Optical Company, which has accomplished an important service for science in this country by the scientific instruments which it has made, died on June 13, at the age of eighty years.

Dr. Rudolf Credner, professor of geography at Greifswald, died on June 6, at the age of fifty-seven years.

Dr. A. J. Bělohoubek, professor of general chemistry in the Bohemian University of Prague, has died at the age of sixty-two years.

The chemical interests of central New York State are fostered by the Syracuse Section of the American Chemical Society, formerly the Syracuse Chemical Society. This is an unusually prosperous organization of over a hundred members. It has just closed a very successful year under the presidency of Dr. J. A. Mathews. Eight meetings have been held, at which the speakers have been: E. G. Acheson on "Deflocculated Graphite," E. C. Spurge on "Essential Oils," Professor A. H. Gill on "Explosions in Common Substances," Dr. Wm. McMurtrie on "The Tartar Industry," Professor L. P. Kinnicutt on "Sewage Disposal," and Professor G. C. Watson on "Certified Milk," besides local members. The June meeting took the form of an excursion to the State Agricultural Experiment Station at Geneva, N. Y. The following new officers were elected: President, W. M. Booth; vice-president, Dr. F. E. Engelhardt; secretary, Dr. H. C. Cooper; treasurer, L. M. Fenner.

THE annual *conversazione* of the Royal Geographical Society took place on June 17 at the Natural History Museum. The guests were received by the president, Major Leonard Darwin, and Mrs. Darwin and the members of council.

A PARTY of thirty members of the National Hungarian Agricultural Society, accompanied by Count Laszloesterhazy, chairman of the society and president of the Agricultural Society of the county of Feher, on June 18 paid a visit to the agricultural experimental station at Rothamsted. Mr. A. D. Hall, director of the experiments, with whom were Dr. Russell and Dr. Miller, received the visitors, who were afterwards entertained to lunch and proceeded under the direction of Professor Dymond, of the Royal Agricultural Society, on a tour of inspection of the laboratory and the sections.

THE ninety-first annual meeting of the Société Helvétique des Sciences naturelles will be held from August 30 next to September 2 at Glaris. A provisional program, as abstracted in *Nature*, states that at general meetings on August 31 and September 2 the following addresses will be delivered: Professor K. Schröter, of Zurich, on an excursion to the Canary Islands; Professor H. Schardt, of Montreux, on the great erratic boulders of Monthey and neighborhood; Professor A. Riggenbach-Burckhardt, of Bâle, on gravity measurements of the Swiss Geodetic Commission; Professor Ch. E. Guye, of Geneva, on the electric arc as a powerful aid to science and industry; Dr. H. Greinacher, of Zurich, on radio-active substances; and Professor R. Chodat, of Geneva, on Paleozoic ferns, their significance in modern plant paleontology. September 1 will be devoted to sectional meetings and to the annual meetings of the Swiss Geological, Botanical, Zoological and Chemical Societies.

IN view of the spread of the sleeping sickness among men and animals in Equatorial Africa the French minister of the colonies has caused a document drawn up by Dr. A. Kermorgant, inspector-general of the colonial sanitary service, setting forth prophylactic measures to be employed for its prevention to be distributed in the form of brochures printed in French as well as in the different dialects spoken in the colonies.

AN International Association for Cancer Research has been founded at Berlin, to promote the investigation of cancer and the care of cancer patients, the collection and publishing of international cancer statistics, and the establishment of an international center of information on all matters concerning cancer research. Other objects of the association are the publication of an international technical organ and the organization of international cancer conferences. So far, thirteen states, including all the great powers except Great Britain, have joined the association, the seat of which will be at Berlin.

THE Bronx Society of Arts and Sciences is installing a museum in the Lorillard Mansion in Bronx Park, New York City, and announces that it will appreciate the aid of all interested. A museum committee, consisting of Albert E. Davis, chairman; Dr. N. L. Britton, John H. Denbigh, Arthur A. Stoughton, A. T. Schauffler, the Rev. Henry M. Brown, Walter E. Hallett and George E. Stonebridge has been appointed, and a tentative plan has been prepared for suitable collections, classified as follows: (1) Collections illustrating the natural history of the Bronx; (2) collections illustrative of the civil history of the Bronx; (3) collections illustrative of the industries of the Bronx; (4) educational features of the Bronx; (5) the park system of the Bronx; (6) library.

UNIVERSITY AND EDUCATIONAL NEWS

An arrangement has recently been effected by means of which the University of Buffalo has acquired from Erie County, N. Y., one hundred and four acres of land to be used for university purposes. The tract is at the summit of the limestone ridge at the northern edge of the city, adjacent to the country club. The Medical Department of the University of Buffalo was founded in 1846 and three other professional schools have been organized since that time. The need for an academic department has long been felt and its organization now seems in a fair way to be accomplished. The land above mentioned will be devoted to that purpose.

Dr. William Edward Wilson, F.R.S., of Daramonahouse, county Westmeath, who died on March 6, leaving personalty valued at £50,121, bequeathed his philosophical and scientific instruments to Trinity College, Dublin, for use in the physical laboratory, and his telescope and its machinery to the Radcliffe Observatory at Oxford.

Mr. Charles Edwin Layton, of London, has made a large number of public bequests, including $30,000 to King's College, London, for scholarships to be awarded to those who show the best promise of genius and aptitude in original scientific work.

The trustees of the Massachusetts Agricultural College have recently established a new department of hygiene and physical culture. Percy L. Reynolds, M.D., has been placed in charge of the department. Dr. R. D. MacLaurin, research chemist at the experiment station, has been elected lecturer of organic chemistry in the college.

Dr. H. J. Davenport, assistant professor of economics in the University of Chicago, has been appointed professor of economics in the University of Missouri.

Dr. Harvey Carr, professor of psychology in the Pratt Institute, will succeed Dr. J. B. Watson (professor-elect in Johns Hopkins University) as assistant professor of psychology in the University of Chicago. Dr. Carr will have charge of the work in comparative psychology and will share in the conduct of the general experimental courses.

Dr. Clarence S. Yoakum, of the University of Chicago, has been appointed instructor in psychology at the University of Texas.

Dr. Victor E. Emmel, Austin teaching fellow in embryology and histology, Harvard Medical School, has accepted the appointment of instructor in histology and embryology in the Medical Department of Washington University, St. Louis, Mo.

At the Indiana University the following promotions have been made: From junior professor to professor, Wm. A. Rawles, Ph.D. (Columbia), economics and political science; S. C. Davisson, Sc.D. (Tübingen), and D. A. Rothrock, Ph.D. (Leipzig), mathematics; W. G. Moenkhaus, Ph.D. (Chicago), physiology; L. S. Davis, Ph.D. (Marburg), chemistry; A. G. Pohlman, M.D. (Buffalo Med. Col.), anatomy; W. R. Alburger, M.D. (Pennsylvania), pathology. W. A. Cogshall was promoted from assistant professor to associate professor of astronomy, and Dr. Charles Heseman from instructor to assistant professor of mathematics.

Dr. Wahrmund, professor of canon law at Innsbruck University, whose pamphlets criticizing Catholic dogmas led to a demand from the Papal Nuncio for his removal, and whose recent attempt to resume his lectures caused the closing of the university, has been transferred in a similar capacity to the German University at Prague.

Professor P. Schiefferdecker has been named the director of a new subdivision of the Anatomical Institute in Bonn.

At Cambridge Dr. Anderson has been appointed university lecturer in physiology; Mr. F. H. A. Marshall, M.A., Christ's, university lecturer in agricultural physiology; Mr. C. G. Lamb, M.A., Clare, university lecturer in electrical engineering, and Mr. C. E. Inglis, M.A., King's, university lecturer in mechanical engineering, all for five years.

Mr. H. J. Mackinder, M.A., who has resigned the office of director of the London

School of Economics and Political Science, to which he was appointed in 1903, retains the readership in geography, to which, under its then title, he was appointed in 1902.

DISCUSSION AND CORRESPONDENCE

MENDELIAN PROPORTIONS IN A MIXED POPULATION

TO THE EDITOR OF SCIENCE: I am reluctant to intrude in a discussion concerning matters of which I have no expert knowledge, and I should have expected the very simple point which I wish to make to have been familiar to biologists. However, some remarks of Mr. Udny Yule, to which Mr. R. C. Punnett has called my attention, suggest that it may still be worth making.

In the *Proceedings of the Royal Society of Medicine* (Vol. I., p. 165) Mr. Yule is reported to have suggested, as a criticism of the Mendelian position, that if brachydactyly is dominant "in the course of time one would expect, in the absence of counteracting factors, to get three brachydactylous persons to one normal."

It is not difficult to prove, however, that such an expectation would be quite groundless. Suppose that Aa is a pair of Mendelian characters, A being dominant, and that in any given generation the numbers of pure dominants (AA), heterozygotes (Aa), and pure recessives (aa) are as $p:2q:r$. Finally, suppose that the numbers are fairly large, so that the mating may be regarded as random, that the sexes are evenly distributed among the three varieties, and that all are equally fertile. A little mathematics of the multiplication-table type is enough to show that in the next generation the numbers will be as

$$(p+q)^2 : 2(p+q)(q+r) : (q+r)^2,$$

or as $p_1 : 2q_1 : r_1$, say.

The interesting question is—in what circumstances will this distribution be the same as that in the generation before? It is easy to see that the condition for this is $q^2 = pr$. And since $q_1^2 = p_1 r_1$, whatever the values of p, q and r may be, the distribution will in any case continue unchanged after the second generation.

Suppose, to take a definite instance, that A is brachydactyly, and that we start from a population of pure brachydactylous and pure normal persons, say in the ratio of 1:10,000. Then $p=1$, $q=0$, $r=10{,}000$ and $p_1=1$, $q_1=10{,}000$, $r_1=100{,}000{,}000$. If brachydactyly is dominant, the proportion of brachydactylous persons in the second generation is 20,001:100,020,001, or practically 2:10,000, twice that in the first generation; and this proportion will afterwards have no tendency whatever to increase. If, on the other hand, brachydactyly were recessive, the proportion in the second generation would be 1:100,020,001, or practically 1:100,000,000, and this proportion would afterwards have no tendency to decrease.

In a word, there is not the slightest foundation for the idea that a dominant character should show a tendency to spread over a whole population, or that a recessive should tend to die out.

I ought perhaps to add a few words on the effect of the small deviations from the theoretical proportions which will, of course, occur in every generation. Such a distribution as $p_1 : 2q_1 : r_1$, which satisfies the condition $q_1^2 = p_1 r_1$, we may call a *stable* distribution. In actual fact we shall obtain in the second generation not $p_1 : 2q_1 : r_1$ but a slightly different distribution $p_1' : 2q_1' : r_1'$, which is not "stable." This should, according to theory, give us in the third generation a "stable" distribution $p_2 : 2q_2 : r_2$, also differing slightly from $p_1 : 2q_1 : r_1$; and so on. The sense in which the distribution $p_1 : 2q_1 : r_1$ is "stable" is this, that if we allow for the effect of casual deviations in any subsequent generation, we should, according to theory, obtain at the next generation a new "stable" distribution differing but slightly from the original distribution.

I have, of course, considered only the very simplest hypotheses possible. Hypotheses other that that of purely random mating will give different results, and, of course, if, as appears to be the case sometimes, the character is not independent of that of sex, or has an influence on fertility, the whole question may be greatly complicated. But such complications seem to be irrelevant to the simple issue raised by Mr. Yule's remarks.

G. H. Hardy

Trinity College, Cambridge,
April 5, 1908

P. S. I understand from Mr. Punnett that he has submitted the substance of what I have said above to Mr. Yule, and that the latter would accept it as a satisfactory answer to the difficulty that he raised. The "stability" of the particular ratio 1:2:1 is recognized by Professor Karl Pearson (*Phil. Trans. Roy. Soc.* (A), vol. 203, p. 60).

PURE CULTURES FOR LEGUME INOCULATION

In the 1907 Report of the Biologist of the North Carolina Agricultural Experiment Station, Dr. F. L. Stevens and Mr. J. C. Temple report some work upon cultures of the nodule-forming organisms of legumes. The cultures used were obtained from the United States Department of Agriculture. The investigators have presented their data in such a manner that the value of pure cultures for inoculating legumes appears questionable and their conclusions emphasize their attitude of disapproval. In carefully reviewing their report, a very brief outline of which appeared in Science, Vol. 26, 1907, p. 311, I have been impressed with the fact that the inferences drawn by the casual reader would almost certainly be unwarrantably antagonistic to the use of pure cultures for inoculating legumes. The investigators' objections to the actions of cultures supplied by this department are briefly as follows:

A considerable number of the cultures hermetically sealed in glass were sterile at the time they were examined by Dr. Stevens and Mr. Temple. The misconception in regard to the viability of cultures distributed by the department at the present time could have been prevented by the insertion of a footnote explaining that since July, 1906, small bottles with wax seals have been substituted for small tubes hermetically sealed in the flame of a blast lamp. It is surprising to me that four out of seven of the old-style cultures examined by Dr. Stevens should have been sterile, as my own investigations previous to adopting this method for distribution indicated that about one half of one per cent. of the cultures sealed in this way in routine work would be injured or sterilized by the heat of sealing. The law of chance must perhaps be invoked to explain the discrepancy in our figures. It must be remembered, however, that the cultures spoken of at this time are the old-style liquid cultures, and that the cultures distributed since July, 1906, are not open to criticism of this sort.

It is surprising to me also to learn that during the multiplication period conducted in the practical manner outlined for use on the farm such great contamination should have become manifest. Two years ago I had small samples of these gross cultures prepared on the farm returned to me by farmers in various parts of the country for examination, the sample being taken and mailed to me at the time the culture was applied to the seed. This, of course, allowed for greater development of contaminations than would have taken place at the time the culture was applied to the seed. Even with this handicap about two per cent. of the cultures received from the farmers were apparently pure, and if contaminated the contamination was evidently very slight indeed. About sixty per cent. were contaminated, but not excessively so, it being easy in all of these cases to isolate large numbers of *Pseudomonas radicicola*. The remainder were in rather bad condition, although I doubt if ten per cent. of the entire number received were so seriously contaminated as to be worthless.

The description of the pot experiments conducted by Dr. Stevens and Mr. Temple is confusing. In the first place, the sterilizing of soil by heating is well known to injure the soil seriously, and, regardless of the condition of the nodule-forming bacteria introduced, it is an open question whether soil sterilized by heating would allow nodule formation until a normal bacteriologic flora and normal soil conditions generally had been reestablished. It is impossible to determine whether any attempt has been made to find out if injurious effect is produced by sterilizing this soil, unless we are to understand that pots Nos. 4 and 5 in tables Nos. 1, 2, 3, 4, 5, 6, 7, 8, 11 and 12 are inoculated with a mixture of culture and unsterilized soil. If this premise is correct it is evident that neither culture nor soil inoculation was able to produce nodules in the sterilized soil. If, on the other hand, one is to understand that pots Nos. 4 and 5 in tables Nos. 1, 2, 5, 7 and 11 are inoculated with culture mixed with sterilized soil then we must admit that no true parallel exists between the two series of experiments, and that it is impossible to determine what the effect of the use of pure cultures has been. There is also a contradiction between the headings and subheadings of some of the tables, making it impossible to determine whether that particular series was inoculated or uninoculated.

For the above reasons I would take exception to the summary of results reported by Dr. Stevens and Mr. Temple, and return the Scotch verdict of not proven to their strictures upon pure cultures and the pure culture method of inoculation. The note following the summary referring to Farmers' Bulletin No. 315, "Progress in Legume Inoculation," issued January 11, 1908, quotes the figures reported in that publication in a way that is very misleading. It is obviously impossible to determine whether or not a culture produced nodules if the entire crop is withered by drought or carried away by floods or if other uncontrollable factors entirely apart from the question of inoculation have destroyed the crop. It is, therefore, unfair to compare the 2,037 doubtful results with the 1,770 successes. As stated in Farmers' Bulletin 315, "the successes credited to the culture have been so recorded only when a clear gain was shown to be due to inoculation. A less strict interpretation of the doubtful reports would place many of them in the column of successes, and undoubtedly many classed as failures to secure inoculation would prove upon adequate investigation to have been failures from causes other than deficient nodule formation." If one must express the result in percentages it would be necessary to consider only the failures and successes, making the percentage of successes 78, instead of less than 50.

In closing, I wish to emphasize the necessity in experimental work of paying more attention to the soil conditions which may affect nodule formation. Some reasons for this Mr. Robinson and I have clearly indicated in Bureau of Plant Industry Bulletin No. 100, Part VIII., "Conditions Affecting Legume Inoculation."

Karl F. Kellerman

Washington, D. C.

A STUDY OF THE REMARKABLE ILLUMINATION OF THE SKY ON MARCH 27, 1908

On the night of Friday, the twenty-seventh of March, 1908, between the hours of 7:45 and 8:30, there was an unusual illumination of the heavens. The display was noted by many observers at Sandy Hook, N. J., and at Montclair, N. J. Some of the New York papers stated that the phenomenon was also visible at Hartford, Conn. Beyond a casual and unscientific reference to the matter in the daily press at the time, I have not been able to find any further reports or study of the phenomenon.

The 27th of March was a remarkably clear and warm day, the temperature mounting well above 70 degrees. The evening was also clear, but decidedly cooler. There was no moon, but Venus shone unusually bright in the western sky. This last fact is mentioned particularly, because the best authorities state that the light of a brilliant evening star is sufficient to preclude any marked illumination like that observed. Every one whom I have interviewed informs me that he had never before witnessed any such display. With the exception of one eye-witness at Millburn, N. J., all of my information has been obtained from observers at Sandy Hook, N. J. I was so unfortunate as to witness the last part of the spectacle, only. Details beyond my own knowledge are furnished from accounts given me by army officers stationed at Sandy Hook and members of their respective households.

The illumination was first noted at about 7:45 P.M. It consisted of a bright nebulous band rising north of west from about twenty degrees above the horizon. The light extended across the sky to near the north of east horizon, diminishing in brightness from west to east, the bands in the east and west being connected by three separate bands. At about 8:15, the illumination faded, except the western solid band, which persisted for about ten minutes. Before it disappeared, however, a series of short narrow shafts, nearly parallel to one another, appeared about fifty degrees above the horizon in a direction slightly west of north. The eastern-western illumination was steady, while the northern shafts were "trembly," somewhat suggesting the aurora borealis. It should be remembered, however, that there were no lights of whatever nature in the north, except these detached shafts.

It would seem plausible on first thought to attribute this display to the zodiacal light, or the aurora borealis, or to a combination of the two. The season of the year and the location of the steady glow appear to indicate the zodiacal light. This is rarely seen in our latitude, except near the equinoctial periods; when the inclination of the ecliptic to the horizon is at a maximum—and then only in localities where outdoor illumination is not general, and the air is unusually clear. In the spring the light is first seen as a pale illumination in the west, suggesting an unusual prolongation of twilight. In the autumn, the phenomenon, often called the "false dawn," is visible before daybreak. The zodiacal light is of frequent occurrence in low latitudes, where the illumination sometimes extends across the meridian, forming a secondary display in the east. At times a detached luminous patch is observed in the sky, about 180 degrees from the sun's position. This is called the "gegenschein," or "counter-glow." I can recall no authentic reports of the appearance in our latitude of a secondary light or the counter-glow.

Returning to the exhibition of last March, the zodiacal light hypothesis fails to account for the detached shafts high above the horizon to the west of north. Some writers appear to make a distinction between auroral displays ("fictitious" auroras, as it were), and the characteristic aurora borealis. Reports of the simultaneous displays of the zodiacal light and auroral phenomena are matters of authentic record. In the case under discussion, there is a chance that two independent phenomena were occurring at the same time, but the chance was infinitesimally small. Moreover, one of the most pronounced sensations of the beholder was that he was witnessing *one* phenomenon, with *one* cause.

As is generally known, neither the aurora borealis nor the zodiacal light has been quite satisfactorily explained. The latter has been variously attributed to extensions of the sun's corona, to the reflection of the sun's light from masses of meteoric matter revolving around the sun in planes near the ecliptic, or around the earth itself. Chaplain G. Jones, of the U. S. Navy, who, in 1855, made a particular study of the zodiacal light while on duty in Asiatic waters, could not explain the disposition of the light as he observed it on any hypothesis other than the last mentioned. Reports have also been published of the appearance of a similar band about the moon.

The main difficulty in the way of the study of the zodiacal light is found in the fact that, owing to the nature of the light, the telescope can not be brought into service. Again, a brilliant display is a rarity, except in equatorial latitudes, where observatories are very scarce. If the light were due to the sun's corona, its spectrum should be identical with that of the solar corona, and if due to reflected sunlight alone, the polariscope should show that the light is polarized. Observations with both kinds of instruments show conflicting—or rather mixed results.

The following hypothesis is submitted as a possible explanation of the phenomenon of last March, and is believed to be in line with the latest theory as to the constitution of matter.

Whatever the sun's corona may be, it is not a heat phenomenon pure and simple. If it is composed of matter at all, it must be in that sub-atomic condition characteristic of the manifestation of electricity. The corona from its very appearance suggests a streaming out from the sun of attenuated matter, or of force. That a repellant force actually emanates from the sun is shown by the solar action upon the tails of comets, always turning them from itself. It seems to have been fairly well established that all substances are radio-active, differing only in degree in the possession of this property. It is but a step further to conclude that all celestial bodies are sending out emanations of matter in the most attenuated state, and that these effects, in the case of the sun, become visible as the solar corona. Following this trend of thought, we may safely assume that the earth and moon each has its own corona. The aurora borealis then may be an exhibition of our corona shining by its own light, the angle at which the sun strikes the corona being such as to preclude the reflection of sunlight to the observer's eye. The zodiacal light might be explained as being due *mainly* to sunlight reflected from our own coronal matter. As in this case we should not be viewing the earth corona by its own light, the flickering effect of the northern light would not be prominent.

The hypothesis here offered seems to account for the puzzling mixed spectra of the so-called zodiacal light. It further explains the existence of the shafts high in the north and the undecided character of the light, on the evening of March 27. Both the zodiacal and auroral theory utterly fail to account for these. Wandering into the domain of conjecture, it is interesting to speculate whether the solar, terrestrial and lunar coronas are identical in nature. If they are not, it would seem to indicate that radio-activity was a function of the heat of the radiating body, and we might expect the spectra to group themselves in the order named as regards simplicity. If the spectra should prove to be the same, we might fairly conclude that coronal material is the final form of disintegrating matter, as a nebula is the first form.

Wilmot E. Ellis

Fort Terry, N. Y.

QUOTATIONS

THE CAVENDISH LABORATORY

Lord Rayleigh, as chancellor of the University of Cambridge, performed his first official act by opening the new wing of the Cavendish Laboratory, which Lord Rayleigh, as a Nobel prize-man, presented to the university. The ceremony was all the more interesting because, as Professor J. J. Thomson observed, it occurred upon the anniversary of the opening of the original Cavendish Laboratory, which the university owed to the generosity of the seventh Duke of Devonshire, who was chancellor in 1874. During the thirty-four years that have elapsed since the founding of the laboratory, Lord Rayleigh has been closely connected with it, and the physical research which it was designed to promote. His interest in it, indeed, began, as he remarked yesterday, before it existed. He had then become acutely aware of the scientific destitution of the university, and of the difficulty of acquiring systematic scientific training. Much good work had been done in physical research, but it had to be carried out by earnest students either in their own houses or in some college where the equipment was more meager than students of the present day can easily realize. Lord Rayleigh's activity in seeking a remedy for that state of things was much greater than might be inferred from his characteristically modest remark that he had some share in urging Clerk-Maxwell to accept the appointment of professor of experimental physics. That brilliant man's tenure of the post was not a long one, and on his lamented death in 1879 Lord Rayleigh succeeded him as Cavendish professor. During the five years of his professorship Lord Rayleigh carried out some fundamental researches with results which more recent investigations have only corroborated. Since that time the post has been held and adorned by Professor J. J. Thomson; but Lord Rayleigh's interest in the laboratory and its work has been continuous and keen. The extension which he has given to its accommodation was very urgently needed on account of the steady growth in the number of students pursuing original research; but the university is poor and, but for his timely aid, might have waited long for this addition to its teaching facilities. The present phase of scientific investigation is marked by a need for costly apparatus which earlier experimenters do not seem to have felt so acutely and which certainly could not have been supplied. Lord Rayleigh, we may judge from a reference to his earlier studies, does not approve the tendency to disparage simpler methods of research, and it is conceivable that some day a great man will again arrive at an epoch-making discovery by means surprisingly simple. Originality is perhaps not always fostered by a wealth of apparatus, still there is an immense amount of work at the present day which can be carried on nowhere but in well-equipped laboratories like the Cavendish. When the present extension has again been overtaken by the influx of students, Cambridge will no doubt again find among her sons some one to emulate the liberal and public-spirited action of her present distinguished chancellor.—The London *Times*.

SCIENTIFIC BOOKS

Social Psychology: An Outline and Source Book. By Edward Alsworth Ross. New York, The Macmillan Company. 1908. Pp. xviii + 372.

It must have required considerable courage on the part of Dr. Ross to venture a new book on social psychology. For although he says in the preface that "the ground is new," still, as he well knows, and as his materials show, the subject itself is very old and has been worn threadbare. The only thing that could be done, and the thing that he has virtually done, was to undertake a new compilation of the matter already extant. For, without making a count, it seems safe to say that fully one half of the matter of the book is between quotation marks, and its character as a compilation would have been apparent if all the citations had been printed in different type. But this is very far from being a criticism of the book. Indeed, under the circumstances it is its highest commendation.

And yet he has by no means utilized all the literature. Professor Sumner's "Folkways" reached him too late for use, but it would have been an inexhaustible source of facts for such a work. One of the most important omitted works is Michailovsky's elaborate treatise on "The Heroes and the Crowd," which first appeared in *Russian Wealth* in 1882 and was republished in a collection of essays in 1896.[1] In this essay imitation and suggestion are ably handled, and many of Tarde's best thoughts are anticipated. The religious epidemics of the middle ages are described in detail, and contagious manias of suicide and homicide are fully treated. The subject of the influence of the mind on the body, now brought into such prominence by christian science, received special attention, not merely in recording the alleged instances of "stigmata," but in enumerating many other illustrations. In no other work, so far as I know, is the case of Jacob's "ring-streaked, speckled and spotted" sheep and goats referred to this principle, not only as illustrating its effect on animals, but as showing that it was understood by Jacob and effectively acted upon.

Another of the older, much neglected works is Carpenter's "Mental Physiology," 1875, which deals in a scientific way with many of the psychic phenomena now referred to social psychology. Carpenter laid great stress on the principle which he called "expectancy," which is really none other than that now perhaps less happily called "suggestion."

But of course Tarde's works stand out as the leading contributions to social psychology, and it is refreshing to see them prominently recognized by Dr. Ross in the preface to this book. It has become so much the custom of American writers, while reiterating the truths they contain, to ignore their source, that this manly acknowledgment will be appreciated by all admirers of the great French sociologist.

Dr. Ross well says that social psychology is not the same as psycho-sociology. It is not

[1] "Heroi i Tolpa," Russkoe Bogatstvo, 1882; Sochineniya, Vol. II., St. Petersburg, 1896, pp. 95–190.

the psychology upon which sociology rests, and which furnishes society with both its motor power and its guidance. That is an entirely different and far more important science. Social psychology is the science of the mutual influence of psychic phenomena. Mr. H. G. Wells has properly described it as "an exhaustive study of the reaction of people upon each other and of all possible relationships."[2]

Social psychology, thus understood, has been treated by all kinds of writers. Very little of value has been contributed by the psychologists proper. When they approach it they load it with such a mass of technical terms, borrowed from their psychological "jargon"—dialectic, ego, alter, socius, eject, project, subject, etc., with the innumerable derivatives of these terms, that, however commonplace such ideas may be, the reader's mental stomach is so turned by their pedantic iteration that it is incapable of following what little thought they may represent.

But many writers besides Tarde have treated special aspects of the subject with clearness and force. Among these Dr. Ross himself must be counted and placed in the front rank, for his "Social Control" and other writings deal primarily with social psychology. In the present work he lays under contribution a great array of authors and a vast literature. No attempt can be made here to summarize this body of knowledge. The arrangement of the material is the original part of the work, and this could not probably be improved upon.

In some of the later chapters Dr. Ross has been able to free himself more fully from his historical bearings, and to strike out into fields more distinctly his own. This is especially the case with Chapter XV., on the Relation of Custom Imitation to Conventionality Imitation, and Chapter XVI., on Rational Imitation, which is the coming form of imitation based on intelligence and scientific knowledge. Chapter XVIII., on the rôle of Discussion, is also luminous, and pushes the subject some distance beyond the point where Bagehot left it. Chapter XXI., on Compromise, is all too brief, and John Morley is not mentioned.

[2] "A Modern Utopia," New York, 1907, p. 83.

The final chapter (XXIII.), on Disequilibration, deals with invention (in the Tardean sense), and displays an astonishing grasp of the progress of human thought. No one has better shown how it is that premature discoveries lie dormant till the world is ready for them. Under the heading that "the higher the degree of possibility, the sooner the invention is likely to be made," he says (pp. 359–360):

> The inventions (or discoveries) in a particular field—and often those in different fields—are in a chain of dependence which obliges them to occur in a series. Each ushers in a train of possibles. Now when no intervening invention needs to be made, an invention may be said to be in the *first* degree of possibility. When it is contingent on another yet to be made, it is in the *second* degree of possibility. And so on. Now, when an invention or discovery reaches the first degree of possibility, it is *ripe*. Thus, after Kepler announces the laws of planetary movement, the discovery of the principle of universal gravitation is in order at any moment. After Galileo has proclaimed the laws of the pendulum, its use in time-keeping needs but a single stride. The electric telegraph is due any time after Ampère's discoveries. The invention of Crookes's tubes brings the X-ray into the foreground of possibility. After the discovery of the Hertzian waves, a few short steps bring wireless telegraphy upon the scene.

And in showing "how society can promote invention," he significantly adds (p. 360):

> The difficulty of making the combination of ideas for any particular invention will depend upon the number of persons who possess these ideas, and on the frequency in this number of individuals with the intellectual capacity necessary to combine the ideas into the invention. There is no way of affecting the latter condition, for the genius is in no wise a social product; but organized society can affect the former condition. A universal system of gratuitous instruction with special aid and opportunities for those who show unusual power amounts to an *actualizing* of all the potential genius in a population, and is the only rational policy for insuring a continuous and copious flow of inventions. It is hardly necessary to point out that only a stimulating, equipping education can mature geniuses. A régime that prunes, clips and trains minds levels genius

with mediocrity. A schooling devised primarily to produce good character, or patriotism, or dynastic loyalty, or class sentiment, or religious orthodoxy may lessen friction in society, but it can not bring genius to bloom. For this the prime essentials are *the communicating of known truths* and *the imparting of method.*

On the whole we have in this work an able marshaling of the knowledge thus far brought to light on the subject of social psychology, and a clear, untechnical, while at the same time often eloquent, discussion of the laws, principles and leading truths of that rather subtle and recondite branch of sociology.

LESTER F. WARD

The Solar System: A Study of Recent Observations. By CHARLES LANE POOR, Professor of Astronomy in Columbia University. New York, G. P. Putnam's Sons.

From the above sub-title we naturally look for something different from the ordinary text-book on astronomy. Nor shall we be disappointed in this respect. The author informs us that the work grew out of a series of lectures, that these were mainly historical and were used to supplement standard text-books and to guide the students in their reading. Though the work includes much which may be found in the ordinary text-book, there is also much not usually to be obtained from such sources. On the other hand, some matters of great interest are hardly touched on in the present work. We mention by way of illustration the minor planets and the subject of eclipses.

The lecture notes seemed to have been followed quite closely. We are informed, for instance, page 235, that the last opposition of Jupiter took place in the latter part of December, 1906, and that the next will fall on the last of January and the first of February, 1908. We also learn that the last favorable eclipse of the sun occurred August 30, 1905, and the next eclipse which can be utilized, will take place October 10, 1912, and will be observable in South America. Precisely what disposition has been made of the eclipse of January 3, 1908, does not appear.

The subject of the solar energy is treated quite fully, with the different theories as to its maintenance, its constancy and results of measurement of the same. We confess, however, to finding ourselves a little disconcerted on learning, page 126, that such measurements are of no vital importance.

Naturally the reader in search of the latest and most interesting information relating to the solar system will turn to the planet Mars. The author acknowledges to having given to this planet more space than the subject really warrants. We find an entire chapter of twenty-four pages entitled "Has Mars Canals?" The leading authorities—Schiaparelli, Lowell, Newcomb, Barnard and many more are quoted at considerable length, with the result that we are finally told that "very little is actually known in regard to the conditions existing on Mars," that many of the problems are psychological and not physical. The seeker after truth, therefore, finds himself at the end of the chapter precisely where he stood at the beginning.

The author gives us an account of the discovery of the seven satellites of Jupiter, beginning with Galileo and ending with Perrine, but the ink is hardly dry on the page before the discovery of an eighth at Greenwich calls for a revision of the chapter, thus illustrating the impossibility of keeping such a work strictly up to date. In this connection let it be noted that the name of satellite IV. is Callisto, not Calypso.

Each planet from Mercury to Neptune is taken up in turn. Many facts of historical interest are given, among which are some old friends not usually found in the text-books, such as the famous Moon Hoax of 1835.

Chapters on comets, on meteors and on the evolution of the system close a very interesting and suggestive volume.

C. L. DOOLITTLE

FLOWER OBSERVATORY

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. V., No. 3 (March, 1908), contains the following papers: "The Physiology of the Nervous System of the Razor-shell Clam (*Ensis directus* Con.)," by Gilman A. Drew. The experiments indicate that, while the ganglia all have their special functions to perform, the pedal ganglia are under the direct control of the cerebral ganglia and are not capable of originating motor impulses when separated from them. Association fibers between the ganglia are well developed and impulses may finally reach muscular organs by roundabout paths when the usual paths have been destroyed. "The Influence of Grafting on the Polarity of Tubularia," by Florence Peebles. "A Study of the Germ Cells of Certain Diptera, with reference to the Heterochromosomes and the Phenomena of Synapsis," by N. M. Stevens. This article is a study of the germ cells of nine species of Muscidæ and Syrphidæ. The spermatogonia contain an unequal pair of heterochromosomes, and the oogonia a corresponding equal pair. The dimorphism of the spermatozoa and its relation to sex determination are the same as in many of the Coleoptera and Hemiptera. In synapsis there is a side-to-side pairing of homologous maternal and paternal chromosomes, and a similar pairing occurs in the prophase of each spermatogonial and oogonial mitosis, and also in ovarian follicle cells. "Momentary Elevation of Temperature as a Means of Producing Artificial Parthenogenesis in Starfish Eggs and the Conditions of its Action," by Ralph S. Lillie. Momentary warming of unfertilized starfish eggs, *e. g.*, to 35° for 70 seconds, during early maturation, results in membrane formation, cleavage and development to an advanced larval stage. Exposure to $n/2000$ KCN solution during, before and after such warming is highly favorable to parthenogenetic development. Initiation of development can not, therefore, depend on acceleration of oxidative processes. Apparently, processes of some other nature—hydrolytic or reducing—are most immediately concerned in fertilization in these eggs. "The Sex Ratio and Cocooning Habit of an Araneid and the Genesis of Sex Ratio," by Thomas H. Montgomery.

The *Istituto geografico militare* of Italy, situated at Florence, has published a new edition of a most effective map of Vesuvius in colors, on a scale of 1:25,000 (2 francs), indicating all determinable lava flows, with their dates down to 1906; also a map of Vesuvius in black, scale 1:10,000 in six sheets (4.50 francs complete), and two special maps of the cone of the volcano, 1:10,000, before and after the eruption of 1906 (each one franc). Those who are thinking of ordering the general map of Italy, 1:100,000, will do well to specify the edition "Systema Gliamas," now in course of publication in four colors (1.50 francs a sheet: 27 sheets published; edition on thin paper preferable). W. M. D.

At the sitting of the Paris Academy of Sciences on June 16 M. Poincaré gave, according to the London *Times*, particulars of a discovery by M. Devaux Charbonnel of a method of photographing the sounds of the human voice with sufficient precision to enable the record to be read. Vowels and consonants are combined with a Blondel oscillograph. The latter, which is extremely sensitive, impresses the sounds upon a photographic plate in the form of curves characteristic of each category. With a little practise it is possible to decipher these characters.

THE COCO BUD-ROT IN CUBA

An appropriation has been approved by the provisional governor of Cuba, Hon. Chas. E. Magoon, for $14,000 to be expended in the next year for combating the coconut bud-rot in the district of Baracoa.

The bud-rot is the most serious disease of the coconut palm. It occurs in Cuba, Jamaica, Trinidad, British Honduras, British Guiana, and perhaps in India, Ceylon and East Africa. Many years ago it spoiled the business of coconut growing in most parts of Cuba. It usually leaves a few scattered trees and this is the condition now around Havana. Even in the Baracoa district, which is especially adapted to coconuts and which escaped the disease longer than most parts of Cuba, it has existed for probably twenty years, but it has increased gradually and has only become alarming within the last few years. The total production of this district is now estimated at two million nuts monthly (including those fed to animals), whereas it was formerly estimated at three million monthly. The decrease is due to bud-rot.

Much work has been done on this trouble in the British West Indies, where the destruction of sick trees and the use of Bordeaux mixture as a preventive have given good results.

Considerable attention has also been given to the bud-rot by the United States Department of Agriculture, which, at the request of the planters, sent Mr. Wm. Busck to Baracoa to investigate the disease in 1901. The measures which he recommended are substantially the same as those which are now to be carried out. The results of his work are given in Bulletin No. 38, Division of Entomology, U. S. Department of Agriculture. In the spring of 1904, Dr. Erwin F. Smith, of the U. S. Department of Agriculture, spent some time in Cuba studying the disease. Mr. Busck had regarded it as caused by a fungus, *Pestalozzia palmarum,* but Dr. Smith regarded it as a bacterial rot. The results of Dr. Smith's work are given in SCIENCE, N. S., Vol. XXI., No. 535, p. 500, March 31, 1905. During the past year his investigations have been continued at Baracoa and other West Indian coconut-producing points.

The subject has been written on largely by Cuban authorities, notable among whom is Dr. Carlos de la Torre, of the University of Havana; and the Department of Vegetable Pathology of the Estación Central Agronómica de Cuba has given it as much attention as possible among many other problems during nearly four years, but without being able thus far to reproduce the disease at will.

The work for which the appropriation has just been made by the Cuban government is in continuation of investigations undertaken by the Cuban Department of Agriculture through the Estación Central Agronómica in March, 1907. At this time Mr. Wm. T. Horne, chief of the Department of Vegetable Pathology of the Estación Central Agronómica, was sent to Baracoa to study means of eradicating the disease and during the summer he made three other visits. The trouble was found widely distributed and progressing at an alarming rate. The principal work done was the treatment of several small groves with the most thorough sanitation possible—*i. e.,* dead and hopelessly sick trees were felled and burned, while new cases and suspected trees were flamed out. In two of the groves which were treated the disease was passing across, killing every tree in its path. The work showed that all trees with fairly well developed cases die. It was thought that some very early cases were saved by the flaming; at least the disease was checked. It was not stamped out in the groves, but the results were as satisfactory as could have been expected in decreasing the infection.

The work now to be undertaken is probably the most extensive measure ever adopted to control the bud-rot of coconuts and it is most sincerely to be hoped that this aid from the general government will sufficiently suppress the disease so that by a vigorous system of inspections it may be thoroughly and permanently held in check.

SPECIAL ARTICLES

REGARDING THE FUTURE OF THE GUANO INDUSTRY AND THE GUANO-PRODUCING BIRDS OF PERU[1]

To the people of Peru the importance of the guano industry needs no emphasis, but it is well, first, to make clear just what is the alarming condition with which the country is confronted, and what is the object to be striven for.

Every one knows that the great ancient deposits of guano are now almost non-existent. As these deposits have been successively exhausted of various high grades, there is now left only the lowest grades that it is profitable to extract, and also some supplies of such very low grade that under present conditions they are not marketable. However, the birds are

[1] The present paper, very slightly modified from a report recently submitted to the Peruvian government and published officially in Spanish, is presented in English with the kind permission of Sr. Larrabure y Correa, Director de Fomento in Lima.

each year making new deposits, especially on their nesting-grounds, and this new fresh guano usually has a very high per cent. of nitrogen and a comparatively low per cent. of sand. Now, as the remaining deposits of old guano are rapidly being exhausted, the annual gross output of guano is bound to decrease very considerably, and the industry will be dependent entirely upon the yearly deposit of the birds.

Probably the general impression held in other countries regarding the accumulations of guano in Peru has been that they were comparable to coal formations, in that they represented the very gradual accumulations of untold years, and were, practically speaking, a finished formation. By the very nature of such deposits they would surely be exhausted sooner or later. Unfortunately this partly erroneous impression seems to have been the controlling one both in Peru and outside. For, while many of the intelligent men of intimate acquaintance with the islands have recognized the producing value of the modern birds, the whole policy of extractors and the government has been, until rather recently, that of making the most of the old deposits, with general disregard of the productive birds.

When one sees one thousand tons of new guano of the highest grade taken from an area of twelve thousand square meters, where the birds have been nesting for much less than one year, when one observes on a neighboring island an area, five times greater, completely covered with birds at their nests, when one, later, finds this latter flock increased by nearly fifty per cent., as the birds have been driven from other islands—with such convincing appeals to the eye and the mind, one will not fail to recognize the present producing value of the birds.

For this new guano of annual production, there is, on the one hand, the insatiable demand of the export trade, and, on the other, a steadily growing requirement for the needs of national agriculture. Since it is generally estimated that the agriculture of Peru requires about forty thousand tons per year, and since this quantity is surely more than the present yearly production, it follows that the impression regarding the exhaustibility of the guano deposits may, doubtless will, prove true, as far as the North American or European consumer is concerned. More than this, it is inevitable that, with the continuance of the present conditions, national agriculture will soon be forced against an actual and disastrous shortage of this fertilizer. The hope of the future lies, then, in the effort to make the annual deposits of guano greater in future years than it now is. National agriculture may have an additional hope, also, that arrangements may be made with the exporting company whereby a greater proportion, if not all, of the fresh guano of high grade may be available for domestic use.

I. THE AIM IN VIEW

To realize the hope that the annual deposit will be greater in future years, it is necessary to cease treating the birds as wild animals whose homes men may invade almost like beasts of prey to seize the useful product, regardless of the producing birds. Under a wiser policy the birds will be looked upon as domestic animals, engaged in a useful labor, and from which a greater benefit will be derived the more an intelligent consideration is shown for their welfare. By the protective measures there are three ends to gain.

1. The present number of birds may be permitted to spend a greater proportion of their time upon their chosen nesting-grounds so that a greater proportion of the guano may be available. The most useful birds, the "guanay" (*Phalacrocorax bougainvillei* Less, a cormorant) and the "alcatras" (*Pelecanus Molinae* Gr., a pelican) spend a great part of their time during the entire year upon the nesting-field or neighboring grounds unless frightened away by the presence of men. In this case they are likely to spend much more time upon the water, or upon the small islets and cliffs, where the deposits are less available, if not largely lost.

2. The present tendency to decrease in numbers may be checked. There is a wealth of reliable testimony from the older men of

long experience in the industry, that the useful birds, especially the alcatras, were formerly vastly more abundant than now. Considering the well-known facts regarding the robbery of eggs on a large scale in past years, the destruction of young and old birds, and the disturbance of the birds in their nesting-grounds by the extraction of guano, it is inconceivable indeed that the birds have not decreased greatly in numbers. If they have endured the treatment they have received without decrease in numbers, then protection can hardly be worth while. On the other hand, if it is true, as represented by every one who should know, that there has been a great diminution in number of birds, then—

3. *We may hope that the protection of the birds will result in a great increase in their numbers.* Before the working for guano on a large scale began and before the nesting-grounds began to be plundered for eggs and fowls, the birds must have existed in a condition of abundance dependent upon their food supply, their enemies and their natural prolificness. New factors have entered in recent years which have caused the birds to decrease materially below this *normal condition of abundance.* If these unfavorable factors are removed by well-considered and well-executed protective measures, why may we not see an increase in number toward the former normal abundance?

I think it conservative to say that the proper protection of the birds means the saving to Peru of hundreds of thousands of dollars' worth of guano each year. The wise action of the government in keeping closed during last season the south island of the Chinchas probably saved one thousand tons or more of guano of high grade during this year. Besides, it has been a benefit to the birds, which, if properly followed up, will yield results in all successive years. The keeping closed of the north island of the Chinchas would not have saved much guano during that season, but, as the beginning of a plan for the fostering of the alcatras, it might have yielded results in future years. For it seems sure that the alcatras was once an abundant and important bird in this region. Now it has practically abandoned the region, but as I showed in a report published in the *Boletin del Ministerio de Fomento* of June, 1907, the few alcatrases which remain had chosen this one island, of all in the Chincha and Ballestas groups, for their nesting-ground. The islands of Lobos de Afuera were abandoned for two years, and the alcatrases settled themselves chiefly in the northern part of the eastward island, and on an islet near by. Here, now, was an ideal arrangement: while the extraction of guano on a large scale was in operation in the Lobos de Tierra Islands, these timid birds were in undisturbed possession of the Lobos de Afuera. Unfortunately, this condition was not permitted to continue, for last season the extraction of guano was resumed on these islands, and the birds were entirely routed. They have now taken new positions, more or less scattered, but with an especial aggregation on the northern part of the westward island. Now guano is again to be extracted from these islands and the pelicans will be routed again from their newly established homes. Is it not time to awaken to the fact that the alcatras is gradually disappearing?

The three instances cited above are adduced to illustrate this point; we need not merely look out for the next two years, but may well plan for protective measures that are intended to work progressively to the advantage of the industry for the next twenty years or more. We want to see many more birds in 1915 than are present in 1908, and more birds in 1920 than in 1915; and this will not be accomplished by routing the birds from their nesting-grounds as soon as they are fairly established.

II. ONE CONTRACTOR TO AN ISLAND

As illustrating the effect of admitting more than one concessionist to an island, let us take the Ballestas Islands, as worked in 1907, for example. As directed by the government, I visited these islands in May and June, and again at the end of July. In the last part of May the work of extraction had been in operation but a few weeks and practically no guano had been shipped, yet every inch of nesting-ground on all three islands had been dug up and thrown into piles, while every bird had been routed. It was perfectly evident that the work of extraction had been carried on entirely without regard to the preservation of the useful birds. I do not mean by this that there was much wanton destruction of the birds, but that practically no consideration was given to the necessities of these fowls for the completing of the rearing of their young or for the mating and other preparations for the next season of reproduction. No inducement was offered to the birds to continue nesting upon the same islands. A little more forethought and system in the manner of working might have saved many tons of guano for the season which is now beginning.

Now, this reckless mode of treating the birds will be continued as long as more than one contractor is licensed to work on the same ground. It is easy to picture the beginning of the work. Two or more contractors have concessions for certain quantities of guano on the north island of the Ballestas. There is on the southwest corner of the island a deposit of several hundred tons of fresh guano. Naturally, this place is the goal of each concessionist. The first to arrive, or the strongest, as the case may be, devotes every effort to the digging up of this area of high-grade guano, since by the act of heaping it in piles his claim is established, and no other contractor has the right subsequently to touch these piles. *Of course, this area of new fresh guano is the chosen breeding-ground of the birds, and so the entire flock of birds, young and old, is routed unceremoniously from the land of their recent nests.* As just the same policy is pursued simultaneously on each of the other two islands of the group, it results that *within the first few weeks of the open season every producing bird on the Ballestas Islands is driven from its nest.*

From the testimony of eye-witnesses it appears that a large number of young fowls were unprepared to abandon their nests, and that the enforced removal of the birds did not occur without the loss of an important number of helpless creatures. From personal observation I know that, even as late as the middle of June, there were large numbers of young birds on the south island of the Chinchas that were still being fed from mouth to mouth by the parents, and I must, therefore, believe that the complete routing of the birds from the Ballestas two months earlier, in April, must have been very harmful. We need not be too quick to blame the contractors in this case. Driven by the force of a very severe competition, they try to establish their claims immediately to as much as possible of the best guano, and, in the heat and bitterness of the competition, they grasp for guano while they are blinded to the welfare of the birds.

If but a single concessionist is admitted to an island, then a more systematic method of extraction may be followed, and more consideration be given to the needs of the birds. It would be better still if only a single concessionist were admitted to the group. Furthermore, the government can require of the concessionist that an intelligent and competent man be put in charge of the work of extraction, who shall be held responsible for the fullest protection of the birds.

I may also refer to the fact that such a measure would eliminate those many and unfortunate disputes between contractors which, as is notorious, have been occurring in recent years on these islands and which reach to the point of threatened and even actual personal violence.

III. CLOSING ISLANDS FOR PERIODS OF YEARS

The plan of working all islands simultaneously condemns itself, and a system of proceeding from one island to the next as soon as the guano from the first is exhausted is little better than the plan of working all islands simultaneously. An improvement on this is the plan which has been suggested several times recently, of dividing the islands into two groups, the islands of one group to be worked one year while those of the other remain closed. This, however, on consideration, is seen to be inadequate, since the birds would thus be disturbed each year as they are driven back and forth from the islands of one group to those of the other.

The merit of a system of rotation depends on leaving the birds unmolested for periods of years, the longer the period the better. For example, it would be an incalculable gain if the alcatrases, which are now using the westward island of the Lobos de Afuera, could be left undisturbed on their grounds for the next four or five years, say until the extraction of old guano from Lobos de Tierra is concluded. Then, in turn, the latter island would be left to the birds for another period of five years, whether the Lobos de Afuera was exhausted in one year or in four years. In other parts of the coast, according to the conditions, certain islands would be opened each year, but in accordance with a plan which would permit the birds to remain undisturbed for periods of years.

In stating that the main hope of the guano industry consists in leaving the fowls unmolested for periods of years, I speak from my own observations on the habits of the birds and on the disturbing effect caused by the presence of even a single visitor. At the same time, it is not a new idea, and the intelligent men of long experience in the industry will insist upon the same principle. I wish to add this: the idea of a systematic closure of islands, if adopted, must be followed resolutely. It may sometimes mean the suffering of national agriculture or of the export trade for want of necessary fertilizer, but the suffering should be accepted rather than break the protective measures. It is fair to choose between two courses, either to plan for the future of the guano industry, adhering to reasonable protective measures, even if present sacrifice is necessary in order to reap the future benefit, or else, continually to cater to present wants and caprices and let the future look out for itself.

IV. CLOSED SEASON

It was a most wise action of the government in establishing a closed season of five months (November to March), when all of the islands were worked each year. Too much dependence, however, can be placed upon this measure. With a proper system of rotation and closure of islands for years, the closed season for the summer months becomes a matter of secondary importance. There is no season of the year when the birds may be disturbed without harm. In the middle of June last year there were numbers of birds in the Chinchas Islands which were still being fed from mouth to mouth by their parents. At the same time the process of pairing for the next season had begun and by July 29 hundreds of eggs had been laid, as the beginning of the next season's brood of young. During what months, then, could work have been conducted on this island without injurious molestation of the birds? The fostering of the birds will be accomplished only by leaving them unmolested for the entire year and for several years in succession. If an island is to be opened it is not of vital importance whether it be opened in April or in June.

I believe it to be more harmful to open too late than too early. To illustrate this, let us make an imaginary case of the south island of the Chinchas. If it be possible to do without this island, it will be most beneficial if the island may remain closed until April or May, 1909. Suppose that it is now decided to keep this island closed, and that later, about August, it is found that the supply of guano from other sources is inadequate and the demands of national agriculture are such that it is deemed necessary to extract guano from this island. The island is opened early in August—with what result? Just at the stage when the majority of the birds have mated for the season, when a large number of eggs are newly laid, and when the females are laden with eggs ready to be deposited in the prepared nests—just at this critical time, the birds are frightened from the island. The new-laid eggs are abandoned, and other eggs laid during this time of change may be lost as the birds chance to stop upon the neighboring rocks or islands. For the change of home is not accomplished in a day; it requires many days or weeks for the birds to realize that the old home must be abandoned, to settle themselves in a new place, and to recover from the demoralization attending the forced change.

More harm is wrought than if the birds had been routed in April; then, by the beginning of the new season of laying, they might have found themselves established in the new homes. The case is imaginary, but it leads to the following important conclusion: Before deciding whether to open or close the south island of the Chinchas, the Lobos de Afuera, the Zarate, the Isla Blanca, or any one of many large and small which have birds in reproduction, it should be carefully considered how much guano is required and from what places it may be obtained. The determination of which islands should remain closed and which open can then be made intelligently, and the islands opened at once or else kept finally and absolutely closed.

It is hardly necessary to refer to the fact that the condition of the sea in the winter months is much more unfavorable for the extraction of guano than in April or May.

The closed season serves a most useful purpose, but for the future the dependence must be placed on closure for periods of years, and less emphasis may be laid on the matter of a month or two.

V. TO PLACE THE EXTRACTION OF GUANO FOR NATIONAL AGRICULTURE IN THE HANDS OF A SINGLE COMPANY

Such a measure as this I believe to be a part of the ultimate solution of the problem. Saying this, I have no reference to any special arrangements which may be pending and with the terms of which I am unfamiliar. In making arrangements with a company, many subsidiary problems arise, such as, the effective protection of the birds, the proper system of rotation of the islands, the manner of conducting the work, the proper distribution of the guano in case the supply does not equal the demand, the analysis of the guano, and the selling by units of nitrogen and of phosphoric acid, the guarantee of an equitable price, etc. Undoubtedly these problems will be carefully studied out before any permanent contract with a company is entered into.

The merit of placing the guano extraction in the hands of a company depends upon making the contract last for a period of years, say for ten years or more. By this means the company is induced to *plan for the future,* which is the desideratum.

It is likewise very desirable that some adjustment may be made with The Peruvian Corporation Limited, with entire regard to all natural obligations, but with a view to securing a harmonious plan of working for the protection of the birds, and also to enabling the national agriculture to get the best of the guano, at a reasonable cost, and with prices proportional to the value of the guano. It is difficult to believe that two companies working in rivalry for the same guano will not work to the injury of the birds, unless each be strictly limited as to territory, or some way be found of harmonizing the rival interests for the benefit of the industry.

There are other important questions which need not be discussed here, but which should be suggested for consideration. A government bureau for the analysis of guano might be established in order to give to the small agriculturist the same advantage which the larger haciendas now enjoy, namely, of buying the guano by analysis. I have known cases of the adulteration of guano by sand, for the simple reason that the guano so reduced in quality could be sold by the contractor at the same price as a guano of higher grade. The price to all farmers, large or small, should be directly proportional to the value of the guano in the fertilizing elements as shown by analysis. The matter of having deposits of guano on shore has sometimes been suggested. This might serve to expedite the extraction of guano on the islands, so that they could earlier be abandoned to the birds, even if the fertilizer could not be sold and delivered at once. The shore deposits might be utilized to equalize the annual supply, and they might serve as the basis for mixing stations, should this prove practicable, where guanos of any desired strength of phosphoric acid and nitrogen could be prepared and supplied according to order.

CONCLUSION

It is seen, then, that there are many questions which require to be carefully studied out. If the best solution is not attainable, then the second best may be adopted, but it may be the earnest hope of all that, after the fullest consideration of the matter, all parties interested may be led to cooperate in the attainment of a plan by which the interests of national agriculture may be safeguarded without the sacrifice of any legitimate interest.

The problem before the government, the national agriculture, and the exporting company, is this: How can the guano industry be saved to the future? Certainly no legitimate interest can be furthered by a continuance of the present unsatisfactory system, with its sacrifice of the birds.

I think the solution of the problem will be furthered if we put the question in this way: What system of regulation will result in the greatest annual deposit of guano twenty years hence?

NOTE

Without attempting at this time precise figures, the following considerations are suggestive and not misleading.

If we take a cubic meter of guano as a ton, then, with an average thickness of 10 cm. (4 inches), an area 10 meters by 10 meters, or 100 square meters, would yield ten tons of guano, and on 60,000 square meters there would be 6,000 tons. A point of significance, economically speaking, is the commercial value of permitting the birds to make the deposit even one centimeter thicker during the year. The flock of cormorants, *Phalacrocorax bougainvillei*, which covered very closely an area of 60,000 square meters (15 acres) and was the largest single aggregation of birds on the coast of Peru, was seen on the south Chincha island last year. It is easy to find that the nests average about three to the square meter, giving a total of about 180,000 nests. Allowing four birds to the nest, that is, a pair of adults and a pair of young, we have 720,000 birds. Two months later I estimated the flock as fifty per cent. larger, the island being at that time, in fact, practically entirely and densely covered with birds. It is not extravagant, then, to say that there were at least one million birds. Of course, very much smaller flocks are commonly estimated at "millions." Nor, again, does it seem out of reason to say that, had this island been opened by the government for extraction of guano, each month that the work endured would have caused the loss from this island of nearly 1,000 tons of guano, a part of which quantity, it is true, would have been deposited on other islands, but a large part of which would doubtless have been irrevocably lost. However, the main point to bear in mind, both from the point of view of the economist and from that of the naturalist, is this—that the continual disturbance of the birds means inevitably their gradual extermination.

Robert E. Coker

Lima, Peru,
April 8, 1908

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 651st meeting was held on May 23, 1908, President Bauer presiding. By invitation, Professor Bailey Willis, of the U. S. Geological Survey, presented and explained the proposal of the Washington Academy of Sciences to establish a weekly *Journal of Science*. The character and scope of the proposed publication were described at some length. The academy is to bear the entire cost of maintaining the *Journal* for the first three years and during this time the members of the affiliated societies are to receive the publication free of cost. In return for this service during the three years' experimental stage of the *Journal* the academy asks that the affiliated societies shall give the *Journal* their programs to print and for which they shall pay. Short abstracts of the papers read before the societies are to be submitted to the society for publication. At the close of the three years' experimental period it is proposed that the *Journal* shall thereafter be paid for by the affiliated societies at the rate of two dollars per member per annum.

Mr. R. L. Faris read a paper on "Tides in the Solid Earth observed by Dr. Hecker," being a review of the results of the horizontal pendulum observations recently published by Dr. Hecker at Potsdam. This paper will be published in full in the May, 1908, number of the *Monthly Weather Review*.

R. L. Faris,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FRIDAY, JULY 17, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION D—MECHANICAL SCIENCE AND ENGINEERING

THE meeting of the section for organization was held in Cobb Hall of the University of Chicago on December 30 and 31, 1907, and January 1, 1908. The vice-president of the section, Olin H. Landreth, professor of civil engineering, Union University, acted as chairman of the section. Dr. George F. Swain, professor of civil engineering, Massachusetts Institute of Technology, was elected councilor. Mr. George W. Bissell, dean of engineering, and professor of mechanical engineering, Michigan Agricultural College, was elected a member of the general committee. Mr. Arthur H. Blanchard, associate professor of civil engineering, Brown University, was elected member of the sectional committee for five years. The secretary was elected press-secretary for the meeting.

At the meeting of the general committee on January 2, 1908, on the recommendation of the sectional committee, Dr. George F. Swain, professor of civil engineering, Massachusetts Institute of Technology, was elected vice-president and chairman of the section for the ensuing year; and Mr. George W. Bissell, dean of engineering and professor of mechanical engineering, Michigan Agricultural College, was elected secretary for the next five years.

The first paper on the program was one by Arthur H. Blanchard, associate professor of civil engineering, Brown University, and was descriptive of the "Experiments with Tar and Oil on the Highways of Rhode Island.'' It divided highways into three classes, interstate trunk lines and popular routes of travel, highways connecting towns which are only a few miles apart and secondary streets of towns, and third, feeders leading to towns and highways of the two preceding classes and those connecting towns which are many miles apart.

The objects of the experiments with tar and oil have been to reduce to a minimum the amount of dust raised by motor-cars, preserve the surface of the road, and to increase its life. The total cost per square yard of tar-macadam on the Post Road between New York and Boston, and in the Town of Charlestown, in 1906 and 1907, was $0.1624. The amount of tar used per square yard was 1.15 gallons. It was found that the different samples of tar and oil used had compositions which were decidedly different.

Judging from the results of the experiments so far made, it is evident that additional experimental work should be done (1) to determine the relation of the composition of tar to the efficiency of a tar-macadam road and tar-painting; (2) to compare the efficiencies of tar-macadam roads constructed by the mixing and penetration methods; (3) to determine the economic value of scarifying, reshaping and reconstructing the surface of old macadam roads by the addition of tar by the penetration method; (4) to discover methods of increasing the bond between the tar-matrix and the surface of the old material of the road; (5) to determine the efficiencies of the various machines on the market for spreading tar and for making the roads; and (6) the efficiencies of the roads treated with the various oils on the market, and in different ways. The author firmly believes that more stress should be laid on the economic construction of more permanent macadam roads and that less attention should be paid to the various surface palliatives. The paper was published in the *Engineering Record* for February 8, 1908.

The subject of the ''Pressure-Temperature Diagram of the Properties of Superheated Steam'' was discussed and illustrated by Henry T. Eddy, professor of mathematics and mechanics, University of Minnesota. He showed that for purposes of both instruction and use the ''P–T'' diagram offered certain advantages over the ''P–V'' diagram which is usually used, and more especially in showing the variations in the specific heat of superheated steam.

A paper descriptive of ''An Instrument for Investigating the Circulation of Water in Water-tube Boilers'' was read by Frank C. Wagner, professor of experimental engineering, Rose Polytechnic Institute, and was discussed at some length by those present who had made similar experiments.

''A Note on the Shearing Stresses in Beams'' was presented by Calvin M. Woodward, professor of mathematics and applied mechanics, Washington University, and discussed by several members.

The same author read a paper on ''The Problem of Power for Airships,'' which was discussed very fully by the members.

An elaborate paper on the ''Classification and Comparison of Hydraulic Turbines as to Performance at Best Speed,'' and illustrated with tables was read by Benjamin F. Groat, professor of mechanics and mathematics, University of Minnesota.

The same author presented a valuable paper on the ''Efficiency of the Screw.'' These two papers add much to the respective subjects and should be put into permanent form for future reference, being too long to be abstracted satisfactorily.

In the absence of the authors, the following papers were read by title: ''The

Use of Arrow-heads in Alternating-Current Vector-Diagrams,'' by A. S. Langsdorf, professor of electrical engineering, Washington University; ''Segregation in Steel Ingots,'' by Henry M. Howe, professor of metallurgy, Columbia University.

The other sessions of the meeting were held in Cobb Hall in conjunction with Section A, Mathematics, and the Chicago Section of the American Mathematical Society. For the joint sessions, invitations had been sent to teachers of engineering and of mathematics in the engineering colleges and technical schools of the country, and to professional engineers who, it was thought, might be interested in the subject of an engineering-mathematics symposium. As a result, the attendance was large and representative and included about one hundred persons interested on the mathematical side, and over fifty teaching and practising engineers. Twenty-one privately endowed, and twenty state-supported educational institutions were represented.

The promotion of acquaintance and personal knowledge was an important factor in the success of the meeting, which was in large part due to the labors and foresight of Professor H. E. Slaught, of the department of mathematics of the University of Chicago, and Secretary of the Chicago Section of the American Mathematical Society.

A subscription dinner for engineers and mathematicians and their friends brought about one hundred persons together at Hotel Del Prado on Monday evening, December 30. The speakers at the dinner were introduced by E. B. Van Vleck, professor of mathematics, University of Wisconsin, Chairman of the Chicago Section of the American Mathematical Society. They were Calvin M. Woodward, dean of the School of Engineering and Architecture, Washington University, St. Louis, Mo.; Charles F. Scott, consulting engineer of the Westinghouse Electric & Manufacturing Co., Pittsburg, Pa.; George F. Swain, professor of civil engineering, Massachusetts Institute of Technology, Boston, Mass.; and Edward V. Huntington, assistant professor of mathematics, Harvard University, Cambridge, Mass.

The first session of the engineering-mathematics symposium was held on Monday afternoon, December 30. Professor Van Vleck acted as chairman. Four papers were presented, as follows:

The Present Condition of Mathematical Instruction for Engineers in American Colleges: Edgar J. Townsend, professor of mathematics, University of Illinois.

The Teaching of Mathematics to Engineering Students in Foreign Countries: Alexander Ziwet, professor of mathematics, University of Michigan.

The Teaching of Mathematics for Engineers: Charles F. Scott, consulting engineer, Westinghouse Electric and Manufacturing Co.

The Point of View in Teaching Engineering-Mathematics: Robert S. Woodward, president of the Carnegie Institution of Washington.

The two sessions, held on the morning and afternoon of December 31, were devoted to a symposium on the question: ''What is needed in the Teaching of Mathematics to Students of Engineering? (*a*) Range of Subjects; (*b*) Extent in the Various Subjects; (*c*) Methods of Preparation; (*d*) Chief Aims.'' The speakers represented three phases of the subject, namely: (*a*) From the standpoint of the practising engineer; (*b*) from the standpoint of the professor of engineering; (*c*) from the standpoint of the professor of mathematics in the engineering college.

Professor Landreth and Professor Slaught were the chairmen of the two sessions. The speakers were as follows:

Ralph Modjeski, consulting engineer, Chicago, Ill.; J. A. L. Waddell, consulting bridge engineer, Kansas City, Mo.; Gardner S. Williams, professor of civil, hydraulic, and sanitary engineering, University of Michigan; Arthur N. Talbot, professor of municipal and sanitary engineering, University of Illinois; George F. Swain, professor of civil engineering, Massachusetts Institute of Technology; Charles S. Slichter, consulting engineer, U. S. Reclamation Service, and professor of applied mathematics, University of Wisconsin; Frederick S. Woods, professor of mathematics, Massachusetts Institute of Technology; and Fred W. McNair, president of the Michigan College of Mines.

Following the presentation of the four formal papers, and of the eight prepared discussions above recorded, a general discussion was held on the entire subject. The following persons took part in this general discussion: Calvin M. Woodward, professor of mathematics and applied mechanics, Washington University; Benjamin F. Groat, professor of mechanics and mathematics, School of Mines, University of Minnesota; Charles S. Howe, president, Case School of Applied Science; Clarence A. Waldo, professor of mathematics, Purdue University; Clarke B. Williams, professor of mathematics, Kalamazoo College; J. Burkitt Webb, late professor of mathematics and mechanics, Stevens Institute; Henry T. Eddy, professor of mathematics and mechanics, College of Engineering, University of Minnesota; Arthur E. Haynes, professor of engineering-mathematics, University of Minnesota; Arthur S. Hathaway, professor of mathematics, Rose Polytechnic Institute; Edward V. Huntington, assistant professor of mathematics, Harvard University; and Donald F. Campbell, professor of mathematics, Armour Institute of Technology.

On motion of Professor Campbell, the chairman was authorized to appoint a committee of three persons, they to increase their number to fifteen, to be chosen from among teachers of mathematics and engineering and from the practising engineers of the country, and this committee of fifteen was authorized by the meeting to take into consideration the whole subject of the mathematical curriculum in the engineering and technical departments of colleges and universities, and to report to the Chicago Section of the American Mathematical Society. On motion of Wm. T. Magruder, ex-secretary of the Society for the Promotion of Engineering Education and professor of mechanical engineering, Ohio State University, the motion was amended that the committee of fifteen shall submit its report to the Society for the Promotion of Engineering Education at its annual meeting in the summer of 1909. The motion as amended was unanimously adopted by those present. It is hoped that at the meeting of the society in 1909, a second engineering-mathematics symposium may be held.

The selection of this important committee was entrusted to Professor Edward V. Huntington, Harvard University, Professor Gardner S. Williams, University of Michigan, and Professor Edgar J. R. Townsend, University of Illinois. They will select the remaining members of the committee, choose a chairman and secretary, and determine the scope of the investigation that they will make.

The papers will be printed in Science in the next few weeks. They will prove to be interesting reading to those engaged in either mathematical or engineering work and will show the tendencies of the thought of the meeting. The key-note of all the discussions was that we need more sympathy and knowledge of the ideals, aims and work of the other fellow.

The meeting was without doubt the best

attended that the sections have held for many years, the interest never seemed to flag and, while no wonderful contributions were made to scientific knowledge, every one went away feeling either that he had gained much information as to the other man's point of view concerning scientifically instructing engineering students in mathematics and of the wishes and needs of the engineering instructor, or that he appreciated more the quality of work that was now being done by teachers of mathematics in engineering colleges.

WM. T. MAGRUDER,
Secretary, Section D

PRESENT CONDITION OF MATHEMATICAL INSTRUCTION FOR ENGINEERS IN AMERICAN COLLEGES[1]

OUR country has witnessed in recent years a most marvelous industrial expansion and development. Along with this movement has come a rapidly increasing demand for trained men, equipped with all that science can contribute, to direct and carry forward this development of our natural resources and our industrial power. In meeting this demand our technical schools have experienced a remarkable growth, and not a little of the educational thought and activity of the country is being directed toward the problems connected with technical instruction. Well-equipped engineering schools have grown up in the larger centers of population and most of the larger state universities now include strong engineering departments. Mathematics is so fundamental to all of this work, and so large a proportion of the students now receiving mathematical instruction in this country anticipate making use of it later in connection with engineering work, that it has been thought best by the Chicago Section of the American Mathematical Society to invite to a joint discussion of the "Mathematical Training of Engineering Students," representatives from some of the leading engineering schools and some of those consulting engineers whose wide experience has brought them into contact with demands of actual practise.

That we may all know what the actual conditions are with respect to this instruction and consequently have some common basis for our discussion and our conclusions, I have been asked to present a statement of the work in mathematics which is now being given to engineering students.

As the basis of our consideration, I have selected seventeen institutions where engineering work is an important feature. Of these, eight give their attention largely or exclusively to technical work, and the remaining institutions have strong engineering departments; so that the mathematical work given in these institutions may be said to fairly represent the preparation in this subject for engineering students in American institutions.

The three most important factors entering into the consideration of our topic are: the entrance requirements, the requirements for graduation, and the qualifications of the instructional force.

As will be seen from Table I., all of these seventeen institutions require for entrance algebra through quadratics, together with plane and solid geometry. Five of the institutions require plane trigonometry, while at several others it may be counted for entrance if the student so elects. It will be observed that four institutions require elementary algebra through progressions, four require the subject of logarithms, and two, Sheffield and Cornell, require the whole of college algebra.

[1] Opening address before the joint meeting of Sections A and D of the American Association for the Advancement of Science with the Chicago Section of the American Mathematical Society for the discussion of the topic "Mathematical Training for Engineers."

TABLE I

	Armour	Case	Cornell	Illinois	Lehigh	Mass. Institute	Michigan	Minnesota	Missouri	Nebraska	Purdue	Rensselaer	Rose	Sheffield	Stevens	Wisconsin	Worcester
Algebra	p. L.	q	Coll. Alg.	q	Adv. Alg.	p	q	p	q. L.	L	q	p	q	Coll. Alg.	p	p L.	p
Plane Geometry	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Solid Geometry	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Plane Trigonometry	"		"		"		"		e	e				"	"	e	
Spherical trigonometry			"														

p = through progressions, q = through quadratics, L = logarithms, e = elective.

There is a general tendency over the country to increase rather than diminish the entrance requirements in mathematics. Several institutions have recently done so, and at a number of others there is a feeling that both trigonometry and college algebra should be required. This disposition to increase the entrance requirements has come about not so much because of a feeling that these subjects can be as well or better taught in the secondary schools, but because of a feeling on the part of the technical schools that the entrance requirements should be made as high as possible in order to give room in the curriculum for those professional and technical branches which are now deemed essential. It may well be questioned whether we are not in some danger of going too far in increasing the requirements. I am sure that we should all agree that the guiding principles should be the limitations of the secondary school program and the ability of the pupil at that stage of his maturity to readily grasp in a comprehensive manner the subjects presented. For example, the advisability of adding college algebra to the entrance requirements is certainly open to the objection that portions of it are clearly beyond the maturity of the average high school pupil, and the introduction of plane trigonometry would seem inadvisable in the average high school on the accredited list of the state universities of the Mississippi Valley. When either of the fundamental principles mentioned is violated, we shall have coming to our freshman class, students with a decided and a justifiable dislike for anything mathematical. Rather than to encounter this danger, it would be far better to extend the engineering course over five years or to require a year of college work in science and mathematics before the student enters upon his technical course. In this connection, it is interesting to note that the University of Minnesota has recently extended its course to five years for students in civil, mechanical and electrical engineering, distributing the required work in mathematics throughout the first four years.

The writer does not share with some the feeling that a greater uniformity in entrance requirements is either desirable or of any particular consequence. Each institution, and especially the state institutions, must take into consideration what the secondary schools contributary to it can do satisfactorily and then shape its work accordingly. The size of the city, the general interest in educational affairs, the trend which local interests give to the public-school curriculum, all tend to make it possible to accomplish in one community, or in one section of the country, what would be quite impossible in another. We must accept our students with such preparation as our normal constituency can give, stimulated, to be sure, and to a certain extent guided by the higher institution of learning, and build our technical courses upon that preparation as best we may.

More general dissatisfaction is expressed with reference to the preparation of our students in algebra than in any other subject. This comes from both eastern and western institutions as well as from those of the Mississippi Valley. At the University of Illinois last year forty per cent. of the freshman class failed to pass a quiz covering the main points of elementary algebra and that after a two weeks' review of the subject, and twenty-three per cent. of the class failed on a second examination some weeks later. Of the one hundred and ninety students who failed on the first test, seventy-four per cent. entered the university without conditions from schools where the work had been examined and approved by the high-school visitor. The poor results which we get in algebra are not due, in my estimation, exclusively to poor instruction in the subject or to the lack of attention in the high school. It is the one subject in mathematics which is begun in the high school and completed in the college course. Often the high-school algebra is completed in the sophomore year and then not taken up again until the student enters upon his technical course. All know how difficult it is to retain the details of any course of study during an interval of several years in which the subject has been but little used. That this lapse of time between the completion of the high-school work and the beginning of the college work is an important element in the case is shown by the fact that of the one hundred and ninety failures mentioned over fifty per cent. had not had algebra for at least four years, and only ten per cent. had studied the subject the year before.

A substantial gain would be made if we should urge upon the high schools the desirability of putting the last half year devoted to algebra in the senior year of the high-school curriculum and include in that work the more difficult parts of the subject as well as a general review of the parts presented earlier. This arrangement has become quite common in Illinois, and the best argument that can be presented in favor of such an arrangement is that of the one hundred and ninety cases of failure cited over sixty-three per cent. had completed the work in the sophomore year and less than eight per cent. had had any work in algebra in the senior year. Similar records have been kept at Illinois for the past seven or eight years and the data given are typical of the other years.

Unfortunately, we can have no assurance that when a student has once mastered a subject, he will forever afterwards retain it. Neither can we hope that algebra will ever be anything other than the weakest place in the preparation of our students so long as the present division of the subject so largely prevails. It is a situation which we must accept, and the only thing we can do is to make such recommendations as will tend to reduce the number of fatalities as the boy passes from his secondary school to his technical course. The technical school must expect to commence its course in college algebra by a brief review of the important points covered in the high school, by taking a back-stitch, so to speak, into the work already done. Most of the western schools admit by certificate to the freshman class, and when a pupil is once graduated from an accredited school, he has earned the right to commence upon his technical course. At the University of Illinois, the problem has been solved by saying to the freshmen in mathematics that while there is no disposition to deprive them of their entrance credit, the department of mathematics may nevertheless determine the conditions under which credit in college algebra can be secured. Accordingly, those students who fail to pass the review quiz are required to take two additional hours per week in the subject for the remainder of the semester in order to earn the same credit that is given to others at the close of the course. This has the advantage of placing all of the students practically upon the same basis, so far as attainments in algebra are concerned, when they enter upon the second semester's work.

A somewhat similar plan as that outlined here is followed also at the University of Wisconsin, and perhaps at other institutions. It will be seen from Table I. that a large number of technical schools are now requiring work in logarithms for entrance. This might very well be introduced in connection with theory of exponents and used with advantage in high-school physics. It is also gratifying to observe that the more recent texts on algebra provide work in the use of the graph and in the plotting of curves. It is very desirable that the work in elementary algebra, including the work of curve-plotting, should also include applications to some of the simpler phenomena studied in the high-school course in physics, and this again is made a feature in some of the more recent texts. Such an arrangement affords an additional reason for putting some of the work in algebra late in the high-school course in order that it may follow rather than precede the work in physics, thus making it possible to introduce a wider range of physical applications than could otherwise be done.

In Table II. is shown the number of restrictions given in each of the various mathematical subjects required of engineering students. The average number given to each subject for the seventeen institutions is approximately as follows: college algebra 50, plane trigonometry 46, analytic geometry 80, and calculus 130. In a number of the institutions named, spherical trigonometry is taught by one of the engineering departments, usually the civil-engineering department, in connection with its applications to geodesy. The number of recitations assigned to calculus usually includes also a short course in differential equations. In two cases where a course of more than usual length in the subject is given for the students of a particular engineering department, the subject has been listed separately.[2] One institution, Rose Polytechnic Institute, is unique among strictly engineering schools in offering throughout the four years of undergraduate work a rather large amount of elective mathematics, including short courses in advanced calculus, least squares, projective geometry and quaternions. In all of the universities listed, and at the Massachusetts Institute of Technology the mathematical department offers a rather wide range of advanced subjects, all of which are open to engineering students so far as the demands of their technical course will permit.

By a study of Table II., it will be seen that a considerable difference exists in the amount of attention given to the various subjects. In making comparisons in algebra and trigonometry, however, the difference in entrance conditions must be

[2] Table III. shows the number of recitations given to differential equations in each case when that subject was reported separately.

TABLE II

	Armour	Case	Cornell	Illinois	Lehigh	Mass. Institute*	Michigan	Minnesota	Missouri	Nebraska	Purdue	Rensselaer	Rose	Sheffield	Stevens	Wisconsin	Worcester
Algebra	65	45		55	{40 C.E.	30	36	70	36	36	90	55	72 [18]		15	{90} (Algebra and Plane Trigonometry)	64
Plane Trigonometry		60		35		30		45	45	54	70	29	54				45
Spherical Trigonometry		10			{22 C.E.	{10 C.E.		25	10		20	11	[18]		10		3
Analytic Geometry	55	100	60	90	80 {58 C.E.	60	108	110	90	108	72	60	54 [18]	90	69	90	64
Calculus	155	125	120	144	108 {96 C.E.	90	144	110	180	126	144	70	180 [72]	100	144	180 {160 C.E.	96
Least squares		{48 C.E.											[18]				
Vector Analysis																	{32 C.E.
Projective Geometry													[18]				
Quaternions													[18]				
Differential Equations		{34 M.E.				{45 E.E.											

C. E. = civil engineers, M. E. = mechanical engineers, E. E. = electrical engineers, [ ] = elective.

*Massachusetts Institute of Technology now offers a course which combines the instruction in algebra, analytic geometry and calculus rather than teaching these subjects as separate branches. In tables II. and III., the distribution of time formerly given to these subjects is indicated as showing better the relative emphasis placed upon each.

taken into consideration. The amount of work given in algebra ranges from fifteen recitations at Stevens Institute, with an entrance requirement of elementary algebra through progressions, to ninety recitations at Purdue with a requirement of elementary algebra through quadratics for entrance. Likewise the work in plane trigonometry ranges from thirty recitations at the Massachusetts Institute to seventy at Purdue. Analytic geometry and calculus are naturally the most important subjects for engineers in the mathematical curriculum. One would naturally expect to find a greater uniformity here. This, however, is not the case. In analytic geometry, it will be noticed that Armour Institute requires but fifty-five recitations, while the University of Minnesota gives one hundred and ten recitations to the subject. Again in calculus the work varies from seventy recitations at Rensselaer to a maximum of one hundred and eighty at Missouri, Wisconsin and Rose. A word should be said, perhaps, concerning the number of recitations recorded in the case of Rensselaer. The department of mathematics of that institution reports that the recitations are from an hour and a quarter to an hour and a half in length and that the efficiency of the work is still further increased by the fact that but two academic studies are carried simultaneously.

It will be of interest also to compare the total amount of time spent upon mathematics at these various institutions. As will be seen from Table III., this ranges from one hundred and eighty recitations at Cornell to three hundred and ninety-six at Purdue. In making this comparison,

TABLE III

Institution	Freshman	Sophomore	Junior	Senior	Total
Armour	Al 65; An 55; C 50	C 85; Diff. eqs. 20			275
Case	Al 45; Tr 70; An 55	An 45; C 125	Diff. eqs. 34 (E.E.)	Least squares 48 (C.E.)	M.E.; 340 E.E.; 374 C.E.; 388
Cornell	An 60; C 120				180
Illinois	Al 55; Tr 35; An 90	C 144			324
Lehigh	An 80; C 108 Al 40; Tr 22; M 25	(C.E.) An 58; C 96			E.E.; M.E.; 188 C.E.; 241
Mass. Inst.	Al 30; Tr 30; An 60	C 90; Sph Tr 10 (C.E.)	Diff. eqs. 45 (E.E.)		M.E.; 210 E.E.; 255 C.E.; 220
Michigan	Al 36; An 108	C 126	Diff. eqs. 18		288
Minnesota	Al 70; Tr 70; An 40	An 70; C 110			360
Missouri	Al 36; Tr 55; An 90	C 180			360
Nebraska	Al 36; Tr 54; An 72; C 18	An 36; C 108			324
Purdue	Al 90; Tr 90	An 72; C 72	C 72		396
Rensselaer	Al 45; Tr 40; An 39	An 21; C 70			225
Rose	Al 72; Tr 54; C 36 [S Tr 18]; [Proj. Geom. 18] [Al 18]	An 54; C 90 [Quat 18] [An 18]	An Dyn 54 (calculus) [C 72] [Least squares 18]		360 [180]
Sheffield	An 90	C 100		[Probs. and computing]	190 [Probs.]
Stevens	Log 15; Sph Tr 10; An 43; C 30	An 26; C 86	Diff. eqs. 28		238
Wisconsin	Al and Tr 90; An 90	C 160; Diff. eqs. 20 (M.E.; E.E.)			M.E.; E.E.; 360 C.E.; 340
Worcester	Al 64; Tr 48	An 64; C 96	Vect. and 32 (E.E.)		272 E.E.; 304

Al = algebra, An = analytic geometry, C = calculus, Tr = trigonometry, M = mensuration, Quat = quaternions, An Dyn = analytical dynamics, [ ] = elective.

we should again take into consideration the difference in entrance requirements. When this is done, the difference is more apparent than real. For example, if we add to the number of recitations given at Cornell the number of recitations given at Purdue to college algebra and trigonometry, which are required for entrance at Cornell as compared with three hundred and ninety-six at Purdue.

It would seem that the technical schools generally might well afford to make more ample provision for elective mathematics. Such courses as spherical trigonometry, least squares, differential equations, might well be placed in such a list. In this way certain subjects which are desirable for some branches of engineering, but not so essential for others, could be taken by those students interested. Sheffield offers as an elective another course which might be given with advantage at other technical schools, namely, a course in scientific computation in which the use of modern calculating machines of various kinds is explained and made use of. It would also be well if the stronger institutions could go still farther and introduce elective courses in spherical harmonics, vector analysis, theory of functions and the mathematical theory of heat, electricity, etc., to the end that the student with exceptional mathematical ability might lay a broader foundation for the theoretical side of engineering. In this connection, it may well be questioned whether the technical schools of this country are in general offering sufficient opportunity for that training which has made it possible for such men as Steinmetz, Osborne Reynolds and Stodola to accomplish the work which has made them famous.

Table III. shows also the sequence and the distribution by years of the required work in mathematics. We are quite as much interested, however, in the character as in the amount and distribution of the mathematical instruction given to engineering students. The close observer will have noticed the change which has been made and is now being made in this respect. In recent years there has swept over the country a wave of enthusiastic discussion concerning a closer and better correlation of mathematics with the physical sciences. This has been due for the most part to the influence felt in this country of the Perry movement in England. Much is to be learned from this movement, and still more is to be avoided. The discussions which have arisen from it have on the whole had a beneficial effect upon the teaching of mathematics both in America and in England.

It has first of all led to the introduction into our text-books, and still more generally into our teaching, of a very much better selection of problems—problems which widen the student's fund of information of physical phenomena and apply the mathematical principles which he is acquiring more extensively than was formerly the case to the physical laws with which he is familiar. Such problems as the following, taken from a recent number of an educational journal purporting to serve the interests of mathematical teachers in the secondary schools, is no longer thought to be in good form by our best instructors:

"I bought 674,867 sheep at less than $10 per head; I paid for them in ten-dollar bills and received back in change $7.39. How many bills did I give?"

Need I call attention to the absurdity of putting such problems into the hands of pupils? How many farmers in any wool-producing state of the country ever even saw that many sheep in his entire life, and, should he have occasion to buy them, would for a moment think of paying for them by counting out 663,395 ten-dollar bills. So long as such problems are given out for the consideration of pupils, just so long we may expect even the best of them to ask the question so often heard in our algebra classes: "What is all of this 'stuff' good for, anyway?"

Contrast with this problem the following, taken at random from an algebra recently published:

"Two boys, A and B, having a 30-lb. weight and a teeter board, proceed to determine their respective weights as follows: They find that they balance when B is 6 feet and A 5 feet from the fulcrum. If B places the 30-lb. weight on the board beside him, they balance when B is 4 and A is 5 feet from the fulcrum. How heavy is each boy?"

In solving this problem the boy has learned just as much mathematics as in solving the first. In addition, his mathematics has been brought into contact with a fundamental physical law, and incidentally he is made to feel that, after all, his mathematics is of consequence to him in solving the sort of questions in which he is interested or is likely to have experience with in the future.

As has been pointed out, a change in the character of the problems is gradually taking place in our mathematical texts. Perhaps a word of caution should be given lest we go too far in the opposite direction, by introducing problems which require a technical knowledge and experience beyond the comprehension of our students. Perry's calculus is a conspicuous illustration of this danger. The subjects discussed in that book would form a good sequel to a certain work in engineering, but the book seems to be hardly suited to meet the needs of American schools as a preparation for engineering study. We should aim to make the mathematical work practical and in harmony with engineering practise, but without making it at the same time technical in its applications, or without going too far afield by teaching mathematical physics.

Another improvement which has recently become noticeable in the teaching of mathematics in this country is the breaking down of the traditional barriers between the different branches and a corresponding closer correlation of the different subjects in the mathematical curriculum. In several of our institutions the sharp division of freshman work into algebra, trigonometry, and analytic geometry is being more or less disregarded and these subjects taught as a single unit. It is thought that the student is thus enabled to grasp more readily these subjects as a whole, and that the instructor can introduce much earlier the principles of analytic geometry and of calculus and postpone to the later part of the course those topics which are relatively difficult and not so essential to the elementary work of the course.

This plan is now being followed somewhat closely at the University of Wisconsin. In the first semester fifteen or twenty recitations are devoted to the elementary portions of trigonometry. This is followed by work in algebra, including the theory of complex numbers, using trigonometry and a large amount of graphic work, and the elementary principles of analytic geometry. In this work trigonometric computation and the use of the slide rule form an important part. In the second semester the algebra and trigonometry are continued and combined with the essentials of analytic geometry.

This correlation of the work of the freshman year seems to have been most thoroughly worked out at the Massachusetts Institute of Technology, where Professors Woods and Bailey have recently prepared a text covering the work given there in the freshman year, excluding, however, trigonometry. The indications are that other institutions are also contemplating a revision and better correlation of the work of the first year.

In some of the recent books, the sharp division of the calculus into differential and integral calculus is done away with, thus making it possible to introduce the student to a wide range of easy applications at an early point in the course and to relegate to its proper place some of the more difficult parts of the differential calculus. There is a tendency also to introduce the methods of the calculus earlier and make them the basis of portions of the analytic geometry. For example, Rose Polytechnic Institute gives a short course of thirty-six recitations in the subject before analytic geometry is taken, and what is accomplished there in this formal way is undertaken at other institutions by introducing into the analytics the elementary notion of derivatives or by teaching the two subjects simultaneously.

While all are agreed that for engineers mechanics should stand in a close and vital relation to the calculus, that in fact it is the principal reason for teaching calculus, not all are agreed, however, as to the best method of accomplishing this purpose. Some would maintain that it should be taught by the mathematical department and in connection with calculus; others and perhaps the larger number feel that it should be given by the engineering departments and made to follow and supplement the calculus, giving the student his first real introduction into the applications of his mathematics to the fundamental principles underlying all engineering courses. However this may be, there is little doubt that more applications to mechanics should be introduced into the course in calculus than is now usually the case, even to the exclusion, if need be, of some of the applications to geometry frequently given. Problems in work, energy and stress form just as legitimately an integral part of a course in calculus as problems in order of contact, asymptotes or envelopes. The applications to geometry and to mechanics should be given about the same relative importance in a well-balanced course in calculus.

Descriptive geometry is another subject in the engineering course which might well be revised and made more mathematical in its treatment. It is to be regretted that the subject has in this country degenerated into little more than mechanical drawing. It would be greatly improved for engineers, as well as the general student, if we should inject into it something of the scientific spirit given it in European schools.

No presentation of the subject under discussion would be complete without some consideration of the preparation which the teacher of mathematics has, or should have, who is to teach the subject to engineering students. There is a strong feeling in some quarters that such an instructor should be a trained engineer in order that he may the better appreciate the kind of applications which are best suited to the training of an engineer and to make sure that the proper emphasis be placed upon those topics considered essential in such training. Some would go still farther and insist that even in the elementary courses in mathematics usually given in the first two years, the purpose and aim of the prospective engineer is so radically different from that of the general student that the content of the course itself should be very different from what is best suited to the student who elects mathematics as a part in a general education.

It goes without saying that we should eliminate from the courses for engineering students that which is non-essential, and we should make them as practical as we may by the generous use of those physical applications which will give the students both skill and facility in applying mathematics to such concrete cases as may arise later in his experience. On the other hand, it would be disastrous to go to the extent of teaching any of the principles of mathematics empirically or of permitting students to assume as already established formulas which he has merely to learn how to apply. We should avoid the danger of going too far in allowing the student to disregard the necessity of a formal demonstration and to regard lightly the logic and the philosophy of mathematics. What is needed first of all is the ability on the part of the student to think mathematically and to have not only a ready but an intelligent command of the fundamental principles of the subject. We should introduce the applications of mathematics not for the sole purpose of giving the student a foretaste of the things which are in store for him, but because such applications give him additional opportunity for gaining a clearer comprehension of mathematical processes and principles which might otherwise be hazy; and I wish to add that this is more essential for the sound training of the special student of mathematics with his limited opportunity for the application of his subject to physical phenomena than it is for the engineering student who in the future is to have opened up to him that wide range of applications which his technical studies provide. In other words, what is essential in the way of applications for the engineering student in the first two years of his mathematical work gives the very best training for the student who is taking mathematics as an element in a liberal education. The proper place for differentiation, so far as the content of the course is concerned, would seem to be after the completion of the course in calculus rather than before. I present this as a plea for the general student, that he should have more of the applications of his mathematics rather than that the engineering student should have less. Both should have thorough drill in the fundamental principles of the subject and in addition all of the applications of those principles which their limited experience and knowledge of physical phenomena will permit. No student, enginering or otherwise, should be led to regard his mathematical work in the same light in which a carpenter may properly regard his jack-plane, a mere tool with which to accomplish certain results; neither should the instructor teach mathematics in the spirit in which a skilled operator might regard a finely-equipped machine shop whose sole purpose is to make more machines. Both extremes are to be avoided in the early courses in mathematics. The opportunity for specialization and differentiation should come later; and any student who is not capable of grasping the fundamental principles of the mathematics usually required in an engineering course should not aspire to a bachelor's degree from a large university or technical school.

What training is essential or desirable, then, on the part of the mathematical instructor of engineering students to best accomplish the general results here set forth? There is no doubt that the ideal thing would be to take men who have completed an engineering course and later supplemented it by special work in mathematics. This, however, does not seem feasible because of the few who could be induced to take such a course of training. It would be quite impossible to induce a sufficient number of engineers to take up the teaching of mathematics to meet the demand, even if that seemed desirable. In most cases the boy enters the engineering course with the view of practising his profession when he has completed the course. As a rule he has little taste or inclination for teaching, and those few who can be induced to enter the less remunerative profession of teaching are absorbed, as indeed they should be, by the engineering departments of our technical schools. To put an engineering graduate at teaching mathematics without first having had special training in mathematics would be wholly undesirable. Such an instructor knows but little about pure mathematics beyond the elementary courses which he is presenting, and, what is even worse, often has but little interest. If he can be induced to take up in a serious way the study of mathematics, he is in a fair way of becoming a good teacher of the subject. I am thoroughly convinced that mathematics should be taught by mathematicians just as engineering should be taught by trained engineers; but the mathematical instructor who wishes to teach engineers should be familiar with the general field of applied mathematics—mechanics, strength of materials, thermodynamics, and in addition so much of the broader field of mathematical physics as possible.

While the mathematical instructor should have some knowledge of its applications, it is equally desirable that the teacher of engineering should from time to time both refresh and revise his knowledge of the fundamental things in mathematics, to the end that he may keep his methods up to date and adapt his teaching to the kind of mathematical instruction which his students have had and avoid those methods and those forms of expression which have long been out of use.

In closing, I wish to add that the rapid increase in engineering students has so greatly increased the demand for mathematical instructors having some knowledge of engineering that it would be highly desirable if more attention should be paid to the preparation of men for such positions. This can best be accomplished, perhaps, in those universities having large engineering departments by a closer correlating of the work of the mathematical department with theoretical work in engineering and mathematical physics. It is to be regretted that so little attention in this country is now being given to these two fields of mathematical activity. Institutions so situated as to undertake it should offer to its students graduate work in these lines in every respect worthy of a doctor's degree, and likewise to its instructors both opportunity and encouragement to do research work in this broad and fruitful field of human endeavor.

Edgar J. Townsend
University of Illinois

INTERNATIONAL FISHERY CONGRESS, 1908

The Fourth International Fishery Congress will convene in the city of Washington, United States of America, from the twenty-second to the twenty-sixth of September, 1908, to deliberate on important matters relating to fishing and fish culture and to submit propositions for the benefit of the fisheries to governments and to state, provincial and local authorities.

The congress will be organized and conducted in conformity with the decisions for the regulation of the international fishery congresses decreed in Paris in 1900.

The membership of the congress will consist of government, state, and provincial representatives, delegates from home and foreign societies, corporations and persons invited by the management of the congress, and persons at home and abroad who are deemed to have an interest in the purposes of the congress and express a wish to take part in it.

All members have the right to vote, to participate in the discussions, and to make independent propositions. In case a corporation should be represented by several delegates, the members of this delegation have the right to only one vote, which shall be cast by the delegate designated to the presiding officer. The delivery of the card of admission gives to members the right to take part in all the enterprises and excursions projected by the congress, to receive all the publications, and to wear the insignia of the congress. The members of the congress are required to conform to its regulations and decisions.

The membership fee is fixed at $2 for each person, excepting the official representatives of governments, who become members by virtue of their credentials.

In response to invitations extended by the government of the United States, twelve national governments have already signified their purpose to be officially represented, and delegates have been appointed by the governors of many of the states of the United States. In view of the small number of the nations which have formally indicated their inability to officially participate and the large number of persons who will attend as individuals or as representatives of important fishery societies, the congress promises to be important in its representative character, size, and the value of its proceedings.

All persons interested in the fisheries, fish culture, and fishery administration, or in scientific investigations and experiments related to the fisheries are invited to attend the meetings and take part in the discussions. To those who can not attend the meetings of the congress an invitation is extended to submit papers on subjects relating to the fisheries, mailing them to the secretary-general of the congress in season to reach him prior to the opening meetings. For the guidance of those desiring to participate in this manner, the following scheme of subjects is submitted, but the papers need not be restricted to the titles suggested:

1. *Commercial Fisheries:*
   (*a*) Apparatus and methods of fishing.
   (*b*) Vessels and boats.
   (*c*) Handling, preparing and preserving the catch.
   (*d*) Utilization of neglected and waste products.
2. *Matters affecting the Fishermen and the Fishing Population:*
   (*a*) Hygiene of vessels and houses of fishermen.
   (*b*) Diseases of fishermen and their families.
   (*c*) Means for preventing loss of life at sea.
   (*d*) Technical education in fishing, fish handling, and fish culture.
   (*e*) Fishery schools.
3. *Legislation and Regulation relative to:*
   (*a*) Fishing.
   (*b*) Fish culture.
   (*c*) Pollution of waters.
   (*d*) Obstruction of waters.
4. *International Matters affecting the Fisheries:*
   (*a*) Regulation and legislation.
   (*b*) Research.
   (*c*) Statistics.
5. *Aquiculture:*
   (*a*) Fresh-water fishes.
   (*b*) Salt-water fishes.
   (*c*) Frogs, turtles, and terrapins.
   (*d*) Oysters and other mollusks.
   (*e*) Lobsters, crabs, crayfish and other crustaceans.
   (*f*) Sponges.
   (*g*) Algæ and other plants.
   (*h*) New appliances and methods.
   (*i*) Utility of fish culture in the ocean and in large inland waters.
6. *Acclimatization:*
   (*a*) American fishes abroad.
   (*b*) Foreign fishes in America.
   (*c*) Introduction of other foreign species.
7. *Fishways and Fish Ladders.*
8. *Biological Investigation of the Waters and Their Inhabitants:*
   (*a*) Methods and appliances.
   (*b*) Results.
9. *Diseases and Parasites of Fishes, Crustaceans, Mollusks, and Other Water Animals.*
10. *Angling and Sport Fishing.*

During the week following the regular sessions of the congress, special meetings will be arranged in New York, Boston, Gloucester and possibly other places in New England, it being the purpose to bring the members together for informal sessions in those places, and at the same time to provide time and opportunity for them to visit localities in which they may have a personal interest. In connection with these meetings arrangements will be made to exhibit to the members the methods of the American sea fisheries and the greatest of the fishery ports and fish markets of the United States.

Other places which may be visited, but for which no special arrangements will be made, are Baltimore, the center of the great oyster industry of Chesapeake Bay, which lies within forty miles of Washington; and Chicago and other lake ports, where the fishery trade and methods of the Great Lakes, the most valuable fresh-water fisheries in the world, may be studied.

Suitable arrangements will be made for the entertainment and instruction of the members in Washington and at the other places visited, and an opportunity will be given for visits to places of general interest.

During the week beginning September 20 the headquarters of the congress will be established in the New Willard Hotel, Washington, D. C., where information relating to hotel accommodations, transportation, places of interest, and other matters will be available. All communications and inquiries before that date should be addressed to the Secretary-

General of the Congress, Bureau of Fisheries, Washington, D. C.

THE AMERICAN CHEMICAL SOCIETY

THE thirty-eighth general meeting of the American Chemical Society was held in New Haven, Conn., June 29 to July 2, and was one of the most successful summer meetings ever held by the society. Two hundred and fifty members were present and one hundred and seventy-four papers were presented.

The large number of papers made it necessary to hold more sectional meetings than usual and the society met in six sections for the presentation of papers.

The society met in the lecture rooms of the Sheffield Scientific School and the following nine papers were presented in general session before all the members: "Official Inspection of Commodities," by A. L. Winton, chairman of the Agricultural and Food Section; "The Increasing Importance of the Rarer Elements," by P. E. Browning, chairman of the Inorganic Section; "The Analyst, the Chemist and the Chemical Engineer," by Wm. D. Richardson, chairman of the Industrial Section; "A Discussion of Some of the Methods used in Determining the Structure of Organic Compounds," by Wm. McPherson, chairman of the Organic Section; "Our Present Knowledge of Plant Proteins," by T. B. Osborne, chairman of the Biological and Sanitary Chemistry Section; "Some Applications of Physical Chemistry," by Frank K. Cameron, chairman of the Physical Chemistry Section; "Chemical Publications in America in Relation to Chemical Industry," by W. A. Noyes; "The Electrolytic Theory of the Corrosion of Iron as applied to the Protection of Steam Boilers," by W. H. Walker; "The Research Chemist," by W. R. Whitney.

On Wednesday afternoon, July 1, an excursion to Ansonia was enjoyed by the visiting chemists for the purpose of visiting the works of the Ansonia Brass and Copper Company and the Coe Brass Manufacturing Company. On the evening of the same day the members met on the East Shore for a social outing and dinner.

The organization of the Division of Industrial Chemists and Chemical Engineers was a feature of the meeting and the following officers were elected: *Chairman*, A. D. Little; *Vice-chairman*, A. H. Low; *Secretary*, B. T. B. Hyde; *Executive Committee*, Wm. H. Walker, Wm. Brady, J. D. Pennock, W. C. Ebaugh, F. B. Carpenter. Twenty-eight important papers were presented before the division and marked enthusiasm was shown. A movement is also on foot for organizing the food chemists, the general and physical chemists and the fertilizer chemists.

The rapid growth of the society under the impetus of the organization of chemists into special groups and the continually improving quality of its journals was noted by all, seven hundred new members having been added in the last eight months.

Matters of decided importance were brought before the council and acted upon. A new section of the society was established with headquarters at Louisville, Ky. It was decided that the winter meeting should be held in Baltimore in affiliation with the American Association for the Advancement of Science and that the summer meeting for 1909 should be held in San Francisco.

The society having been represented by its president in the recent conference in Washington on the Conservation of our Natural Resources, it was voted that a standing committee on the conservation of our natural resources be established and that the American Chemical Society should attempt to point out how chemists could assist this movement.

W. D. Richardson was elected editor-in-chief of the new *Journal of Industrial and Engineering Chemistry* and the following were elected as associate editors: Henry M. Howe (metallurgy of iron and steel), A. H. Low (metallurgy of gold, silver and lead), Geo. C. Stone (copper, zinc and other non-ferrous metallurgy), Willis R. Whitney (applied electrochemistry), F. W. Lovejoy (photochemistry), A. E. Leach (foods), L. P. Kinnicutt (water, sewage and sanitation), F. B. Carpenter (fertilizers and soils), Robert Wahl (fermented and distilled liquors), Virgil Coblentz (pharmaceutical chemistry), T. J.

Parker (heavy chemicals), J. B. F. Herreshoff (sulfuric acid), Karl Langenbeck (ceramics), G. E. Barton (glass), Ernest B. McCready (cement, mortar and building materials), Clifford Richardson (asphalt and petroleum), A. D. Little (cellulose and paper), Francis I. du Pont (explosives), E. G. Bailey (fuels), J. D. Pennock (destructive distillation), John Alden (textiles, bleaching and dyeing), P. C. McIlhiney (pigments, resins and varnish), W. C. Geer (rubber), Ernest Twitchell (fats, waxes and soaps), W. D. Horne (sugar and starch), W. K. Alsop (leather), G. R. Underwood (glue), Edward Mallinckrodt (fine chemicals), M. C. Whitaker (gas), W. F. Hillebrand (pure and analytical chemistry), W. H. Walker (engineering chemistry), Wm. Campbell (metallography), W. C. Ebaugh and F. H. Thorp (miscellaneous industrial chemistry).

The Committee on the Qualifications of Chemists made a preliminary report on the establishment of an Institute of Chemistry, which has been under consideration for the past two years and it was decided on account of its great and far-reaching importance to refer this matter again to a representative committee of fifteen for further consideration to report back to the council.

The committee appointed to consider the training and education of chemists and chemical engineers made its report and as a result a movement is under way to establish a Section or Division of Chemical Education within the society, which shall especially appeal to teachers and shall study more particularly the existing standards and methods of instruction throughout the country and the possibility of improving them.

The society adjourned after one of the pleasantest meetings in its history.

SCIENTIFIC NOTES AND NEWS

The medal struck by the Linnean Society to commemorate the fiftieth anniversary of the reading of the papers on natural selection by Darwin and Wallace was, on July 1, awarded to Dr. Alfred Russel Wallace, Sir Joseph Dalton Hooker, Professor Ernst Haeckel, Professor Eduard Strasburger, Professor August Weismann, Dr. Francis Galton and Sir E. Ray Lankester.

On the occasion of King Edward's birthday, baronetcies were given to Sir T. Lauder Brunton, F.R.S., and Dr. W. W. Cheyne, F.R.S., and the knighthood to Professor A. G. Greenhill, F.R.S., and Colonel David Bruce, F.R.S.

M. Henri Becquerel has been elected permanent secretary of the Paris Academy of Sciences for the physical sciences.

Dr. William Osler, regius professor of medicine at Oxford, has been selected as an independent candidate for the lord rectorship of Edinburgh University.

At the eighty-third annual commencement of Hobart College the address before the Phi Beta Kappa Society was delivered by Professor A. G. Webster, of Clark University, who received the honorary degree of LL.D.

Dr. William J. Holland, director of the Carnegie Museum, has returned from his visit to Germany and France to present on behalf of Mr. Andrew Carnegie life-size plaster casts of the Diplodocus. In recognition of his services to science, the German emperor conferred upon Dr. Holland the Order of the Crown, while President Fallières bestowed upon him the Cross of the Legion of Honor.

The Rumford Committee of the American Academy has made the following grants in aid of researches in light and heat: To Professor N. A. Kent, of Boston University, an additional appropriation of $400 for a set of echelon plates for use in his research on the conditions influencing electric spark lines. To Professor Joel Stebbins, of the University of Illinois, an additional appropriation of $100 for his research on the use of selenium in stellar photometry.

A gold medal was recently struck and presented to Professor Ramón y Cajal, in the name of his friends and admirers throughout Spain. Professor Cajal refused to permit a public ceremony, and the medal was presented informally at his home on May 27.

PROFESSOR H. H. TURNER, F.R.S., has been elected correspondent of the Paris Academy of Sciences in the section of astronomy.

THE prize of £50 of the Gordon-Wigan fund, Cambridge University, for a research in chemistry has been awarded to Mr. L. A. Levy for his research entitled "Investigations on the fluorescence of platinocyanides."

DR. O. HOFFMAN-BANG, director of the Copenhagen Agricultural Experiment Station, Denmark, is visiting the stations in this country.

DR. BERTRAM H. BUXTON, professor of pathology in the Medical College and director of the department of experimental pathology of Cornell University, is on his way to London, where he will remain until September.

THE *Roosevelt,* Commander Peary's Arctic exploring ship, left the pier at East Twenty-fourth Street, New York City, on the afternoon of July 6. Commander Peary, his crew and invited guests, including members of the Arctic Club, were on board the vessel, which was convoyed by a government tug to City Island, whence it proceeded to Oyster Bay, where President Roosevelt inspected it.

NEWS has been received to the effect that Dr. Sven Hedin, the Swedish explorer, left Gartok, a town in Tibet, on the headwaters of the Indus, early in November of last year, with the intention of spending the winter at Khotan, in Chinese Turkestan. He planned to return to Leh, in the valley of the Indus, this summer.

COLONEL DAVID BRUCE, who will be in charge of the new commission to proceed to East Africa to investigate the sleeping sickness, will be accompanied by Captain A. E. Hamerton.

DR. GUILLERMO PATTERSON, JR., has resigned an assistantship in pathological and physiological chemistry in Cornell University, and is on his way to the Isthmus of Panama, where he will collect samples of medicinal herbs for analysis and will continue his studies on local climatology. His address will be: Apartado No. 116, Panama City.

MR. HERBERT J. SPINDEN, of the Peabody Museum, Harvard University, has been commissioned by the American Museum of Natural History to spend the summer among the Nez Percé Indians and other tribes speaking dialects of the same linguistic stock, for the purpose of securing data on such phases of their culture as he has not previously investigated. The museum has received permission from the U. S. government to send the Rev. G. L. Wilson to Fort Berthold Reservation, North Dakota, in order that he may procure additional information regarding the traditions and tribal history of the Mandan Indians.

PROFESSOR W. M. DAVIS's summer school of geology has opened successfully. He has studying under him foreign as well as American students. By the time he reaches Grenoble in July he will have at least fifteen in his party.

THE executive board of the International Botanical Society has appointed Edward W. Berry, of the Johns Hopkins University, American editor for paleobotany of the *Botanisches Centralblatt.*

THE following are among the pensions which were granted during the year ended March 31, 1908 (amounting in all to £1,200), and which are payable under the provisions of the British Civil List: Sir Edwin Ray Lankester, K.C.B., £250, in consideration of his eminent services to science; Dr. John Hall Edwards, £120, in recognition of his devotion to the furtherance of radiography in its application of medical and surgical science; Mrs. Sarah Elizabeth Tichborne, £60, in consideration of the useful discoveries of her husband, the late Dr. C. R. C. Tichborne, in chemistry and pharmacology, and of her inadequate means of support; Mrs. Theodora Copeland, £60, in recognition of the services rendered to astronomical science by her husband, the late Dr. Ralph Copeland, and of her inadequate means of support; Mrs. Jessie Wilhelmina Blyth, £60, in consideration of the eminent attainments of her husband, the late Professor James Blyth, in physical science.

WE learn from *Nature* that a monument to the memory of Boucher de Perthes was unveiled at Abbeville on June 8. Boucher de

Perthes, who made important discoveries in prehistoric anthropology in the neighborhood of Abbeville, died there in 1868. In 1832 he found at Thuison, near Abbeville, the first stone engravings, and in 1863, in the Moulin Quignon cave, the remains of Quaternary man with flint axes. The collections made by Boucher de Perthes were bequeathed to the state, and are preserved in the Museum of Saint-Germain-en-Laye.

W. R. Cassie, professor of physics at the Royal Holloway College for Women and secretary of the Physical Society, died on June 22, aged forty-seven years.

Mr. George Sim, the Scottish naturalist, died at Aberdeen on June 15, at the age of seventy-three years.

The annual visitation of the Greenwich Royal Observatory took place on June 3, the board of visitors being constituted as follows: Lord Rayleigh, Mr. H. F. Newall, Professor W. G. Adams, Professor J. Larmor, Professor Sir J. Norman Lockyer, Lord Rosse, Principal Sir A. W. Rücker, Captain Sir W. de W. Abney, Professor Sir R. S. Ball, Professor R. B. Clifton, Dr. J. W. L. Glaisher, Sir W. Huggins, Mr. E. B. Knobel, Professor H. H. Turner, Professor Sir G. H. Darwin, Rear Admiral A. Mostyn Field (hydrographer of the navy) and Mr. W. D. Barber (secretary). A large number of gentlemen interested in astronomy were present by invitation of the astronomer royal, and took part in the inspection of the observatory and instruments.

We learn from the London *Times* that the proposals for the formation of a new institute on the lines of the Iron and Steel Institute in connection with the nonferrous metals are taking definite shape. A further meeting was held in London on June 10, and it is understood that the movement has the cooperation and approval not only of copper smelters, copper wire drawers, copper and brass founders and other metal manufacturers, but also of boiler makers and marine engineers. The leading firms of shipbuilders have also announced their intention of supporting the proposed institute, and of course shipbuilders are among the largest consumers of brass and copper. The new institute is to be founded on an international basis, and it is stated that the manufacturers and metallurgists in France, Germany, Sweden, the United States, and other countries have announced their intention of supporting the proposed society.

There will be held in Berlin from October 3 to 18, inclusive, 1908, an exhibition under the auspices of the Brewers' College and Institute for Experimental Research on the occasion of its twenty-fifth anniversary. The management of the exhibition is undertaken by Professor M. Delbruck and Professor E. Struve. The offices are in the Institute for Brewing and Allied Trades, Seestrasse, Berlin N. 65. A copy of the regulations governing this international exhibition may be had by addressing Dr. Harvey W. Wiley, Washington, D. C., also an entry form for a description of samples of hops and barley which any one may desire to exhibit. Samples of barley should consist of not less than 30 kilograms and of hops 4 kilograms. Prizes will be awarded and a jury will be appointed for that purpose. It is hoped that the growers of hops and barley in this country will take an active part in this exhibit. Full instructions will be found in the regulations referred to above.

An International Congress of Historical Science is to be held this year in Berlin from August 6 to August 12. The work of the congress will be carried on in general and sectional meetings. There are eight sections, as follows: (1) Oriental History; (2) History of Greece and Rome; (3) Political History, medieval and modern; (4) History of Civilization and the History of Thought, medieval and modern; (5) Legal, Social and Economic History; (6) Ecclesiastical History; (7) History of Art; (8) Sciences subsidiary to History (Archives, Libraries, Chronology, Diplomatic, Epigraphy, Genealogy, Historical Geography, Heraldry, Numismatics, Paleography, Study of Seals). At the general meetings lectures will be given by Professor Maspero, Professor Cumont, Sir Frederick Pollock, Sir William M. Ramsay and Professor Monod. Copies of the program can be obtained from the secretary of the congress, Dr. Caspar, Kaiser-Allee 17, Berlin W. 15.

The Royal medals and other awards given annually by the Royal Geographical Society for the encouragement of geographical science and discovery have, as we learn from *Nature,* been distributed as follows: The founder's medal was presented to Lieutenant Boyd Alexander, for his African explorations and careful trigonometrical survey of the region between the Benue and Lake Chad. Lieutenant Boyd Alexander devoted a considerable time to the exploration of Lake Chad, and added materially to our knowledge of that constantly shifting lake. A careful study was made of the hydrography of the various river systems, the Niger, the Congo and the Nile, through which the expedition has passed. Detailed maps were made of the more unknown parts of the region, such as the Bamingi, Kibali and the Yei rivers. Much information was gathered concerning the physical features of the region passed through; careful studies were made of several of the types of natives, and important additions were made to our knowledge of the natural history of the extensive region. The patron's medal was awarded to H.S.H. the Prince of Monaco, for his work in oceanography. Among the notable additions to scientific knowledge made on board the *Princess Alice* are: (1) the results of using the deep-sea traps invented by the Prince, which threw a new light on the life on the floor of the deepest parts of the ocean; (2) successive seasons' exploration on the coast of Spitzbergen and in the adjacent seas; and (3) studies of the conditions of the upper air by means of meteorological kites in mid-Atlantic. Other awards were as follows: Murchison award to Colonel Delmé-Radcliffe, for his work when as resident in the Nile province of Uganda he mapped the whole province, and for the work which he did afterwards when in charge of the English section of the Anglo-German Boundary Commission, between Victoria Nyanza and Mount Ruwenzori. The Gill memorial to Dr. T. G. Longstaff, for his exploring work in the western Himalayas and Tibet, and especially on his last expedition in the Garhwal Himalayas, when he ascended the summit of Trisul. The Back bequest to Lieutenant George Mulock, for his long-continued work, mostly during his own time, in preparing the six sheets of the Antarctic charts, showing the results of the *Discovery* expedition. The Cuthbert Peek grant to Rai Sahib Ram Singh, a native Indian surveyor, who has done excellent surveying work on the expeditions of Captain Deasy, Dr. Stein, Captain Rawling and Major Ryder.

UNIVERSITY AND EDUCATIONAL NEWS

The Drapers' Company has undertaken to give Oxford University £22,000 for a new electrical laboratory and £1,000 toward its equipment.

Queen's University, Ontario, has received from Dr. J. P. Thomson, Brisbane, a valuable collection of specimens for its museum.

The graduating class of the Forest School of Yale University disbands on June 13, at the conclusion of their work in Alabama. Twenty-eight men out of a class of thirty-two will take the federal civil service examinations in forestry and nearly all of them will enter the government service.

Dr. Wallace Craig, of the University of Chicago, has been appointed to the chair of philosophy and psychology in the University of Maine.

Dr. Fred W. Thyng, teaching fellow at Harvard University and in charge of the courses in biology at Tufts College the past year, is to be assistant in anatomy at the Northwestern University Medical School.

At Cornell University appointments have been made as follows: Mr. David A. Molitor, who is now working on designs of the locks of the Panama Canal, professor of topographic and geodetic engineering; Dr. Sutherland Simpson, of the University of Edinburgh, professor of physiology; Dr. Andrew Hunter, of Leeds University, assistant professor of biochemistry; Dr. Dennie Hammond Udall, professor of veterinary medicine in Ohio State University, acting professor of the principles and practise of veterinary medicine, to succeed Dr. James Law; H. N. Ogden and V. Karapetoff, promoted to professorships of sanitary engineering and electrical engineering, respectively; J. E. Trevor, professor of thermodynamics. In the Medical College in New York City: O. H. Schultze, assistant professor of pathological anatomy; J. S. Ferguson, assistant professor of histology; W. J. Elser, assistant professor of bacteriology. S. H. Gage was made professor of histology and embryology, emeritus, and James Law professor of the principles and practise of veterinary medicine, emeritus. Professors Gage and Law retire this year, as has been already announced, according to the provisions of the Carnegie Foundation.

The trustees of Princeton University have made the following appointments: Mr. Henry Jones Ford, of Baltimore, professor of politics, to succeed Professor Harry A. Garfield, who begins his administration as President of Williams College, his alma mater, next autumn; Henry Norris Russell '97 and Raymond Smith Dugan, assistant professors of astronomy; Gilbert Van Ingen, assistant professor of geology; John Gale Hun, Charles Ranald MacInnes and Carl Eben Stromquist, preceptors in mathematics; John Havron, Jr., instructor in civil engineering, and Frank Irwin, instructor in mathematics.

C. E. Porter has been appointed professor of botany at the University of Santiago de Chile.

At University College, London, Mr. H. Deans has been reappointed to lecture on railway engineering; Mr. A. T. Walmisley to lecture on waterways, docks and maritime engineering; and Mr. W. N. Blair to lecture on roads, street-paving and tramways, during the session 1908–09. Dr. C. Spearman has been reappointed reader in experimental psychology.

Mr. Richard Noel Gerrod Thomas has been appointed to a lectureship in physical chemistry at Balliol College, Oxford.

M. Raoul Bricard has been appointed professor of applied geometry in the Paris Observatoire des Arts et Métiers.

DISCUSSION AND CORRESPONDENCE

THE MENDELIAN INHERITANCE OF MUTATIONS

The revival of Mendel's writings and the extensive elaboration of the group of facts he discovered seem to have resulted in a corresponding neglect of the works of Darwin. A large amount of recent literature of Mendelism and mutation can be read without meeting any intimation that Darwin also studied and interpreted phenomena of the same kind. Darwin lacked, of course, the technical vocabulary of the modern Mendelian cult, but he made many observations and experiments, and collected a large series of pertinent facts from the records of earlier investigators. The conclusions he reached are very definite, and have not been refuted.

Darwin's fundamental discovery was that normal, constructive evolution is a gradual process. He did not fail to see that abrupt variations and Mendelian inheritance are not in accord with the idea of continuous changes in the characters of species, but he decided that such facts are not of primary importance in evolution. He understood that the characters of mutations are not necessarily new, and was aware that no complete inventory of the characters transmitted by a plant or animal can be made from the pedigrees of a few close-bred generations. He associated mutations with reversions and other monstrosities, and reckoned the Mendelian inheritance of mutations as a further evidence of abnormality.

> When a character which has been lost in a breed reappears after a great number of generations, the most probable hypothesis is, not that one individual suddenly takes after an ancestor removed by some hundred generations, but that in each successive generation the character in question has been lying latent, and at last, under unknown favorable conditions, is developed.[1]

All the characters above enumerated, which are

[1] "Origin of Species," Chapter V. In the first edition (p. 160) the words of the sentence are somewhat different, but the same idea of persistent transmission and ultimate reappearance of ancestral characters is clearly conveyed: ". . . When a character which has been lost in a breed, reappears after a great number of generations, the most probable hypothesis is, not that the offspring suddenly takes after an ancestor some hundred generations distant, but that in

transmitted in a perfect state to some of the offspring and not to others—such as distinct colors, nakedness of skin, smoothness of leaves, absence of horns or tail, additional toes, pelorism, dwarfed structure, etc.—have all been known to appear suddenly in individual animals and plants. From this fact, and from the several slight, aggregated differences which distinguish domestic races and species from one another, not being liable to this peculiar form of transmission, we may conclude that it is in some way connected with the sudden appearance of the characters in question. . . . Some few characters, however, are incapable of fusion, but these are unimportant, as they are often of a semi-monstrous nature and have appeared suddenly.[2]

Writers on Mendelism have charitably assumed that only the accidental oversight of Mendel's writings kept Darwin from appreciating the new "principles of heredity." But in reality Darwin was acquainted with a much larger range of Mendelian facts than Mendel himself. Even the Mendelian proportions in the representation of the parental characters were not unknown to Darwin. Thus he found that reciprocal crosses between symmetrical and unsymmetrical snapdragons yielded only the ordinary unsymmetrical types of flowers in the first generation, while in about one quarter of the next generation (37 plants out of 127) the symmetrical character returned to expression.

Whether Darwin supposed that such proportions would remain regular in particular cases, does not appear, but there is no reason to believe that more knowledge on this point would have altered his conclusions, for he had facts to show that a general diversity of proportions attends "this peculiar form of transmission."

The proportions in which the parental characters are shown in Mendelian hybrids are not more exact than in the inheritance of sexual characters. Sex-inheritance is certainly a form of alternative expression, for the secondary characters of one sex are known in many instances to have been transmitted through the opposite sex. Characteristics of one sex can even be brought to expression in the other sex, as a result of castration, parasitism and disease. In sex-inheritance the contrasted characters of the parents secure expression in equal numbers of the offspring. In typical Mendelian inheritance the proportions are three to one, but the percentages are variable and are connected by intermediate numbers.

Mendelism is not a general phenomenon in nature, nor is it confined to distinct groups of animals or plants, or to particular kinds of characters. The Mendelian proportions simply mark one condition or stage of adjustment of variable physiological functions whose results can be traced from ordinary graded and blended expressions of parental differences, through many degrees of alternative expression, until they reach the highly specialized form of inheritance shown in sexual characters.[3]

Transmission is distinct from expression, just as the imprinting of an invisible image on a photographic plate by the light is distinct from the subsequent development of a visible image by solutions of chemicals. With organisms, as with photographs, different methods and conditions of development can bring different results from the same beginnings. The differences arise from the relations that govern expression, instead of from differences in the characters or in the methods of transmission. Reversions, mutations, sexual and Mendelian differences, and even the so-called environmental variations, can all be understood as varied combinations and degrees of expression of characters equally and impartially transmitted.[4]

Alternation in the expression of characters is an elective alternation, a choice among the transmitted characters of those that are

each successive generation there has been a tendency to reproduce the character in question, which at last, under unknown favorable conditions, gains an ascendancy."

[2] "The Variation of Animals and Plants under Domestication," Chapters XV. and XIX.

[3] "Mendelism and Other Methods of Descent," *Proc. Washington Acad. Sci.*, 9: 189–240.

[4] "Transmission Inheritance Distinct from Expression Inheritance," Science, N. S., 25: 911, 1907.

brought into expression. The Mendelian hypothesis of alternative transmission involves the idea of exclusion, of the formation of germ-cells which are "pure," in the sense that the protoplasmic rudiments of some of the parental characters are supposed to be omitted from some of the germ-cells. For the existence of such incomplete germ-cells only arithmetical reasons have been advanced.

If Mendel could have read the works of Darwin the hypothesis of *alternative transmission* might have been spared. His facts could have been associated with the many other instances of *alternative expression* enumerated by Darwin. Mendelism, as a theory of alternative *transmission* of characters, is still as lacking in a biological basis as in the days of Darwin. The conception of alternative *expression* of characters accommodates the facts better than the Mendelian conception of alternative transmission.

To represent the theories of mutation and Mendelism as emendations of Darwinism necessitated by the discovery of new facts is misleading. In reality these doctrines are fundamentally opposed to the Darwinian conception of evolution by gradual change in the characters of species. Darwinians have often gone too far in claiming that natural selection is the cause of evolution, but the theory of mutation departs as far from the truth in the opposite direction, in ascribing evolution to sudden jumps from one species to another, without any relation to selection.

There is no reason to suppose that sudden individual variations in uniform varieties represent new characters, except as symptoms of degeneration. Uniform varieties are special products of artificial selection or of isolation in nature. A series of mutants arising from the same uniform stock shows a range of individual diversity corresponding to that of the members of a natural, broad-bred species, though the mutants differ from the members of a normal species in frequent evidences of degeneration. Thus the mutations of a narrow-bred variety can be understood as representing the return to expression of characters transmitted from ancestors of much greater and more normal diversity.

O. F. Cook

Washington,
April 24, 1908

BIOTYPES OF CORN

To the Editor of Science: In my recent article, Science, June 5, I stated that Dr. Shull, in his investigations of the elementary species of corn, had been led to think that no biotype of corn had twelve rows, but that he had found those which tended to produce ten and fourteen rows. I further stated that Dr. East had been led, from his investigations, to believe that a type existed having twelve rows. This statement was made after having heard a fragmentary discussion between these gentlemen at the recent meeting of the American Breeders' Association.

Recent correspondence with both of these gentlemen shows that the point of discussion between them was as follows: Dr. East, in discussing Dr. Shull's paper, stated that he thinks there is a physiological reason for the ideal number of rows in corn biotypes to be in multiples of 4; and that therefore more biotypes will be found having 8, 12, 16, etc., rows than those having 10, 14, 18, etc., rows. Dr. Shull replied that in his work he had found no evidence that the multiples of 4 are more favored than the other multiples of 2.

W. J. Spillman

U. S. Department of Agriculture

QUOTATIONS

THE COLLEGE GRINDSTONE

The recently published "Life and Letters of Sir Richard Jebb" must fill the occupants of academic chairs in America with envious despair. This picture of the life of a college professor in Great Britain is far different from that of the college professor in America. It is different, of course, from that of the average university teacher in England; for Jebb was a man of exceptional parts; he was able to do large amounts of various kinds of work—teaching, investigating, lecturing and writing—all of it brilliant. Nevertheless, he represents an ideal of accomplishment and achievement toward which the English university teacher more or less consciously strives. In America, on the other hand, this notion of the scholar and man of letters combined in one person is but dimly conceived by most members of the academic body; and it has apparently never entered the heads of many college trustees. We have had a Longfellow and a Lowell; and among the living we might name a few more who enjoy something beyond parochial fame; but the vast majority can hope to be nothing more than competent teachers and the editors of useful text-books—a respectable but not an inspiring career.

The reasons for this shortcoming—if we may use so harsh a word—are not far to seek. We need only refer to the fact that in but few places in this country is any tradition of culture firmly established. We have not half a dozen university seats where a man like Jebb would have received strong encouragement, to say nothing of stimulation. Moreover, he would be something of an alien within the university itself. The steady mediocrities and the glib talkers who figure so largely in our boards of trustees and who are not infrequently chosen to college presidencies, are naturally biased by an unconscious but none the less genuine distrust of men who are not of their own kind. These authorities, though they nominally desire to encourage scholarly production, really like best the solid teacher who carries a huge amount of class and committee work capably and without flinching, or that other one who dissipates his energies in keeping the college constituency "warm"—talking at all the teachers' meetings and similar gatherings. These are the activities that, in the eyes of college administrators, actually count, and therefore win solid rewards. Nor is this surprising. Most American colleges are much straitened for money. The one thing which they must do is to maintain the class-room instruction as well as may be, and keep growing in numbers so as to appeal to the public as an institution deserving of more liberal support. To these two ends other aims are, by the pressure of a growing population, clamorous alumni, and an empty treasury, ruthlessly sacrificed.

To the merchants, manufacturers and bankers, who constitute the backbone of our intelligent and public-spirited boards of trustees, it appears absurd that a professor should find fifteen or twenty hours of class-work a week a heavy load. Three or four hours of teaching or lecturing a day, for nine months in the year, seems to your business man mere play. Yet the truth is that six or eight hours a week of first-rate class work, informed as to the latest results of research, thoroughly digested, and carefully presented, will keep a professor busy. If he attempts more, he degenerates into a machine; he offers the same lectures and cracks the same jokes year after year; he becomes a mere dealer in routine. That is, he has no chance to refresh himself, to get new points of view, in fine, to think. For the professor the time spent in experimentation that is not immediately productive of striking results, in reading, in mulling over his ideas while he walks, plays golf, or rides the bicycle, and in discussing with a colleague the newest theory as to the constitution of matter or the recently discovered fragment of Menander, is not pure loafing or genteel recreation. This is the very process by which he subjugates his facts, assimilates his learning, and ripens his scholarship. But the unhappy truth is that thinking is a luxury in which our average underpaid and over-driven college teacher can not afford to indulge. Whatever his personal inclinations, he knows that the people to whom he must look for approval, for means to extend his department, for library books and laboratory apparatus, for bread and butter for himself and his children—that these people are primarily interested in other things; and that he is at liberty to do only so much thinking as is compatible with devoting all his time and energy to classes and committees.—New York *Evening Post*.

SCIENTIFIC BOOKS

Text Books of Physical Chemistry. Stoichiometry. By SYDNEY YOUNG, D.Sc., F.R.S., Professor of Chemistry in the University of

Dublin. Together with an introduction to the Study of Physical Chemistry, by Sir William Ramsay, K.C.B., F.R.S. Pp. lxi + 381. London, Longmans, Green and Co. 1908.

The term stoichiometry which originally was applied to the calculation of chemical equivalents has been extended by Ostwald to include not only the determination of atomic and molecular weights, but the study of the properties of solids, liquids, gases and solutions as well. It is in this broader sense that the author uses the word in the title of the present volume, which may be regarded as the most satisfactory of this admirable series of texts which we owe to Professor Ramsay.

Unfortunately many of the text-books which appear nowadays are characterized by a sort of inbreeding, each one reading like a reassortment of the sterotyped pages of its predecessors. This fault the author has avoided to a remarkable degree. The interest of the reader is held not only by the refreshing novelty of the treatment but also by the introduction of much comparatively unfamiliar material and many new tables and figures. If a criticism were to be made it would be that the author's zeal in the exposition of experimental results has caused him to neglect those fundamental thermodynamic considerations which would have added much to the symmetry and logical completeness of his work.

Never has a simple experiment, carried out with the highest accuracy and scientific honesty, been rewarded by more signal consequences than Lord Raleigh's determination of the density of nitrogen. The continued study of the small discrepancies which he found, and which might have been glossed over by a less critical observer, have led directly on the one hand to the discovery of the five new elements of the argon family, and on the other to the complete revision of our accepted table of atomic weights. The work of D. Berthelot, Guye and others has established the complete validity, at very small gas pressures, of the principle of Avogadro, and has enabled them by physico-chemical means alone to determine the atomic weights of a considerable number of elements with an accuracy which rivals that attained in the most refined chemical analyses. How this method has led to a notable amendment of Stas's value for the atomic weight of nitrogen, and thence indirectly to a modification of many other important atomic weights, is fully described by the author. He discusses also some of the more important determinations which have been made by chemical means and shows the futility in such cases of the calculation of the so-called probable error, a point which he might well emphasize more strongly.

In the chapters on liquids, the critical state, and liquid mixtures Professor Young deals with subjects to which his life has been devoted. The reader expects therefore a comprehensive and stimulating treatment and he is not disappointed.

The introduction to physical chemistry by Professor Ramsay which is included in this book has already appeared in another volume of the series. It is a very compact statement, along conventional lines, of the historical development of chemical theory. The reviewer notes one paragraph, on solubility, page xxxv, which may be very misleading to a beginner.

Gilbert N. Lewis

Behind the Scenes with the Mediums. By David P. Abbott. Chicago, The Open Court Publishing Co. 1906. 8vo, pp. 328.

To the psychologist or layman interested in the *modus operandi* of deception, this painstaking book by Mr. Abbott will prove as invaluable as it is interesting. It brings home with renewed emphasis the technical expertness that goes into the performances of the modern mystifier, particularly of the type that appeals to the spiritualistic or other prepossessions of the sitters. It emphasizes equally how unevenly matched must be this mystifier and the ordinary or even the extraordinary investigator who interprets his inability to discover how the effect is produced into a warrant for the belief that something defying natural experience has been witnessed. In the face of such manifold and complex procedures, the assurance of even the sincere and observant that their watchfulness precluded any such varieties of deceit appears most feeble. When one considers the difficulty of describing in proper sequence and with sufficient detail an ordinary procedure, the impossibility of deciphering a performance studiously devised to conceal every item of its real purpose becomes glaringly evident.

The largest amount of ingenuity seems to have been expended in the devising of tricks that shall reveal knowledge apparently out of range of the performer's sphere of influence. The reading of sealed billets is a favorite device and is endlessly variable in procedure, running the gamut of manifolding paper, chemically revealed impressions, the substitution of prepared messages, the intrusion of confederates, concealed speaking tubes and telephones, and codes of signals of some measure of resourcefulness, to say nothing of prepared "blue books" of gossipy information for each town visited and the helpful *esprit de corps* of the profession. At times there is a skillful service of simple physical principles with an appropriate translation into the mystifying terminology. A clever device by which any one of a series of pendulums will begin to respond by taps against the sides of the glass in which it is suspended, is managed by the performer's giving an impact to the table upon which the glasses stand and timing his gentle pushes with the period of the pendulum designated. The pendulums are all made of slightly different lengths; and with a little practise the right one is set going, to the perplexity of the sitters. Even an ordinary magnet embedded in a plaster hand is sufficient to serve as the medium of "thought vibrations," while telescopic projecting rods that disturb furniture ten feet off become the proof for the moving of objects without contact. Such are the things undreamt of in the philosophy which our forefathers designated "natural" and which in these practical generations ministers to the needs of so varied interests as physics, parlor entertainments, and a belief in the survival of materializing and materialized spirits.

Nothing less than a reading of the volume will convey an adequate sense of the versatility of device, yet in individual cases of the poverty of resource and obviousness of deception that make up the professional equipment of the medium. Such reading is eminently to be recommended, and is nowhere to be found in more convincing form than in Mr. Abbott's narrative. The very directness and simplicity of the story argues its singleness of purpose; which is the matter-of-fact enlightenment of the *modus operandi*. This in turn is doubly convincing by the fact that Mr. Abbott himself has tried and tested that whereof he speaks, has produced the effects described, has gained the confidence of the mediums, who have in some cases adopted the devices of Mr. Abbott's performances (which it is needless to state were given merely as effects by natural means to be explained by the sitters as their judgments dictated), and has cultivated for years the field in which he is expert. It is for these reasons that the practical value of the book, both as a record, and as a rationalizing instrument, is quite sufficient to deserve a word of appreciation on the part of those interested in spreading the gospel of common sense and sound science.

The psychological aspects of deception are not specifically treated, but appear conspicuously between the lines. The mental physiognomy of the species "medium" stands revealed in recognizable though variable features. It presents usually a somewhat bourgeois, coarse, temperament, attracted by the ready gullibility of the clientele and the get-rich-quick instincts of the adventurer, and with this combines a variable stock in trade in a commanding presence, an insinuating manner, a shrewd observation, a bold finesse, or a real even if somewhat criminal interest in playing the game and winning. A medium who actually bullied his sitters to provide the proper moment for picking their pockets (to extract a letter or other document to obtain name and address) is thus described: "The medium was a very large and powerful man . . . at one time he had been a pugilist. After this he became a minister of the Gospel, finally taking up the profession of a spirit medium, as this was more lucrative for one of his talents and personal appearance." In other social circles the type may appear thus. "There is a lady medium in Omaha who is the wife of a prominent citizen. She is afflicted, being nearly blind. This lady, in her seances, produces large quantities of cut flowers, which she claims to materialize from their 'astral forms.' Most persons would think that a lady of her standing, and afflicted in the manner she is, would not deceive." The flowers are real flowers, and the medium allows ladies to examine her clothing to see that no flowers are concealed about her person. Yet no one pays attention to a confederate under whose ample skirts the "astral" flowers take shelter until needed, nor is the public aware of regular consignments of flowers to the medium from "a greenhouse in Council Bluffs." As to the psychology of the sitters, it is doubtless complex and divisible into many types. In the main it is not the performance that convinces against protest and despite intellectual antagonism; but rather that prepossession finds support in seeming mystery and flies to evils that it knows not of. The most common trait is the assurance that in the case observed there really was no room for trickery or malobservation. Why such assurance should be so common a trait it is not easy to explain. One wishes for such persons the attitude attributed (possibly without due warrant) to Sir Walter Scott: when asked whether he believed in ghosts, he is said to have replied, "No! I have seen too many of them."

J. J.

A UNIQUE COLLECTION OF PERIDOTITE

State Mineralogist J. F. Whitlack, of Little Rock, Ark., has recently arranged and placed on exhibition at the Bureau of Mines, Manufactures and Agriculture, a unique collection of peridotite which is attracting much attention.

The collection contains specimens of the peculiar peridotite breccia from the three well-known American localities, those of Arkansas, Kentucky and New York, arranged side by side with similar rock and concentrates from the most noted of the African mines, indicating more forcibly than could a lengthy description the extremely close resemblance between the rocks of these widely separated localities. So close is the resemblance between the peridotites from these various localities, as shown by the specimens both rough and polished, that it is almost impossible to distinguish between them.

The rock is a dark green, almost black, porphyritic mass composed largely of grains and crystals of olivene. The tendency of this mineral to alteration is well known, and specimens of the alteration products—the green and yellow serpentinous earths from the various localities—are also shown. These earthy products are interesting economically as well as scientifically, for it is by washing and screening them that the heavy concentrates are obtained from which the diamond and other gems are subsequently sorted. The collection thus shows the various stages through which the rock passes from practically the fresh unweathered condition through the partly altered peridotites into the softer green and yellow earths to the concentrate of pebbles and gems. Besides the much prized diamond the latter includes the light green olivene, bright red garnet and deep blue diopside crystals. The last named has not as yet been recognized in the Arkansas deposits.

To the scientist the problem of explaining how these gems come to be locked up in this peculiar volcanic material is of greater interest than the question of securing them, and it is hoped that a study of the conditions at some of these localities may explain the perplexing problem. At several of the occurrences the diamondiferous peridotite penetrates beds of shales rich in carbon, hence it has been suggested that the diamond, which is merely crystallized carbon, owes its presence to the fact that the heated material forced its way as a partially liquid mass through the adjoining carbon-bearing shales, absorbing some of their carbon which later crystallized from the cooling magma as the diamond. This plausible hypothesis would no doubt still be regarded as the true explanation were it not for the fact that at several of the diamond mines no carbon shales are known, hence the diamond could not have been derived from this source. At present opinion is divided as to whether the diamond should be considered a constituent of the rock itself as is the mica, garnet, ilmenite, etc., or whether it has crystallized at great depths and merely been brought upward by the peridotite.

The discovery of diamonds at one of the American peridotite localities is causing some speculation as to whether the other two localities where this rock is known to occur and to contain the accessory minerals which so frequently accompany that gem, may not also contain the diamond. The remarkable similarity of the rocks at all three of the American localities with those of South Africa, not only in appearance as indicated in the collection mentioned, but also in eruptive character, in inclusions, in structure and in chemical composition, as has been frequently noted, makes such a supposition not improbable.

A catalogue describing the rocks of this collection in detail, together with a bulletin outlining the important facts concerning the Arkansas diamond field has been issued by Commissioner Guy B. Tucker, of the Bureau of Mines, Manufactures and Agriculture. Either of these may be obtained by applying to the Commissioner of Mines, Little Rock, Arkansas.

PHILIP F. SCHNEIDER
LITTLE ROCK, ARK.

SPECIAL ARTICLES

THE EFFECT OF AN ANGLE IN A CONDUCTOR ON SPARK DISCHARGE

AT a recent meeting of the American Philosophical Society held in Philadelphia the writer gave the preliminary results of his experimental work to determine the direction of flow of the electrical current in a wire. A large, eight-plate "static" machine, enclosed in a glass case containing also the Leyden jars, was used as a source of electricity.

The positive and negative discharges are led to two large metal cylinders hung in the air on insulators, and armed with a multitude of pin-points. In this way the positive and negative discharges are not superposed in the same conductor. The discharge was led around a sharply made right angle in the wire. This was done by means of a small splinter of bamboo, forming a sharp edge. A photographic plate in a holder of hard rubber was placed under the angle so that the discharge could be sent downward to the angle and then led horizontally away over the plate holder.

By reversing distant connections made by two small wires, the discharge could also be sent around the angle in the opposite direction.

The plate holder rests on a large sheet of plate glass forming a table top. Below this sheet of glass is a plate of metal connected to the water pipe. Its distance from the photographic plate may be varied. In all of the work done on the negative discharge this plate was not needed. Its use does not change the nature of the result.

It is found that when the negative discharge plunges down to the angle the electrical particles pass on into the air and through the rubber cover, whose thickness is three sixteenths of an inch, to the photographic film. This is shown by the character of the image formed on developing the plate. If the action is too strong, the electrical stresses produce branching images due to incipient breaking down of the film. By diminishing the spark length or by removing the angle further from the film, the image becomes a round spot just under the wire carrying the downward discharge. This image is apparently of the same character as is produced by X-rays or radio-action.

When the discharge is reversed, so that the negative particles pass across the plate to the angle and then upwards, the spot is much feebler, or does not form at all. The result depends somewhat on the extent to which the discharge is an oscillatory one. Oscillations are to be prevented.

When the positive discharge is sent around the angle, no such effect is produced. This is the case even when the grounded plate is brought as near as is possible without inducing spark discharges over the plate-holder. In such cases, however, the plate may be fogged by negative action from below, and proceeding from the plate grounded on the water pipe.

By the use of this grounded plate and by replacing the thick hard-rubber cover of the plate holder by a thin sheet of black paper, in two cases distinct images have been produced by the positive discharge. In this case only a few millimeters of air separated the discharge wire from the film. It is then, however, very difficult to prevent the electric stresses from forming the branching images. When this begins the results are quite uncertain. When a negative discharge of the same spark length is used under the conditions which gave the faint positive image, the image produced covers a couple of square inches of plate. Five spark discharges of the negative produce a much greater effect than was produced by a hundred of the positive, in the two cases when the latter discharge produced any effect. The behavior of the positive line is somewhat perplexing. An X-ray tube will operate in this line, the cathode being connected on the cylinder hung in air. But these cathode particles do not appear to be active at the angle.

It may be possible to devise some method of electrometer examination which will not result in the destruction of the instrument. The continuous current has not yet been examined. This, however, involves different conditions from those existing in the circuits here examined. There are many precautions necessary in this work which can not be here discussed, but which will be presented as soon as final results can be given. It has required the use of sixty dozen photographic plates in order to reach the results already attained.

It is evident that the effects here described point to the action of the β and α "rays," in radio-active phenomena.

Francis E. Nipher

DINICHTHYS INTERMEDIUS NEWBERRY FROM THE HURON SHALE

In the spring of 1907 Dr. Lynds Jones found part of a dinichthyid mandible in the Huron shale near Huron, Ohio, and the writer collected it for the Geological Museum of Oberlin College. The specimen includes all of the cutting blade of the mandible excepting about one centimeter of the posterior end. The length of the cutting blade is sixteen centimeters. This indicates that the entire length of the mandible was about thirty-five centimeters. The width is eleven centimeters. In size it agrees with mandibles of *Dinichthys intermedius* Newb. and in form it agrees closely with the same species, differing in the greater and more regular concavity of the top between the second cusp and the posterior end of the cutting edge, and in the prominence of the cusp-like projection between the anterior tooth and the main cusp. As pointed out by Hussakof,[1] the prominence of this projection is probably an individual variation and is not of specific value. In the writer's opinion the first difference mentioned is not of specific value. The denticles on the posterior part of the cutting edge are smaller than in most specimens of *Dinichthys intermedius*. Teeth are absent from that part of the jaw where they are prominent in *Dinichthys hertzeri*. The differences between this mandible and those of *Dinichthys intermedius* are so slight that the writer has no hesitation in referring it to that species. The specimen is important in demonstrating the presence of a second species of *Dinichthys* in the Huron shale and in showing that the type of mandible of *Dinichthys intermedius* and *Dinichthys terrelli* did not develop from the *Dinichthys hertzeri* type.

A figure of this specimen will be published later with figures of other specimens recently collected from the Huron shale.

E. B. Branson

Geological Department,
Oberlin College

SOCIETIES AND ACADEMIES

SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

The twenty-eighth meeting of the society was held in the physiological laboratory of the New York University and Bellevue Hospital Medical College, April 15, 1908. President Lee in the chair.

Members elected.—Otto C. Glaser, Alfred G. Mayer, John B. Murphy, Isaac Ott.

[1] *Bull. Am. Mus. Nat. Hist.*, Vol. XXI., p. 411.

Program[1]

"Influence of Cold and Exercise in Phlorhizin Glycosuria," by Graham Lusk.

"The Influence of Carbohydrate on the Protein Metabolism of a Fasting Pregnant Dog," by J. R. Murlin.

"The Transplantation of Parathyroid Glands in Dogs," by W. S. Halsted.

"The Nervous Coordination of the Auricles and Ventricle of the Heart of the Lizard," by Marie Imchanitzky. (Communicated by S. J. Meltzer.)

"The Influence of Diet on the Chemical Composition of the Body," by Lafayette B. Mendel.

"The Chemical Composition of Nonstriated Mammalian Muscle," by Lafayette B. Mendel and Tadasu Saiki.

"Increased Susceptibility of Protozoa to Poison due to Treatment with Alcohol," by Lorande Loss Woodruff.

"The Relative Specificity of Anaphylaxis," by F. P. Gay and E. E. Southard.

"On the Relation of Calcium Metabolism to Tetany and the Cure of Tetany by Administration of Calcium," by W. G. MacCallum and Carl Voegtlin.

"The Relative Toxicity of the Chlorides of Magnesium, Calcium, Potassium and Sodium," by Don R. Joseph and S. J. Meltzer.

"The Action of Calcium upon the Pupil and its Relation to the Effects of Mydriatics," by John Auer and S. J. Meltzer.

"The Destruction of Strophanthin in the Animal Organism," by Robert A. Hatcher and Harold C. Bailey.

"On the Nature of the So-called Glycogenolytic Fibers in the Greater Splanchnic Nerves," by J. J. R. Macleod.

"Prevention of Syphilis in Macacus Rhesus by Atoxyl," by Simon Flexner.

"Further Notes on a Rat Tumor," by Simon Flexner and J. W. Jobling.

"On Nucleic Acids," by John A. Mandel, W. A. Jacobs and P. A. Levene.

"Regarding the Innervation of the Blood Vessels of the Kidney," by R. Burton-Opitz and Daniel R. Lucas.

[1] Authors' abstracts of the papers read before the Society for Experimental Biology and Medicine are published in the *Proceedings of the Society for Experimental Biology and Medicine*. A number is issued shortly after each meeting, and costs 15 cents a copy. Copies may be obtained from the managing editor, William J. Gies, 437 West 59th Street, New York.

"Regarding the Innervation of the Blood Vessels of the Intestine," by R. Burton-Opitz.

"Note on Anaphylaxis to Horse Serum," by Paul A. Lewis.

"A Study of 'Protagon' prepared by the Wilson-Cramer Method," by L. J. Cohen and William J. Gies.

The twenty-ninth meeting of the society was held at Cornell Medical College, May 20, 1908. Silas P. Beebe in the chair.

Program

"Heredity of some Human Physical Characteristics," by C. B. Davenport.

"The Experimental Production of the Maternal Part of the Placenta in the Rabbit," by Leo Loeb.

"Hemolytic Action of the Venom of *Heloderma suspectum*," by Elizabeth Cooke and Leo Loeb.

"The Biological Relations of Seed Proteins," by Thomas B. Osborne.

"Variation in Hydrochloric Acid Secretion during the Digestive Period," by Nellis B. Foster and Adrian V. S. Lambert.

"The Effects of some Organic Acids on the Secretion of Gastric Juice," by Nellis B. Foster and Adrian V. S. Lambert.

"The Effect of Mechanical Obstruction of the Pyloric Outlet on Gastric Secretion," by Nellis B. Foster and Adrian V. S. Lambert.

"Transplantation of Devitalized Arterial Segments," by Isaac Levin and John H. Larkin.

"A Study of Nitrogen Metabolism in a Case Presenting Short Paroxysms of Fever of Unknown Origin," by Theodore C. Janeway and Herman O. Mosenthal.

"Histological Changes in Transplanted Blood Vessels," by Wilbur Ward. (Communicated by Francis Carter Wood.)

"Note upon the Supposed Presence of a Gastric Hormon in the Salivary Glands," by A. S. Loevenhart and D. R. Hooker.

"The Relation of the Weight of the Stomach- and Cecum-contents to the Body Weight in Rabbits," by Don R. Joseph.

"The Inhibitory Influence of Magnesium upon some of the Toxic Effects of Eserin," by Don R. Joseph.

"Influence of Iodides on Autolysis," by L. B. Stookey.

"Relation of the Thyroids to Autolysis," by L. B. Stookey and Vera Gardner.

"On the Physiology of the Thyroids," by L. B. Stookey.

"On the Pharmacology of the Iodides," by L. B. Stookey and Vera Gardner.

"Glycogen Formation from Arabinose in Chicks," by L. B. Stookey and A. Halden Jones.

"Is Oxalic Acid a Product of Hepatic Uricolysis in Man?" by L. B. Stookey and Ethel L. Leonard.

"The Life Cycle of Paramecium," by Lorande Loss Woodruff.

"An Examination of Bardach's New Protein Test," by Emily C. Seaman and William J. Gies.

"A Study of Metabolic Effects of Experimental Polycythemia in Dogs," by William Weinberger (by invitation).

"On the Metabolic Influence of Magnesium Sulfate in Dogs, with Special Reference to the Partition of the Nitrogenous Constituents of the Urine," by Matthew Steel (by invitation.)

"On the Determination of Ammonia, by the Folin Method, in Urines containing Crystalline Ammonio-magnesium Phosphate," by Matthew Steel and William J. Gies.

William J. Gies,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 206th meeting of the society Mr. C. W. Wright presented a "Brief Discussion of the Copper Deposits of Kasaan Peninsula, Southeastern Alaska." He first stated briefly the general geology of Kasaan Peninsula and then described the occurrence of the copper and its possible origin. Greenstone lavas, tuffs, conglomerates, sandstones and limestones constitute the stratified rocks and intruding these are batholithic masses of granodiorite. Granite and syenite dikes invade the granodiorite and in turn are cut by dikes of porphyry, felsite, diabase and basalt. Three types of ore deposits are recognized: (1) Chalcopyrite-magnetite deposits associated with amphibole, epidote, garnet and orthoclase, and occurring as irregular masses 10 to 300 feet in dimensions along the contacts of the intrusives. (2) Chalcopyrite-pyrite-sphalerite deposits associated with quartz and calcite and occurring in fissures or sheer zones 5 to 10 feet wide in the greenstone tuffs. (3) Galena-sphalerite-chalcopyrite and tetrahedrite deposits associated with quartz calcite and barite and occupying fissures 2 to 8 feet wide in the limestones. The first type are commercially the most important, and were described more fully. The facts relative to the origin of these contact metamorphic deposits are: (1) that a considerable transfer of material to local points at the intrusive contacts took place, (2) that the ore-bodies were deposited after the solidification of those portions of the adjacent intrusives now exposed, (3) that the minerals contained are those which form at relatively high temperatures from gaseous or aqueous solutions, (4) that the contacts of the intrusives have been favorable localities for the passage of these solutions. Though the source of these mineral solutions is hypothetical they are believed to have been derived from an underlying magma and probably the same magma from which the granodiorite, granite and syenite were ejected. Evidence tends to show that the origin of the copper deposits can not be attributed directly to the adjacent intrusive rocks and that both the intrusive and intruded enclosing rocks have played but a passive rôle in their formation. Their genesis is referred to an underlying igneous magma from which the greater portion of the material composing the ore deposits was ejected in a gaseous or aqueous state at a period subsequent to the ejection of the intrusive rocks with which the copper deposits occur.

Ralph Arnold,
Secretary

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The American Institute of Chemical Engineers was organized on June 22 at the Engineers' Club of Philadelphia. The following officers were elected for a term expiring at the next regular meeting, which will be held in December:

President—Samuel P. Sadtler, Philadelphia, Pa.

First Vice-President—Charles F. McKenna, New York City, N. Y.

Second Vice-President—H. Aug. Hunicke, St. Louis, Mo.

Third Vice-President—E. G. Acheson, Niagara Falls, N. Y.

Treasurer—William M. Booth, Syracuse, N. Y.

Secretary—John C. Olsen, Brooklyn, N. Y.

Auditor—Richard K. Meade, Nazareth, Pa.

Directors were elected for terms of one, two or three years as follows:

One year—Ludwig Reuter, Berkeley, Cal.; Thorne Smith, Isabelle, Tenn.; H. P. Brown, Wilmington, Del.

Two years—J. M. Camp, Duquesne, Pa.; Charles A. Catlin, Providence, R. I.; Eugene Haanel, Ottawa, Canada.

Three years—George P. Adamson, Easton, Pa.; David Wesson, Wilmington, Del.; Edward Gudeman, Chicago, Ill.

David Wilbur Horn,
Secretary pro tem.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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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., or during the present summer to Wood's Hole, Mass.

THE SALARIES OF PROFESSORS IN AMERICAN COLLEGES AND UNIVERSITIES[1]

THE Carnegie Foundation for the Advancement of Teaching, in seeking to carry out its primary object of establishing a retiring allowance system in the colleges, universities, and technical schools of the United States, the Dominion of Canada, and Newfoundland, has found it necessary to conduct various enquiries into the condition of education in these three countries. Among the first of these studies was one which had to do with the salary and tenure of office of the professor and of other officers of instruction. The results of that study are given in the present bulletin and are based upon data supplied by some seven hundred and fifty institutions in the United States and Canada, the figures given in all cases being presented exactly as they were received from the officers of these institutions.

The organization of colleges and universities in the United States is fashioned very much after that of business corporations; the board of trustees corresponding to the board of directors, the chairman of the board to the chairman of the board of directors, the president of the college to the general manager. The president is the connecting link between the administrative body of trustees on the one side and the teaching body on the other.

[1] From Bulletin number two of the Carnegie Foundation for the Advancement of Teaching. This bulletin, entitled "The Financial Status of the Professors in America and in Germany," contains much additional information and discussion.

In Canada the organization is somewhat more democratic, the governing boards in most cases being elected from the alumni and containing generally members of the faculty.

The instructing staff in most institutions, both in the United States and Canada, consists of professors, associate professors, and assistant or adjunct professors. These form the faculty or permanent body of teachers. In addition there are grades of instructors, lecturers, tutors and assistants whose positions are in great or less measure temporary.

Not all of these offices appear in all institutions. Even in some of the larger universities there are only two grades in the faculty, the professor and assistant or adjunct professor. In many smaller colleges the greater part of the teaching staff is included in the faculty with a very limited number of instructors and assistants. The grade of preceptor is unique in Princeton, where its holders are considered of faculty rank.

While this paper will deal, so far as seems necessary to render clear the status of the professor, with all of these grades of the instructing staff, it is upon the holder of the professorial title as embodying the force and tradition of college teaching that the attention will be principally directed.

As was pointed out in the second annual report of the president of the foundation, the words "college" and "university" have no well settled meaning in America, nor is the sphere of higher education by any means carefully defined. As a result the degree-giving institutions in these countries present every variety of educational and administrative complexity. Even the well-informed educator is apt to speak of our colleges and universities as if they formed a homogeneous species conforming more or less clearly to some typical condition. Not only is this not the fact, but these institutions do not even fall into any definite number of such species. There is no method of classification which, when applied to the thousand American and Canadian degree-conferring institutions, will enable the student to divide them into clear species. Whatever criterion is chosen will result in placing some institutions in company to which they are not entitled to belong.

The number of students, or the "bigness" of the college or university, is probably the most usual method of classification. But in regard to the number of students one finds a range continuous from institutions with fifty students to institutions with five thousand, and if in this continuous series arbitrary lines are drawn, the groups thus made put together institutions whose consideration side by side could serve no useful purpose; for instance, Johns Hopkins University with the University of Southern California, Yale University with the Temple College, and Williams College with Maryville College.

The size of the teaching staff would naturally be considered a more scientific method of classification, but here again there is a continuous gradation from institutions with five to institutions with five hundred teachers, and groups selected on this basis would result in such incongruities as placing Valparaiso University with Leland Stanford Junior University, Union College, Nebraska, with Amherst College, and Howard College at Birmingham, Alabama, with Ripon College.

The maintenance of professional schools might be considered as a significant line of cleavage, but such a means of demarcation, which would put in the supposedly less important group Princeton, Brown, Wesleyan, Vassar, Bryn Mawr, and Trinity (Hartford), and in the higher group such institutions as Hamline University, Epworth University, Baylor University, Kansas City University, and some forty or fifty other essentially minor institutions can not be considered an illuminating classification.

The presence of a certain number of resident graduate students is a significant feature of an institution for higher education, and might be used with advantage in a classification if graduate students in the various institutions had to comply with similar requirements before being enrolled. It is true that the graduate student must have received a college degree, but a collegiate degree in the United States means anything from a bachelor of arts or a bachelor of science of such an institution as the Ohio Northern University, Ada, Ohio, up to the bachelor of arts and bachelor of science of such universities as Columbia, and the University of Chicago. Until the collegiate degrees begin to have a definite meaning, it will be futile to base any classification upon the graduate schools, which essentially rest upon these degrees.

The annual income is one of the better ways of grouping American colleges and universities, because a "dollar" is somewhat the same all over the United States; whereas a "student" may mean a person in the "school of oratory" or a candidate for the degree of doctor of philosophy. The word "teacher" may mean a full professor working exclusively for his college or a musician in Chicago who is the "non-resident director" of the schools of music of a chain of small colleges throughout Illinois and the adjacent states, the same individual being counted thus in a score or more of college catalogues. The test of annual income, however, fails to divide institutions into any sharp groups. The institutions range almost continuously from so-called colleges receiving an annual income of eight hundred and fifty dollars up to universities with a yearly budget of a million and a half dollars. It is true that between six hundred and fifty thousand dollars a year income and eight hundred and fifty thousand dollars a year income occurs a break, but there does not seem any solid reason why the ten universities above this break should be considered apart from the Universities of Missouri, Toronto, Pennsylvania, Minnesota and Nebraska, which come immediately below.

It must also be noted that the figures in regard to annual incomes are not absolutely to be relied upon. Many institutions say frankly that the return under this head is only an approximation, and although the foundation has made every effort to exclude such extraordinary items as gifts, special legislative appropriations for the erection of buildings, etc., from this calculation of annual incomes, it can not feel certain that in all cases the figures given under this head represent the normal yearly income of the institution—the income which can be devoted to running expenses. Thus the Ohio State University at Columbus, in estimating its annual income, included the unexpended balance of a legislative appropriation for building operations granted several years before, and Harvard University included in its annual income the value of certain securities which it had sold during the year in order to make a reinvestment. The foundation has been unable to obtain copies of all college treasurers' reports, and so has been unable to check all the returns made. Such inclusion of building appropriation, bookkeeping items, etc., will doubtless account for some cases where, according to the institution figures, a disproportionately small percentage of the income is devoted to the salaries of the instructing staff. In many small colleges, on the other hand, the regular income is insufficient to pay the salary account, and it is necessary every year to make up the deficiency by the solicitations of gifts.

It may be mentioned here that the income of the University of Oregon, as given in the following table, is the income appropriated for it by the legislature a year and a half ago. The legislature of 1907 passed an act making an annual appropriation to the university of $125,000, but the referendum has been invoked against this act under the new initiative and referendum provision of the constitution of Oregon and the university, therefore, can not tell whether it will receive this appropriation until the referendum is held in June (1908). In the meantime, the university has to maintain itself upon the remnant of the old appropriation. This is the first time that the initiative and referendum has appeared in higher education in the United States.

Besides these reasons for not favoring the annual income as a means of classification, it should also be noted that in many institutions, particularly in women's colleges, the payments of the students for board are included in the income of the college. Wherever this is the case it is indicated in the table by a footnote. But while this footnote guards the reader from error, it does not enable the figures thus "starred" to be used for any useful purpose of calculation. To accept an income so calculated as if it were a real income would indicate that Vassar College was in receipt of a larger revenue than Princeton University, and the Randolph-Macon Woman's College than Radcliffe.

Since American colleges and universities fail under any system of classification to fall into natural groups, the only available method is to choose arbitrarily a system which is most useful for the purpose in view. A system of classification based on the amount of money expended annually for teachers' salaries has been adopted. This system results in incongruities. It places the College of the City of New York above the University of Virginia, and the Agricultural College of Utah above Clark University. But it results in fewer incongruous arrangements than any other single criterion.

There is one grave fault in this system of classification, and that is the impossibility of bringing within it the colleges and universities of the Roman Catholic Church. Almost all of these institutions are under the control of religious orders, and at least in the collegiate and graduate departments the teachers are priests who receive in money but a nominal compensation. The University of Notre Dame du Lac (Congregation of the Holy Cross) and Georgetown University (Society of Jesus), possessing incomes equal to those of Syracuse University and of Colgate University, must thus be omitted from this calculation, together with a number of less wealthy institutions whose revenues are on the scale of Rutgers and of De Pauw. But while the omission of these colleges and universities makes the list look incomplete, the omission is really unimportant in the economic sense. It would be meaningless to attempt a financial comparison between teachers to whom teaching is an ordinary economic function and teachers whose teaching is a part of their priestly duties. At some future time the foundation hopes to present from the pen of a distinguished ecclesiastic an adequate study of the Roman Catholic institutions.

The calculation on the basis of teachers' salaries will also be inadequate in regard to such institutions as New York University, where, as its syndic reports, a number of professors in all departments donate their services, in whole or in part, to the university. It will be necessary also to consider carefully the cases where houses or apartments are added to the salaries of the members of the instructing staff. The houses at the University of Virginia and the suites of rooms at some of the colleges of the University of Toronto are a considerable addition to the stated salary, and even when, as at Washington and Lee University, a charge is made for the houses allotted to professors, the charge, in view of the character of the residence, is a nominal one.

Taking the salaries paid to teachers as a basis of classification of American and Canadian degree-giving institutions, we have the following table:

TABLE I

Institutions Classified by Expenditure for Teachers' Salaries

Number of Institutions	Figures Indicating Range of Expenditure for Teachers' Salaries
92	$ 5,000–$10,000
91	10,000– 15,000
48	15,000– 20,000
29	20,000– 25,000
19	25,000– 30,000
18	30,000– 35,000
17	35,000– 40,000
17	40,000– 45,000
7	45,000– 50,000
6	50,000– 55,000
7	55,000– 60,000
8	60,000– 65,000
8	65,000– 70,000
4	70,000– 75,000
2	75,000– 80,000
4	80,000– 85,000
2	85,000– 90,000
1	90,000– 95,000
3	95,000–100,000
2	100,000–105,000
2	105,000–110,000
4	110,000–115,000
2	115,000–120,000
4	120,000–125,000
8	125,000–150,000
2	150,000–175,000
5	175,000–200,000
3[2]	200,000–225,000
4[3]	225,000–250,000
1[4]	250,000–300,000
4[5]	300,000–400,000
4[6]	400,000–500,000
3[7]	500,000–600,000
University of Chicago	$ 699,000
Harvard University	841,000
Columbia University	1,145,000

[2] Johns Hopkins University, Northwestern University, New York University.

It will be seen from the table that five ninths of the institutions making reports have an instructional pay-roll of less than twenty thousand dollars. Failure to report this item is very common among the smaller institutions. Almost all the large institutions, on the other hand, send in this report. It is, therefore, safe to say that if the figures were obtainable in every case, two thirds of the degree-granting institutions of the United States and of Canada would show a budget for teachers' salaries of less than twenty thousand dollars. Seven ninths of the institutions making reports spend less than fifty thousand dollars on instructional salaries. If the list were complete, institutions of this character would number six sevenths of those granting degrees.

The average salary of a professor is reported in many more cases by the college authorities than is the college's total annual expenditure in professional and other instructing salaries. From a study of these figures it appears that one third of the degree-granting institutions pay on an average less than a thousand dollars a year to their full professors; indeed, in

[3] McGill University, University of Missouri, University of Nebraska, Ohio State University (Columbus).

[4] University of Minnesota.

[5] Massachusetts Institute of Technology, Princeton University, University of Toronto, Leland Stanford Junior University.

[6] University of California, University of Pennsylvania, University of Wisconsin, University of Illinois.

[7] Cornell University, Yale University, University of Michigan.

thirty-five institutions making reports the average salary of the full professor is less than five hundred dollars a year. These salaries are poor enough under any circumstances, but it must be remembered that most of the institutions paying such salaries are not colleges in any sense, except that they are called colleges and that they confer collegiate degrees. These poorly paid professors are therefore not really doing the work of higher education, nor have they in most cases given themselves adequate preparation for college teaching. In the vast majority of cases these professors are teaching high-school and even grammar-school subjects; they have devoted to their training only the time ordinarily given to preparation by a teacher in secondary education; and their salaries, although small, are not so utterly incommensurate as they would be if paid to a professor doing collegiate work.

To study the financial standing of the teachers in all of the degree-granting institutions would therefore be to deal with a large number of institutions that are simply high schools. Conclusions drawn from such a heterogeneous group would be of little value. Yet to draw a line across this ascending scale of college salary budgets is a difficult task. Wherever the line is drawn there will be reasons for moving it down to include a few more institutions or up to have it exclude a few others.

It will necessarily be an arbitrary line, but at one place in the gradation of institutions it will be less an arbitrary line than if drawn at any other place. A glance at Table I. shows that at the point where forty-five thousand dollars a year is spent on salaries to the instructing staff the number of institutions drops sharply. Above this abrupt drop are one hundred and three institutions. Let us, therefore, take these institutions as typical of American higher education, and see what are the results obtained from an analysis of the status of their professors and instructors. Table II. gives these one hundred and three institutions, with their appropriate figures, in the order of their annual expenditure in teachers' salaries.

It may be that there are colleges not included in Table II. which are better representatives of higher education than some which are there listed. The table does not pretend to give the one hundred institutions in America which are the best from an educational point of view, any more than the arrangement of institutions in the table is meant to indicate anything beyond the total size of the annual salary accounts. The value of this table is that it is an impersonal selection of colleges and universities according to a fairly representative criterion. For the purpose of this table, it is more valuable to have the selection made according to an objective standard which every one can estimate, than to have a more exact approximation into which personal judgment enters.

The foundation recognizes, however, that the salary budget of an institution is closely related to the size of the institution, and that the size of a college is an imperfect method of estimating its educational value. Table IX., in a later part of this paper, is therefore intended as a necessary supplement to Table II. It contains the names of fifty-four institutions, which were not included in Table II. on account of the comparative smallness of their expenditure for salaries, and yet which in the opinion of the foundation ought to be considered if the higher education of the United States is to be rightly estimated. Table IX. and the discussion thereon will show what excellent educational results can be obtained by resources which are within moderate limits.

These two tables, the one a purely objective selection on a mathematical basis, the other an attempt of the foundation to correct the false impression which a selection only on that standard might give, will together present an approximately complete statement of the financial status of the teacher in the institutions of higher education in the United States and Canada. Nevertheless the total number of institutions which assume to deal with the higher education can not be disregarded, although many of them are occupied in a large part with education that is not of a collegiate grade. While these colleges of meager support and limited facilities can not be grouped, as mentioned before, in significant educational divisions, it is evident to one who studies the countries as a whole that the problem of higher institutions must be taken up from the standpoint of the state or province as a unit. The state governments have themselves in all cases a system of education limited by state lines. The same denominations have erected colleges and universities in different states, so that the problem of higher education is almost necessarily studied from the standpoint of the state.

Looked at from this standpoint, it is evident that if the system of higher education is finally to have unity, strength, and thoroughness, enormous sums of money must be spent to develop these numerous institutions, or else many of them must be in the end abandoned. One can scarcely doubt that the latter course will finally come about by the mere progress of events, for there can be no doubt that many of these institutions are wholly unnecessary. They have been produced partly from a genuine interest in education; partly by denominational and local rivalry; sometimes by the enterprise of real estate agents; and under a system of laws which allowed any group of men to come together and call the institution which they founded a college. There are in most states many more such institutions than are necessary for the work of higher education and the multiplication of the number undoubtedly lowers the general standard of institutions.

Thus the State of Iowa contains six institutions of higher education in organic connection with the Methodist Episcopal Church.[8] Two of these, Cornell College and Upper Iowa University, are both under the control of the Upper Iowa Conference of that church. The combined revenues of these six institutions are only a little over one fifth of the sum appropriated each year by the people for the support of the state university. They about equal the annual revenue of Vanderbilt University. It is apparent that here has been a great dissipation of energy, when by a wise concentration of resources the Methodists of Iowa could have built up a single institution comparable with the excellent facilities of Vanderbilt, and able, if its organization had not been too widely extended, to have been an admirable colleague of the state university. The Presbyterian Church has also controlled four colleges in Iowa,[9] whose incomes, if combined, would have been equal to the incomes of Haverford or of Lafayette.

In Ohio the Methodist Episcopal Church has founded or given its official patronage to five separate institutions of learning.[10]

[8] Cornell College, Mount Vernon; Morningside College, Sioux City; Simpson College, Indianola; Upper Iowa University, Fayette; Iowa Wesleyan University, Mount Pleasant; and Charles City College, Charles City.

[9] Coe College, Cedar Rapids; Parsons College, Fairfield; Buena Vista College, Storm Lake; Lenox College, Hopkinton. Coe College, however, with the consent of the Synod of Iowa has recently taken into consideration an abrogation of this relationship to the Presbyterian Church.

[10] Ohio Wesleyan University, Delaware; Ohio Northern University, Ada; Mount Union College, Alliance; Scio College, Scio; and Baldwin University and the German Wallace College, Berea.

TABLE II

Degree-conferring Institutions in the United States and Canada appropriating Annually $45,000 or over for the Total Payment of the Salaries of their Instructing Staffs[11]

Institution	Total Annual Income	Annual Appropriation for Salaries of Instructing Staff	Average Salary of Professor	Average Age at Entrance to Grade of Professor	Average Salary of Associate Professor	Average Salary of Assistant Professor	Total Number of Students in University	Total Instructing Staff in University	Ratio	Total Number of Students in Undergraduate Colleges and Nonprofessional Graduate Schools	Total Instructing Staff in Undergraduate Colleges and Nonprofessional Graduate Schools	Average Salary $2,048 Cost per Student $280 Ratio
Columbia Univ.	$1,675,000	$1,145,000	$4,289	37.5		$2,201	4,087	559	7.3	2,545	253	10
Harvard Univ.	1,827,789	841,970	4,413	39	$3,600	2,719	4,012	573	7	2,836	322	8.8
[19]Univ. of Chicago	1,304,000	699,000	3,600		2,800	2,200	5,070	291	17.4	3,902	211	18.4
Univ. of Michigan	1,078,000	536,000	2,763		2,009	1,624	4,282	285	15	2,899	198	14.6
Yale Univ.	1,088,921	524,577	3,500	35		2,000	3,306	365	9	2,620	236	11.1
[12]Cornell Univ.	1,082,513	510,931	3,135			1,715	3,635	507	7.1	2,917	283	10.3
Univ. of Illinois.	1,200,000	491,675	2,851		2,168	1,851	3,605	414	8.7	2,281	190	12
Univ. of Wisconsin	998,634	489,810	2,772	32.8	2,081	1,636	3,116	297	10.4	2,558	231	11
Univ. of Penna.	589,226	433,311	3,500			1,850	3,700	375	9.8	2,618	166	15.7
Univ. of California	844,000	408,000	3,300		2,200	1,620	2,987	350	8.5	2,451	218	11.2
Stanford Univ.	850,000	365,000	4,000	35	2,700	2,000				[17]1,668	146	10.7
Univ. of Toronto	610,000	324,000	3,600	42.5		2,400	3,498	368	9.5	1,732	153	11.3
[14]Princeton Univ.	442,232	308,650	2,914	35		1,824				1,301	158	8.2
Massachusetts Inst.	505,000	301,000	3,192	38	2,115	1,653				1,415	211	6.7
Univ. of Minnesota	515,000	263,000	2,600	32		1,700	3,889	303	12.8	2,169	116	18.6
Ohio State Univ.	475,000	244,000	2,041		1,692	1,400	2,014	127	15.8	1,376	87	15.8
Univ. of Nebraska	425,000	240,000	2,200	35		1,500	2,886	173	16.6	1,808	90	20
Univ. of Missouri	655,000	239,110	2,355	33		1,575	2,070	144	14.3	1,360	101	13.4
McGill Univ.	425,000	225,000	3,060		2,150	1,700	1,163	191	6	542	95	5.7
New York Univ.	303,500	220,000	3,466			1,830	3,110	211	14.7	827	46	17.9
Northwestern Univ.	491,132	218,157	3,265	35	2,325	1,535	2,485	261	9.5	936	56	16.7
Johns Hopkins Univ.	311,870	211,013	3,184			1,344	651	172	3.7	328	75	4.3
Univ. of Texas	339,577	199,394	2,889	32.5	2,300	1,893	1,693	110	15.3	1,169	80	14.5
Syracuse Univ.	279,000	180,000	1,806		1,291	978	2,875	199	14.4	1,807	89	20.3
Smith College	278,717	177,150	2,150			1,646				1,482	97	15.2
Univ. of Kansas	285,000	176,000	2,100		1,600	1,200	1,786	126	14.1	1,282	97	13.2
N. Y. City College	455,000	175,270	4,788		3,189	2,250						
State Univ. of Iowa	324,048	173,355	2,152	37.5		1,271	1,791	149	12	1,200	86	13.9
Dartmouth College	250,000	155,000	2,600	40	2,200	1,800	1,219	88	13.8	1,161	70	16.5
Tulane Univ.	274,000	146,000	3,000	35	2,000	1,500	1,433	148	9.6	525	55	9.5
Iowa State College	210,000	140,286	2,000		1,600	1,300				1,098	108	10.1
[14]Wellesley College	438,493	136,586	1,900			1,350				1,209	118	10.2
Vassar College	483,000	129,500	2,896			1,690				996	81	12.2
Kansas State College	393,500	129,100	2,140	34.5		1,435				1,034	69	14.9
Indiana Univ.	215,000	129,000	2,400	35	1,707	1,200						
Purdue Univ.	255,000	128,920	2,200			1,800	1,713	124	13.8	1,605	119	13.4
Oberlin College	223,729	128,400	1,941	33		1,250	1,406	109	12.8	803	44	18.2
Univ. of Cincinnati	254,699	123,141	3,000	35	2,000	1,300	994	120	8.2	638	52	12.2
Armour Institute	215,000	123,000	2,150	35	1,682	1,328				622	62	10
Univ. of Virginia	202,190	122,960	3,100	35		1,425	785	91	8.6	467	61	7.6
Univ. of Washington.	202,000	122,400	1,950		1,700	1,450	1,061	72	14.7	907	64	14.1
Westrn. Reserve Univ.	179,661	116,141	2,700		1,880	1,790	914	155	5.8	566	53	10.6
Agric. Col. of Utah	130,566	115,400	1,800	35		1,300				530	55	9.6
[15]Brown Univ.	214,198	114,630	2,680	37	1,843	4,389				924	81	11.4
Washington Univ.	158,051	114,034	2,471			1,400	1,124	174	6.4	331	45	7.3
West Virginia Univ.	200,000	110,000	2,080	35	1,600	1,350	667	62	10.7	284	41	6.9
Michigan State Col.	325,000	110,000	2,300	34	2,000	1,200				683	78	8.7
Lehigh Univ.	166,500	107,000	2,137	30		1,537				674	75	11.8

TABLE II—*continued*

Degree-conferring Institutions in the United States and Canada Appropriating Annually $45,000 or over for the Total Payment of the Salaries of their Instructing Staffs [11]

Institution	Total Annual Income	Annual Appropriation for Salaries of Instructing Staff	Average Salary of Professor	Average Age at Entrance to Grade of Professor	Average Salary of Associate Professor	Average Salary of Assistant Professor	Total Number of Students in University	Total Instructing Staff in University	Ratio	Total Number of Students in Undergraduate Colleges and Nonprofessional Graduate Schools	Total Instructing Staff in Undergraduate Colleges and Nonprofessional Graduate Schools	Average Salary $2,048. Cost per Student $280. Ratio
Bryn Mawr College...	$126,808	$106,687	$2,500		$2,000	$1,500				362	47	7.7
Tufts College............	180,000	104,600	1,870			1,375	1,083	198	5.4	453	45	10
George Wash. Univ...	189,643	101,610	1,693	32.5		1,094	1,258	196	6.4	643	82	7.8
Penna. State College..	251,920	97,190	2,010			1,390				784	81	9.6
Univ. of Colorado......	175,000	95,000	2,050	32		1,400	840	112	7.5	726	57	12.7
Williams College......	168,000	95,000	2,714	32	2,100	1,730				475	58	8.1
Clemson Agric. Col...	271,720	93,650	2,100		1,800	1,400				658	41	16
Univ. of Utah..........	156,000	85,653	1,881		1,900	1,700	565	50	11.3	390	39	10
Amherst College.......	133,214	85,500	2,853	36	1,700	1,566				513	38	13.5
Vanderbilt Univ.......	169,000	83,000	2,800		1,900	1,400	902	110	8.1	342	44	7.7
Boston Univ............	186,484	82,340	2,419	35		1,628	1,428	150	9.5	519	34	15.2
[14]Mount Holyoke Col.	225,000	81,000	1,350	40		1,100				711	87	8.1
State Col. of Wash....	130,000	80,000	1,750	35	1,700	1,400				1,100	65	16.9
[12]Univ. of Tennessee..	153,877	78,000	2,000	39	1,600	1,300	694	106	6.5	353	34	10.3
Western Univ. of Pa..	137,139	76,617	1,864	38			966	144	6.7	187	23	8.1
Texas College..	160,000	74,000	2,000			1,300				623	52	11.9
Univ. of North Car...	104,121	72,326	1,975			1,242	731	73	10	483	48	10
State Univ. Oklahoma	110,000	72,274	1,800			1,400	394	36	10.9	201	28	7.1
Clark Univ..............	145,000	70,000	3,000			1,650				159	37	4.2
Stevens Inst. of Tech.	108,000	69,000	3,200			2,000				429	42	10.2
Univ. of Maine.........	135,000	69,357	1,800	34	1,500	1,200	702	74	9.4	514	50	10.2
Drake Univ.............	101,856	67,849	1,500	32		1,000	866	93	9.3	515	20	25.7
Miami Univ.............	113,000	66,300	2,000		1,650	1,150	570	41	13.9	313	28	11.1
Ohio Wesleyan Univ.	165,000	66,000	1,800		1,300	850	1,178	119	9.8	580	43	13.4
Univ. North Dakota..	153,136	65,500	2,200	35		1,550	425	49	8.6	230	30	7.6
Wesleyan Univ.........	123,000	65,000	2,575	33		1,750				316	29	10.8
Alabama Polyt. Inst..	92,000	65,000	2,000		1,700	1,500				543	50	10.8
Worcester Polyt. Inst..	89,594	61,107	2,369			1,725				465	46	10.1
Simmons College......	127,024	61,000	2,900		2,266	1,660				545	59	9.2
Colgate Univ............	114,532	60,930	1,740			1,500				287	24	11.9
Va. Polytechnic Inst.	118,000	60,764	1,980	33		1,260				577	57	10.1
Case Sch. Applied Sci.	145,500	60,205	2,861	32.5		1,443				440	40	11
Ohio Univ................	165,000	60,160	1,900	25	1,600	900	1,224	38	32.2	414	21	19.7
Union Univ.............	110,126	60,159	2,300	35		1,400	627	108	5.7	270	33	8.1
Univ. of Vermont.....	105,000	60,000	2,100	35	1,650	1,375	497	65	7.6	345	37	9.3
Rensselaer Poly. Inst.	110,400	58,721	3,300	35	2,500	1,800				485	29	16.8
Howard Univ...........	91,555	58,619	1,837	32.5		1,000	785	92	8.5	265	17	10.1
Queen's University...	88,221	58,351	2,000			1,200	1,134	80	14.1	914	48	19
Univ. of Mississippi...	105,000	57,300	2,000		1,325	1,000	344	28	12.2	274	24	11.4
Univ. of S. Dakota...	80,000	56,000	1,650			1,100	359	44	8.1	173	18	9.6
Swarthmore College..	84,000	55,335	2,100			1,400				332	36	9.2
Ga. Sch. Technology.	82,500	55,000	1,945			1,000				562	42	13.3
Univ. of Idaho.........	99,639	54,920	1,800			1,581				231	28	8.2
Temple College.........	72,895	54,272	1,500	35			2,343	198	11.8	199	31	6.4
Radcliffe College......	90,000	53,000	[16]									
Rutgers College........	87,000	53,000	2,300			1,600				255	34	7.5
North Dakota College	114,000	52,150	2,000	30		1,300				820	33	24.8

TABLE II—*continued*

Degree-conferring Institutions in the United States and Canada appropriating Annually $45,000 or over for the Total Payment of the Salaries of their Instructing Staffs [11]

Institution	Total Annual Income	Annual Appropriation for Salaries of Instructing Staff	Average Salary of Professors	Average Age at Entrance to Grade of Professor	Average Salary of Associate Professor	Average Salary of Assistant Professor	Total Number of Students in University	Total Instructing Staff in University	Ratio	Total Number of Students in Undergraduate Colleges and Nonprofessional Graduate Schools	Total Instructing Staff in Undergraduate Colleges and Nonprofessional Graduate Schools	Average Salary $2,048 Cost per Student $280 Ratio
Wash. and Lee Univ.	$70,000	$50,000	$2,600	35		$1,500	468	35	13.3	385	32	12
State Univ. of Ky.....	90,247	49,250	2,000	33		1,200				466	43	10.8
James Millikin Univ.	64,003	49,160	1,400	30		1,000				231	32	7.2
N. Carolina College...	114,000	49,000	2,000	30		1,240						
Montana State College	133,000	48,650	1,800			1,500				291	32	9
Univ. of Oregon.......	60,000	47,927	1,800	40		1,400	570	87	6.5	340	34	10
Haverford College.....	78,650	45,300	3,440	35		2,240				143	22	6.5
Univ. of Rochester...	60,334	45,000	2,383			1,750				340	21	16.1

[11] The data for instructors and assistants are omitted.

[12] Not including Medical School.

[13] Including the preceptors as assistant professors.

[14] Including payments of students for board.

[15] Most of the faculty receive a small extra compensation for teaching at the Women's College.

[16] Faculty consists of members of the faculty of Harvard University, paid a certain amount per course.

[17] Law students are not classified separately from collegiate undergraduates.

[18] A combination of the average salary of associates, $1,469, and the average salary of instructors, $1,050.

[19] Professors who are heads of departments receive on an average $5,800.

The Presbyterian Synod of Tennessee (north) elects the trustees of Maryville College, and also the trustees of Greenville and Tusculum Colleges. Washington College, while its trustees are not elected by the synod, is a Presbyterian institution. All three of these colleges are located in the mountainous region of East Tennessee. The Northern Presbyterian Church, through its recent union with the Cumberland Presbyterian Church, has also come into possession of Cumberland University in Central Tennessee. The Southern Presbyterian Church has a university in West Tennessee. If all of these institutions are really devoted to higher education, it is evident that one or more of them are superfluous. Throughout the country there are numerous instances of single bodies in one denomination, like the Northern Presbyterian Synod of Tennessee, having within their own limited area more than one college or university. There is something pathetic in the devotion which is poured into some of these unnecessary colleges. One finds an institution in which the few college students who come are instructed by perhaps a single competent teacher, assisted by professors who are young boys just out of college. The salaries are pitifully small, the "dean" in such a college sometimes receiving not more than $800 a year and the professors $50 a month. The small endowment which has been given suffices to keep the institution alive and there is often poured into it a large measure of sincere but misguided devotion, the more to be regretted because the students who come to such an institution can usually

TABLE IX

Data concerning Partial List of Institutions in which Annual Expenditure for Instructing Salaries Ranges from $10,000 to $45,000

Institution	Total Annual Income	Annual Appropriation for Salaries of Instructing Staff	Average Salary of Professor	Average Age of Entrance to Grade of Professor	Average Salary of Associate Professor	Average Salary of Assistant Professor	Total Number of Students in Institution	Total Instructing Staff in Institution	Ratio	Total Number of Students in College	Total Instructing Staff in College	Ratio
Iowa College	$60,000	$44,250	$1,500	33	$1,000	$ 950	[21]553	35	15.8	450	31	14.5
Polytech. Inst., Brooklyn.	59,000	43,150	2,783			1,234				250	40	6.2
University of the South	60,845	42,836	1,500	35		1,100	[21]317	34	9.3	119	11	10.8
DePauw University	67,000	42,750	2,000			850	[21]753	35	21.5	548	25	21.9
Pomona College	50,000	42,000	1,500			[22]1,050	[21]317	31	10.2	267	23	11.6
Lafayette College	77,142	40,374	2,000			1,370				442	36	12.2
Bowdoin College	72,063	39,550	2,000	30		1,350	394	53	7.4	305	20	15.2
University of Wyoming	84,299	39,080	1,900	34	1,700	1,500	[21]222	30	7.4	110	21	5.2
Colorado College	[20]60,000	38,000	1,775			1,056	[21]607	44	13.7	407	31	13.1
Dickinson College	61,748	37,576	1,700	33		[22]1,200	392	26	15	314	18	17.4
Adelphi College	54,000	37,575	2,000			1,400	[21]463	27	17.1	295	24	12.2
University of Arizona	90,000	37,300	1,900			1,200				[21]63	[23]7	9
Univ. of South Carolina	72,857	36,730	2,000		1,500	1,200	[21]285	29	9.8	191	18	10.6
Cornell College	55,436	36,702	1,220	32		[22]900	[21]455	39	11.6	395	27	14.6
Woman's Col., Baltimore.	67,151	36,450	1,818	32.5		[22]1,167				340	28	12.1
Trinity College, Conn.	43,045	36,250	2,000			1,400				208	22	9.4
Beloit College	75,000	35,000	1,600	32		1,200				303	30	10.1
Wash. and Jeff. College	46,880	34,500	1,823							264	16	16.5
Allegheny College	47,000	34,200	1,800	34		1,200				266	19	14
Lawrence University	43,000	34,000	1,400	31		950	[21]493	33	14.9	327	26	12.5
Dalhousie University	40,240	33,500	2,300			[22]1,500	358	48	7.4	266	21	12.6
Trinity College, N. C.	63,000	33,060	1,850			750	[21]280	26	10.7	264	23	11.4
Lake Forest College	41,165	32,932	1,800	33		1,300	[22]			[21]217	19	11.4
Rand.-Mac. Woman's Col.	[24]130,713	32,707	1,639	37.5		[25]1,307	[26]358					
Hamilton College	50,000	32,500	1,800			1,300				178	19	9.3
Rose Polytechnic Institute	43,756	31,600	2,250	37.5	1,800	1,200				229	23	9.9
Colorado School of Mines.	110,000	30,500	2,233			1,550				[22]294	17	17.2
University of Wooster	43,057	31,380	1,500	37.5		[21]1,100	547	34	16	362	28	12.9
University of Montana	71,500	30,100	1,800				[22]247	20	12.3	189	19	9.9
Olivet College	46,600	29,200	1,300	35		1,000	[22]255	29	8.7	211	20	10.5
Albion College	37,078	28,775	1,550	30		900	[22]383	25	16.1	239	17	14
Kenyon College	[27]47,000	[27]28,500	1,600	32.5						118	15	7.8
College of Wm. and Mary	43,000	28,495	1,800			[21]1,000						
Mt. St. Mary's College	50,000	28,000	[28]1,000			[28]400						
Bates College	39,167	26,500	1,433	32						438	23	19
Wilson College	[24]110,000	26,500	[28]1,000	32		[28]900	[22]344	34	10.1	240	22	10.9
Earlham College	58,000	24,000	1,550	30			[22]380	31	12.2	325	27	12
Wabash College	41,608	23.550	1,600			930				[22]291	17	17.1
Carleton College	34,900	23,150	1,400	32		[21]1,300	[22]315	20	15.7	281	17	16.5
Colby College	56,939	23,033	1,800	32.5		[21]1,350				[22]237	15	15.8
Marietta College	24,244	22,670	1,433			[21]1,120	275	21	13	129	16	8
Centre College	32,369	21,827	1,600	30						[22]154	20	7.7
Hobart College	37,200	21,657	1,700	35	1,400	1,100				104	16	6.5
Wells College	[24]90,041	21,150	1,600	36.5	1,275	900				169	24	7
Drury College	29,000	21,000	1,400			687	[22]461	21	21.9	269	14	19.2
Coe College	28,137	20,989	1,200	30		700				[22]206	28	7.3
Ripon College	47,100	20,900	1,336			800	[22]201	24	8.3	157	20	7.8

TABLE IX—*continued*

Data concerning Partial List of Institutions in which Annual Expenditure for Instructing Salaries Ranges from $10,000 to $45,000

Institution	Total Annual Income	Annual Appropriation for Salaries of Instructing Staff	Average Salary of Professor	Average Age of Entrance to Grade of Professor	Average Salary of Associate Professor	Average Salary of Assistant Professor	Total Number of Students in Institution	Total Instructing Staff in Institution	Ratio	Total Number of Students in College	Total Instructing Staff in College	Ratio
Middlebury College	$28,491	$20,160	$1,870	32						[22]178	11	16.1
Penna. Col. for Women	41,000	20,000	[28]900	28						45	10	4.5
Elmira College	38,139	18,672	[28]1,000	30			278	17	16.3	197	12	16.4
Monmouth College	36,967	18,500	1,270	35		$1,075	[22]425	25	17	233	18	12.9
Franklin College	37,552	15,000	1,350	28			[22]214	15	14.2	160	13	12.3
Clarkson Me. Sch. of Tech.	24,540	11,950	1,350							[22]80	11	7.2
Knox College	28,012	11,509	1,400	32		1,200	[22]521	27	19.2	224	19	11.7

[20] Interest at 5 per cent. on $500,000 additional endowment will be available in 1909.

[21] Entitled "associate professors."

[22] Catalogue for 1906–7.

[23] Exclusively in college.

[24] Including payments of students for board.

[25] Entitled "adjunct professors."

[26] Catalogue does not separate the students in the department of music, of art and of physical culture from the students in the college.

[27] Including Bexley Hall, the theological seminary.

[28] Also board, apartments and laundry.

find much better instruction in near-by colleges, or high schools, where the teaching staff is stronger, the facilities better, and the temptations to low standards are not present. In some parts of the union, colleges which are only high schools are fulfilling a most useful educational function. It might well be considered by these latter colleges, however, whether it would not be better for education in general, and more dignified on their part, for them to discontinue granting the college degrees, and frankly call themselves high schools or academies or junior colleges.

At an early date the foundation hopes to present a thorough study of the institutions of higher learning in several states from the point of view of the area, population, material resources and probable expansion of each state. There are states whose territory is so great or which are so divided by natural barriers that duplicate institutions may be justified, just as there are states whose citizens are justified in thinking more in terms of the future than of the present. All these things should be taken into account in estimating the field of higher education within a single state.

Occasionally in this paper figures will be given and comparisons made which might be considered to imply criticism of the internal administration of institutions. It must be remembered in this connection that there has been but little study in comparative college economics. It would seem that colleges and universities have managed their finances and drawn up their budgets with slight knowledge of similar problems in other colleges and universities. Data on this subject were not easily obtainable. But from the data collected it is evident that widely differing systems of administration prevail.

Table II. does not contain the names of all the colleges and universities in the United States and Canada which pay $45,000 or over in salaries annually to their instructing staffs, because some such institutions did not answer inquiries of the foundation, or return answers in a form available for statistical purposes. The table contains the names of one hundred and three colleges and universities in the United States and Canada which have given specific information that their total payments in instructing salaries exceed $45,000 annually.[10a]

THE TEACHING OF MATHEMATICS TO ENGINEERING STUDENTS IN FOREIGN COUNTRIES[1]

YOUR committee has asked me to speak of the teaching of mathematics in foreign engineering colleges. My remarks will have reference almost exclusively to the German colleges and schools, partly because I am most familiar with the conditions existing in Germany and partly on account of the rather instructive campaign for reforming the whole teaching of mathematics, recently inaugurated in Germany.

As regards other countries I will only say that the situation in England and Scotland where, during the last quarter of a century, technical education has rapidly developed on quite characteristic and individual lines, deserves careful attention. But I am not sufficiently well acquainted with the facts to discuss this educational movement. In France, it is well known that the theoretical training given to engineers is on a very high level, higher even than in Germany, I believe. Thus, the requirements for admission to the École Polytechnique, or even to the École Centrale, include in mathematics almost as much as our engineering students get in their college course. On the top of this preparation, the student receives in the École Polytechnique an excellent two years' course in higher analysis and theoretical mechanics, and then only is he allowed to enter upon his special technical work. It must also be taken into account that admission to the École Polytechnique is by competitive examinations held throughout France, so that this institution, receiving as it does the pick of students from the whole country, can maintain a high level of theoretical excellency. The École des Ponts et Chaussées and the École des Mines to which the student passes from the École Polytechnique, are thus what we might call graduate schools of the highest rank.

Turning now to the German engineering colleges, a comparison with our own best engineering colleges shows apparently but little difference, both as regards requirements for admission and as to the schedule of courses offered in the schools themselves. Nevertheless, I believe that the scientific standard is decidedly higher in the German than in the American engineering college. I am not here concerned with the question whether such a high standard of theoretical knowledge is essential, or even desirable, for the engineer; I merely state the fact. Moreover, it is quite possible that ultimately the average German engineer knows no more mathematics than the average American engineer. All I wish to maintain is that, in my opinion, an able German student, in his Technische Hochschule, or engineering university, can gain a more thorough scientific equipment than an equally able American student in his alma mater.

[10a] The data for instructors and assistants are not reproduced.—ED.

[1] Read before Sections A and D, American Association for the Advancement of Science, and the Chicago Section of the American Mathematical Society, Chicago meeting, December 30, 1907.

The mathematical requirements for admission are about the same in Germany as with us: algebra, geometry, trigonometry. Not a few students now enter the German engineering college with some knowledge of analytic geometry and even of calculus, but many still come without this knowledge. The important point is that the preparatory training in mathematics (including arithmetic) is distributed systematically and continuously over a period of nine years. The same is true of other preparatory studies. It is obviously quite impossible to attain in a four-year high-school course the results attained in the nine-year course of a German Gymnasium, Realgymnasium, or Oberrealschule. This difference in preparation must always be kept in mind in making comparisons between German and American universities.

The mathematical courses offered in the German engineering colleges and required for a degree cover plane and solid analytic geometry, differential and integral calculus and differential equations—*i. e.*, about the same subjects that are required in this country. The subject of theoretical mechanics, which is treated rather differently in different schools, and even in the same school for different degrees, I shall here leave out of consideration, for the sake of simplicity. The amount of time devoted to the higher mathematics, not including mechanics, appears roughly from the following table, in which the first figure in each case gives the number of hours per week devoted to lectures, the second the number of hours devoted to "exercises." These exercises are a comparatively recent innovation. In my time the student had nothing but lectures; to gain a working knowledge of the subject he had to take a text-book and work for himself. Even now, these exercises are optional; they probably exist everywhere, although the table may not show them. There are no periodic examinations such as we have at the end of each semester; but most students take at the end of their course the Staatsexamen, or if particularly ambitious, the Diplomexamen. The lectures in mathematics are rather more advanced and more complete than those in our engineering colleges. But the requirements in the final examinations are not very high.

	First Semester	Second Semester	Third Semester	Fourth Semester	Total
Karlsruhe.........	6+2	6+2	3	2	17+4
Stuttgart...........	7+3	6+4	3+1	......	16+8
Munich.............	6+3	6+2	5+2	2+2	19+9
Hannover..........	8+1	6+2	......	......	14+3
Danzig..............	6	5	4+1	3+1	18+2
Braunschweig ...	8+2	6+2	2	......	16+4
Zürich	8+4	8+4	4+1	.....	20+9

In addition to the more thorough preparation of the German student and to the somewhat higher standard of the lectures on pure mathematics, and largely owing to these circumstances, the treatment of applied mathematics is, I believe, on a higher level in Germany than in this country. The student is better prepared; no time is lost in "recitations," *i. e.*, in trying to find out whether the student has committed things to memory; the professor is thus enabled to treat scientific questions scientifically. Besides, on an average, the German professor of an engineering subject has himself a higher degree of scientific training and is more interested in the mathematical, and in general the scientific, aspects of his subject than his American colleague.

It is of course always hazardous and, moreover, of little use to make such general statements and comparisons; and I do not wish to attach any great importance to them. Neither the German nor the American engineering college is as good as it might be or should be; no institution ever is; an institution is good only in so far as it is continually changing, developing, rising. The above comparisons are, therefore, given merely as a basis for better understanding the efforts that are now made in Germany for the improvement of mathematical teaching in all its phases. To these efforts I wish to call your special attention.

The German movement for the reform of the teaching of mathematics is of a somewhat complex nature; at least three different movements may be distinguished. One of these, originating with the German association of engineers (Verein deutscher Ingenieure) had as its direct object the improvement of the mathematical instruction in the engineering colleges, with a view to making the instruction less abstract and theoretical and more practically useful to the engineer. To a certain extent, this object has been attained. Practical exercises for acquiring a working knowledge of mathematics have been introduced everywhere, and the lectures on pure mathematics have become less theoretical. Some of the originators of this movement, especially Professor Riedler, of the Charlottenburg College, went so far as to demand that in engineering colleges mathematics should be taught by engineers. Whether or not this was meant as more than a threat I do not undertake to say; certainly, as far as my knowledge goes, no attempt has ever been made in a German engineering college to put the teaching of mathematics in the hands of any one but a trained mathematician. But I believe that in the selection of men for such positions more attention has been paid in recent years to the qualifications of the aspirants; mathematicians with a bent towards applied science being given the preference for positions in engineering colleges.

The second of the three movements referred to above has for its object the reform of the teaching of mathematics in the universities. It is the oldest of these movements, and has borne fruit in a variety of ways. But I can here only advert to it very briefly. The tremendous creative mathematical activity that characterized the last three quarters of the nineteenth century in Germany led to a condition in the universities that was injurious to the preparation of teachers for the secondary schools (Gymnasium, Realgymnasium, Oberrealschule). Too much stress was laid on leading the student as fast as possible to original research in some special line. The system has been described as a system, not of double entry, but of double forgetting; upon entering the university the students, most of whom are fitting for teaching in the secondary schools, are made to forget and almost despise the more elementary mathematics, and when beginning their professional teaching career they are again compelled to forget as fast as possible all the higher and highest mathematics to which they had devoted most of their time at the university. The remarkable development of mathematical activity in our country during the last fifteen or twenty years may bring about a similar situation. Fortunately, the leaders of American mathematics are well aware of the danger of losing the healthy contact with the more elementary mathematics and with applied science. Of course, it is, and always will be, the chief object of a real university to foster original research and productive scholarship. But it is well even for the most advanced specialist not to burn the bridges behind him, but to keep in mind the connection of his specialty with the foundations of knowledge, on the one hand, and with kindred branches of science on the other. As Sir Isaac Newton expressed it in his quaint way in a letter to Dr. Lord: "He that in ye mine of knowledge deepest diggeth, hath, like every other miner, ye least breathing time, and must sometimes at least come to terr, alt for air."

The desire to make the university teaching of mathematics more practically useful and bring it into live contact, as far as possible, with the whole tendency of modern scientific thought led, on the one hand, to a strengthening of all branches of applied mathematics, not only by courses offered in the universities, but also by such publications as the Encyklopädie, which includes applied mathematics in the widest application of the term; on the other, it led to reforms in the courses offered to future teachers of mathematics, and ultimately to a thorough investigation of the teaching of elementary mathematics in the secondary schools of Germany.

The improvement of the teaching of elementary mathematics is the aim of the third and most recent mathematical reform movement in Germany. The reforms proposed in this connection by the committee of the German Association of Naturforscher und Aerzte, at the Meran meeting, in 1905, appear to me to deserve very careful consideration. They would apply, in this country, to the teaching of mathematics not only in the high schools, but just as much in the engineering colleges. For, with the preparation that our students actually have, I am convinced that the best method of imparting a good working knowledge of the elements of analytic geometry and calculus is not through lectures, but through actual teaching based mainly on solving problems, that is, by the methods not of the German university, but of the German secondary school.

The proposals of the committee[2] do not change very essentially the number of hours required for mathematics. These are to be: in the Gymnasium as well as in the Realgymnasium, four hours per week in each of the nine years; in the Oberrealschule generally four hours per week, in the third and fourth years six hours. The first three years are devoted to common arithmetic and intuitional geometry, the next three years to algebra and geometry carried along together, the last three years to advanced algebra, trigonometry, advanced geometry, conic sections (treated synthetically and analytically) and, in the Oberrealschule, the elements of the calculus. Apart from matters of detail this distribution does not vary very much from the practise now followed in the best Prussian schools.

While thus the general program can not be said to constitute a radical departure from existing conditions, the statement of what should be the principal aim of mathematical teaching and the indications given for carrying out this aim throughout the whole course[3] appear to me as the most important features of the report. In addition to the well-recognized object of mathematical teaching to train the mind in rigorous logical reasoning the report insists particularly on the training of geometrical intuition and on acquiring the habit of functional thinking. The carefully prepared explanations accompanying the detailed program for the nine-year course show how these aims should guide the instruction at every step. The insistence on the idea of the functional relation can not be recommended too strongly to our writers of college text-books, from trigonometry to differential equations. But, as this report demands, it should even enter into the very elements of algebra and geometry.

It should be observed that the committee that prepared this report was not composed of mathematicians only; all branches of science taught in the secondary schools were represented in it; and all these branches received equally careful attention. While the portion of the report devoted

[2] See *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht*, Vol. 36 (1905), pp. 533–580.

[3] *Loc. cit.*, pp. 543–545, 550–553.

to mathematics covers almost the whole range of the subject, from arithmetic to the elements of the calculus, required of our engineering students, there is nowhere any reference to students of engineering or to any other special class of students. I might, therefore, appear out of order in speaking of this report at the present occasion. But I wish to say most emphatically that, in my opinion, there is no special "mathematics for engineers"; nor is there any method of teaching mathematics, specially adapted to engineering students. If it is wrong to present mathematics in a form so abstract as to make it unintelligible to the student, it is just as wrong to present the results of mathematics in a form so concrete as to reduce the science to a mere art of performing certain mechanical operations, to make it, as the saying goes, a mere tool, and not a habit of thinking.

In conclusion allow me to say that I should be the last to advocate a remodeling of our institutions of learning on the German plan, or the French plan, or any other existing plan. But I believe that the time has come in this country when one or two years of general college study can be demanded as preparation for the professional engineering course, at least for those more able students who wish to obtain a thoroughly scientific preparation for their professional career. An opportunity should then be offered to students of engineering of scientific ability to extend their knowledge on the theoretical side.

Alexander Ziwet
University of Michigan

THE BRITISH BUREAU OF SLEEPING SICKNESS

The British Colonial Office has issued the following statement:

At the instance of the late secretary of state for the colonies and with the cooperation of the government of the Sudan and the Royal Society, his majesty's government have decided to establish in London a bureau for the collection and general distribution of information with regard to sleeping sickness. The Royal Society will find accommodation for the bureau at Burlington House, and one fourth of the cost of up-keep will be borne by the Sudan government.

The bureau will be under the general control and direction of an honorary committee of management, appointed by and responsible to the secretary of state for the colonies. The committee will be composed of the following: Chairman, the Right Honorable Sir J. West-Ridgeway, G.C.B., who is also chairman of the advisory committee of the tropical diseases research fund; Sir Patrick Manson, M.D., K.C.M.G., F.R.S.; Sir Rubert Boyce, F.R.S.; Dr. Rose Bradford, F.R.S. (representing the Royal Society); Colonel D. Bruce, C.B., F.R.S.; Mr. E. A. Walrond Clarke (representing the foreign office); Mr. H. J. Read, C.M.G. (representing the colonial office), with Mr. R. Popham Lobb, of the colonial office, as secretary.

The main function of the bureau, which will be administered by a paid director, will be to collect from all sources information regarding sleeping sickness, to collate, condense, and, where necessary, translate this information, and to distribute it as widely and quickly as possible among those who are engaged in combating the disease. The publications of the bureau will be divided into two categories, viz., scientific publications intended for those who are engaged in research work or in carrying out medical administration in the infected districts, and publications of a less technical character for the use of government officials, missionaries and others, whose duties involve residence in those districts. One important piece of work will be the preparation of a map of the whole of tropical Africa, showing the distribution of the disease and of the different species of blood-sucking insects which are suspected of conveying it. A map of this kind showing, as it would, the extent to which the distribution of the disease coincides with the distribution of the different species of insects, is expected to supply valuable information to scientific investigators and to give guidance to the different administrations, by indicating the lines of advance of the disease and the districts which require special protective measures. The duties of the director of the bureau will for the present be undertaken by Dr. A. G. Bagshawe, of the Uganda Medical Staff.

BEAUPERTHUY ON MOSQUITO-BORN DISEASES

Dr. Agramonte, in an article quoted from the Havana *Cronica Medico* by the *British Medical Journal,* calls attention to the pioneer work of Louis Daniel Beauperthuy, born in Guadeloupe in 1808. Writing in the *Gaceta Oficial de Cumanà* in May, 1853, Beauperthuy says:

To the work I undertook (health officer in a yellow fever epidemic in Cumanà) I brought the knowledge gained during fourteen years' microscopic observation of the blood and secretions in every type of fever. These observations were of great service to me in recognizing the cause of yellow fever and the fitting methods of combating this terrible malady. With regard to my investigations on the etiology of yellow fever I must abstain for the present from making them public. They form part of a prolonged study, the results of which are facts so novel and so far removed from all hitherto accepted doctrines that I ought not to publish them without adducing fuller evidence in support. Moreover, I am sending to the Académie de Paris a communication which contains a summary of the observations I have made up to the present, the object of which is to secure the priority of my discoveries concerning the cause of fevers in general. . . .

The affection known as yellow fever or black vomit is due to the same cause as that producing intermittent fever.

Yellow fever is in no way to be regarded as a contagious disease.

The disease develops itself . . . under conditions which favor the development of mosquitos.

The mosquito plunges its proboscis into the skin . . . and introduces a poison which has properties akin to that of snake venom. It softens the red blood corpuscles, causes their rupture . . . and facilitates the mixing of the coloring matter with the serum.

The agents of this yellow fever infection are of a considerable number of species, not all being of equally lethal character. *The zancudo bobo,* with legs striped with white, may be regarded as more or less the house-haunting kind. . . .

Remittent, intermittent and pernicious fevers, just like yellow fever, have as their cause an animal, or vegeto-animal virus, the introduction of which into the human body is brought about by inoculation.

Intermittent fevers are grave in proportion to the prevalence of mosquitos, and disappear or lose much of their severity in places which, by reason of their elevation, have few of these insects.

The expression "winged snakes" employed by Herodotus is peculiarly applicable to the mosquito and the result of its bite on the human organism.

Marshes do not communicate to the atmosphere anything more than humidity, and the small amount of hydrogen they give off does not cause in man the slightest indisposition in equatorial and intertropical regions renowned for their unhealthiness. Nor is it the putrescence of the water that makes it unhealthy, but the presence of mosquitos.

It was to the *Gaceta Oficial de Cumanà* that Beauperthuy seems to have written most fully, but he made more than one communication to the Académie des Sciences. One of these, dated from Cumanà, January 18, 1856, is entitled "Researches into the Cause of Asiatic Cholera and into that of Yellow Fever and Marsh Fever," and in this he says that as early as 1839 his investigations in unhealthy localities in South America had convinced him that the so-called marsh fevers were due to a vegeto-animal virus inoculated into man by mosquitos.

SCIENTIFIC NOTES AND NEWS

Oxford University has conferred its doctorate of science on Dr. F. Raymond, of the Hôpital de la Salpêtrière, professor in the University of Paris; J. J. Harris Teall, M.A., F.R.S., director of H.M. Geological Survey; and James Ward, ScD., fellow of Trinity and professor of mental philosophy in Cambridge University.

Dr. Birkeland, professor of physics at Christiana, has been given the honorary degree of doctor of engineering by the Technological Institute of Dresden.

Sir George Darwin, K.C.B., F.R.S., has been elected a foreign member of the Amsterdam Academy of Sciences.

Sir William Ramsay has been elected a foreign member of the Società italiana delle Scienze.

Dr. Max Rubner, professor of hygiene at Berlin, has been awarded the Liebig gold medal by the Bavarian Academy of Sciences for his work in veterinary science.

The twenty-fifth anniversary of the connection of Professor A. Ceccherelli with the surgical clinic at Parma, Italy, was celebrated on June 24. A "Festschrift" was presented by his friends and pupils, and two albums, with autographs of colleagues at home and abroad and a gold plaque.

Dr. August Schuberg, associate professor of zoology at Heidelberg, has been appointed director of the laboratory for protozoa in the Berlin Bureau of Health.

Dr. Adolf Meyer, recently elected director of the psychiatric clinic of the Johns Hopkins University endowed by Mr. Henry Phipps, will shortly visit Europe with the architect of the new buildings to inspect foreign psychiatric clinics.

Dr. J. H. Musser, Philadelphia, is chairman of the national committee for the United States of the sixteenth International Medical Congress, to be held in Buda-Pesth next year.

The United States government will be represented at the fourth Latin-American Scientific Congress to be held at Santiago, Chili, next September by W. H. Holmes, Bureau of American Ethnology; Col. W. C. Gorgas, United States army; Professor Bernard Moses, University of California; Professor William B. Smith, Tulane; Professor Paul S. Reinsch, University of Wisconsin; Professor Leo S. Rowe, University of Pennsylvania; Professor William R. Shepherd, Columbia; Professor A. C. Coolidge, Harvard; and Professor Hiram Bingham, Yale.

As heretofore, there is this year at the summer session of Cornell University a series of lectures open to the public on Monday evenings through the session. These deal with the present problems in various sciences. The course was opened on July 6, by President Schurman, and other speakers in the course are Professors Nichols, Titchener and Dennis. On Wednesday evenings general lectures are given. Arrangements have been made for one by Professor Condra on the great irrigation projects of the government in the arid lands of the west, one by Mr. Charles W. Furlong on the remote regions of Patagonia, which he visited last winter, and another by Mr. Louis A. Fuertes on birds.

We learn from *Nature* that the council of the Royal College of Surgeons has given permission to Dr. Elliot Smith and Dr. Wood Jones, of the Cairo Medical School, to carry out, in the museum of the college, an examination of a collection of material found during excavations in the Nile Valley. The material is representative of peoples inhabiting Nubia in ancient times, and is expected to throw light on their pathology and the results of their surgery. The Egyptian government has expressed its willingness to present the collection of specimens to the museum of the Royal College of Surgeons.

The council of the Royal Society has awarded the Mackinnon studentships for the year 1908 as follows: One in physics to Mr. J. A. Crowther, of St. John's College, Cambridge, for an investigation of the passage through matter of the β rays from radioactive substances; one in biology to Mr. D. Thoday, of Trinity College, Cambridge, for a research into the physiological condition of starvation in plants and its relation to the responsiveness of protoplasm to stimulation, especially to stimuli affecting respiration.

The astronomical observatory and library founded in honor of Maria Mitchell, adjacent to her birthplace, on Nantucket, were formally dedicated on July 15.

William Dampier, the navigator, has been commemorated by a tablet placed in the parish church of his native village, East Coker, Somersetshire. It takes the form of a marble slab, bearing a brass plate with inscription recounting Dampier's geographical achievements, together with representations of the vessels and nautical instruments of his time. There is also a medallion portrait.

The German emperor has supported the medical and scientific men in Berlin in objecting to the form of the monument designed in honor of Virchow. It is not a statue of Virchow, but introduces as the chief group a symbolic representation of his lifework, in the form of a struggle between a giant and a fabulous beast, while on a pedestal a medallion portrait of Virchow is placed.

Dr. F. Noll, professor of botany at Halle, died on June 22 at the age of forty-nine years.

Dr. Oskar Liebreich, professor of pharmacology at Berlin, known for the introduction of hydrate of chloral in 1872 and for other important pharmacological work, has died at the age of seventy years.

The death is, also, announced of Professor Giuseppe Ponzio of the Royal Polytechnic Institute of Milan, an eminent Italian engineer.

The San Jacinto Valley in California will hereafter be known as the Cleveland National Forest. It has been so renamed by President Roosevelt in honor of the president under whose administration the first national forests were created. In 1897, in honor of Washington's one hundred and sixty-fifth birthday anniversary, and upon the recommendations of the National Academy of Sciences, President Cleveland created thirteen national forests, containing about 23,000,000 acres. The San Jacinto forest was one of the original thirteen so created.

The U. S. Civil Service Commission announces an examination on August 12–13, 1908, to fill a vacancy in the position of assistant, at $1,400 per annum, in the Naval Observatory, Washington.

Attempts are being made by the New Zealand government to preserve forms of the dominion's bird-life that are becoming rare. Mr. A. Hamilton, director of the Dominion Museum, in Wellington, has gone out into the forest-clad, mountainous districts of the north island to obtain specimens of the huia bird (*Heteralocha acutirostris*), which is one of the most interesting members of New Zealand's ancient avifauna. The Luia lives under parliamentary protection, but as its white-tipped tail feathers, which were formerly worn by the Maoris to denote aristocratic rank, are much sought after and command a high price, a good deal of destruction takes place. The birds obtained by Mr. Hamilton will be placed on some of the island bird sanctuaries established by the government.

The sub-Antarctic scientific expedition, which set out from New Zealand some time ago, and spent several weeks on the Auckland and Campbell Islands, south of New Zealand, is preparing a series of reports, dealing with terrestrial magnetism, ichthyology, geology, bird and insect life, botany and other branches of science. The New Zealand government has made a grant of £500 to cover the cost of publication, which will be undertaken by the state printing office. The reports will be printed in one large illustrated volume, which will be issued next year.

The Italian government has appropriated $3,000 as its annual share in the expenses of the central office, which the International Public Health Conference last December agreed to organize, with headquarters at Paris.

The fifth congress of the International Association for Testing Materials is to be held at the beginning of September, 1909, in Copenhagen.

The annual *conversazione* of the Institution of Electrical Engineers, London, was held on June 25 at the Natural History Museum, South Kensington. Colonel R. E. Crompton, the president, and Mrs. Crompton, and the council of the institution received the guests, who numbered about 1,700.

The Royal Meteorological Society arranged at the recent show of the Royal Agricultural Society, held at Newcastle-on-Tyne from June 30 to July 4, a meteorological section in connection with the agricultural education and forestry exhibition. This included various patterns of self-recording and other instruments, as well as diagrams relating to rainfall, temperature, sunshine, the influence of weather on crops, health, etc. A collection of photographs illustrating meteorological phenomena was also exhibited. A fully equipped climatological station, with the various instruments in position, was arranged in a railed-off enclosure outside the exhibition building; and an address on "Meteorology in Relation to Agriculture" was given each day by Mr. W. Marriott.

The first biennial convocation of the grand chapter of Alpha Chi Sigma, the professional chemical society for students in American universities, met on June 27 at the University of Wisconsin. The official delegates representing the seven universities on the chapter roll are as follows: Alpha chapter, University of Wisconsin, F. P. Downing; Beta, University of Minnesota, O. O. Whited; Gamma, Case School of Applied Science, Karl W. Ketterer; Delta, University of Missouri, L. S. Palmer; Epsilon, University of Indiana, W. B. Jadden; Zeta, University of Illinois, E. J. Bartells; Eta, University of Colorado, Frank J. Petura. This is the only fraternity of the kind that is national in its character, and it has been remarkably successful since its organization at the University of Wisconsin in 1902. The purpose is to promote good fellowship and closer relations between those interested in chemistry as a profession.

The United States National Museum has received as a gift from Mr. J. N. Léger, minister from Haiti to the United States, a case which contains models representing over a hundred different fruits of Haiti arranged for exhibition purposes. This collection of models of fruits and vegetables, which was exhibited at Jamestown, is probably the most complete series of its kind that has ever been prepared. The fruits of Haiti include many forms that are rarely seen in this country, and this set of models can not fail to be of interest. The following are the names of the most curious fruits of the island: cashew, ginger plant, mango, alligator pear, castor oil seed, custard apple, pomegranate, guava, tamarind, naseberry, and a large green bread fruit.

The Sunday Society, which exists to obtain the opening of museums, art galleries, libraries, and gardens on Sundays, has, says *Nature,* been making attempts, though as yet unsuccessfully, to secure the opening on Sundays of the science and art collections at the Franco-British Exhibition. The experience gained during the last twelve years would appear to show that the Sunday opening of national museums and galleries has been greatly appreciated, and that there has been no abuse of the privilege. The last published returns show that in 1906 the number of Sunday visitors to the British Museum was 57,738, an average Sunday attendance of 1,110; at the Natural History Museum for the same year the corresponding numbers were 61,151 and 1,176. In 1905 the number of visitors to the Victoria and Albert Museum on Sundays was 93,005, an average Sunday attendance of 1,755; the corresponding numbers in the same year for the Bethnal Green Museum were 74,990 and 1,415.

On May 23, as we learn from the London *Times,* took place the inaugural ceremony of the International Institute of Agriculture in the presence of his Majesty the King of Italy, who attended in state and formally opened the new building erected for the use of the permanent delegates. The Italian government was represented by seven ministers and the chief officers of state, while some 30 foreign delegates attended on behalf of the various countries which have promised their cooperation. Speeches were made by Signor Tittoni, the foreign minister, who welcomed the foreign delegates; by M. Vasconcellos, the Portuguese Minister, in reply, and by Senator Faina, who explained the history and aims of the institute. The foreign delegates were afterwards entertained at a dinner by the king in the Quirinal, at which there were present, among others, Sir Thomas Elliot (Great Britain), Sir Edward Buck (India), Mr. Rutherford (Canada), Mr. Taverner (Australia) and Boghos Nubar Pasha (Egypt). The new building is situated within the gardens of the Villa Borgese, on rising ground immediately upon the left of the main entrance. The architect, Signor Passerini, may be congratulated on having devised an edifice which is worthy of its beautiful surroundings; also on having wisely spared, as far as was possible, the pine trees which once crowned the height and still almost conceal the new palace from view. The palace, which is the gift of the King of Italy, is of considerable size, and contains meeting rooms, reception rooms, and private rooms for the delegates resident in Rome. All the fittings are of the most complete, even luxurious, character, and no money has been spared to ensure comfort as well as convenience. Besides the palace itself, King Victor Emmanuel has generously endowed the institute with an income of £12,000 a year, which, added to the contributions of those countries which have joined in the scheme, will make a total of about £40,000 a year to defray its expenses. The international character of the institute is already complete; every nation has given its adhesion, and, with few exceptions, has appointed its delegates. There is no need to explain again the aims of the institute, which have already been fully set out in the columns of the *Times*. It owes its existence, first, to the imagination of an American, Mr. Lubin, who started the idea; secondly, to the initiative of the King of Italy, who brought his influence to bear in order to realize it. Three years have not yet elapsed since the conference assembled in Rome, June, 1905, at the king's invitation, and already the institute has taken an actual and material shape. The rapidity of its first growth is a good augury for its future success.

A committee on the use of lead in the manufacture of earthenware and china has been appointed by the British home secretary. The committee is to consider the dangers attendant on the use of lead in pottery, and to report how far these can be obviated by improved appliances and methods in lead processes, by the limitation of the use of lead, by the substitution of harmless compounds for raw lead, or of other materials for lead, and by other means. The committee is also instructed to consider the danger and injury to health arising from dust or other causes in the manufacture of pottery, and the special rules regulating the decoration of earthenware and china. The members are: Mr. E. F. G. Hatch (chairman), Mr. A. Vernon Harcourt, F.R.S., Dr. George Reid, Mr. William Burton and Mr. Bernard Moore.

The Ohio state legislature has passed the following resolutions:

Whereas, the health of the nation is of paramount importance, and "our national health is physically our greatest national asset" (President Roosevelt) and,

Whereas, in the growth of nations it inevitably happens that the people are massed in large centers, thereby, if uncontrolled, creating unsanitary conditions destructive of life and health, and,

Whereas, such conditions can be removed and prevented only by the intelligent care and oversight of public health officials endowed with broad powers and necessary means for action, and,

Whereas, in the prevention of diseases by the enforcement of health measures by local officials in both urban and rural districts adequate results can be obtained only when such measures are soundly based upon well substantiated facts and observations in relation to sanitation and hygiene, and,

Whereas, the United States government, in ways impossible for the state and municipality, may gather information and conduct research work to determine the causes of disease and the best measures for their prevention, and by cooperation with state and local authorities may promote the health of all the people, and,

Whereas, the President in his Provincetown speech expressed the hope "that there will be legislation increasing the power of the national government to deal with certain matters concerning the health of our people everywhere," therefore,

Be it *Resolved* by the General Assembly of the State of Ohio, that the Congress of the United States be, and it is hereby memorialized and urged, to create and establish a National Bureau of Health, and endow it with power and funds commensurate with the highly important duties with which it will necessarily be entrusted; and,

Be it further *Resolved*, that the senators and members of the House of Representatives from Ohio, in the congress of the United States, be, and they are hereby requested, to urge congress to adopt such legislation as may be necessary to secure the establishment of said proposed bureau of health.

Resolved, that the secretary of the state of Ohio transmit immediately upon the passage of this resolution a copy thereof to the Senate and the House of Representatives of the United States, and to each of the representatives of Ohio therein.

A PRELIMINARY report of the consumption of pulp wood and the amount of pulp manufactured last year has just been issued by the Bureau of the Census. The advance statement is made from the statistics collected by the Census Bureau in cooperation with the United States Forest Service. Many of the figures bring out interesting facts which show the rapid growth of the paper-making and allied industries during the last decade. Nearly four million cords of wood, in exact numbers 3,962,660 cords, were used in the United States in the manufacture of paper pulp last year, just twice as much as was used in 1899, the first year for which detailed figures were available. More than two and one half million tons of pulp were produced. The pulp mills used 300,000 more cords of wood in 1907 than in the previous year. The amount of spruce used was 68 per cent. of the total consumption of pulp wood, or 2,700,000 cords. The increased price of spruce has turned the attention of paper manufacturers to a number of other woods, hemlock ranking next, with 576,000 cords, or 14 per cent. of the total consumption. More than 9 per cent. was poplar, and the remainder consisted of relatively small amounts of pine, cottonwood, balsam and other woods. There was a marked increase last year in the importation of spruce, which has always been the most popular wood for pulp. For a number of years pulp manufacturers of this country have been heavily importing spruce from Canada, since the available supply of this wood in the north-central and New England states, where most of the pulp mills are located, is not equal to the demand. Figures show that the amount of this valuable pulp wood brought into this country was more than two and one half times as great in 1907 as in 1889. In 1907 the importations were larger than ever before, being 25 per cent. greater than in 1906. The spruce imports last year amounted to more than one third of the consumption of spruce pulp wood. Only a slightly greater amount of domestic spruce was used than in 1906. Large quantities of hemlock were used by the Wisconsin pulp mills, and the report shows that the Beaver State now ranks third in pulp production, New York and Maine ranking first and second, respectively. Poplar has been used for a long time in the manufacture of high-grade paper, but the supply of this wood is limited and the consumption of it has not increased rapidly. Wood pulp is usually made by either one of two general processes, mechanical or chemical. In the mechanical process the wood, after being cut into suitable sizes and barked, is held against revolving grindstones in a stream of water and thus reduced to pulp. In the chemical process the barked wood is reduced to chips and cooked in large digesters with chemicals which destroy the cementing material of the fibers and leave practically pure cellulose. This is then washed and screened to render it suitable for paper making. The chemicals ordinarily used are either bisulphite of lime or caustic soda. A little over half of the pulp manufactured last year was made by the sulphite process, and about one third by the mechanical process, the remainder being produced by the soda process. Much of the mechanical pulp, or ground wood, as it is commonly called, is used in the making of newspaper. It is never used alone in making white paper, but always mixed with some sulphite fiber to give the paper strength. A cord of wood ordinarily yields about one ton of mechanical pulp or about one half ton of chemical pulp.

PROFESSOR H. W. CONN, of Wesleyan University, has sent to the press the manuscript of a new bulletin of the State Geological Survey, "The Algæ of the Fresh Waters of Connecticut," as a companion to a previous bulletin, "The Protozoa of the Fresh Waters of Connecticut." Professor Conn was assisted in the work by Mrs. L. H. Webster, a former graduate student. The bulletin contains over 300 illustrations by the two authors and Harold J. Conn (Wesleyan 1908), son of Professor Conn.

More than seventeen million pounds (17,211,000) of metallic aluminum were consumed in this country during last year, according to Mr. W. C. Phalen, of the United States Geological Survey, whose statistical report on the production of aluminum and bauxite has just been published by the survey as an advance chapter from Mineral Resources of the United States, Calendar Year 1907. This is an increase of 2,301,000 pounds over the consumption in 1906. The great increase in domestic production that was predicted in the early part of 1907 was not realized, and the failure of the predictions is attributed by Mr. Phalen, in large part at least, to the falling off in demand toward the close of the year as a result of general business depression. The output of bauxite, which finds its most important use as raw material for the production of metallic aluminum, increased almost 30 per cent. in quantity and a little over 30 per cent. in value in 1907 as compared with the quantity and value of the output in 1906. In the earlier year 75,332 tons, valued at $368,311, were produced; in the later, 97,776 tons, valued at $480,330. Although Arkansas still leads in the total production, the output from Georgia, Alabama and Tennessee increased in 1907 over 50 per cent., as compared with an increase of perhaps 20 per cent. in Arkansas. Bauxite ore to the amount of 25,066 tons, valued at $93,208, was imported during the year, making the consumption of bauxite in 1907 amount to 122,842 tons, valued at $573,538. In addition to its use in the production of metallic aluminum, bauxite is in demand for the manufacture of aluminum salts, artificial abrasives (alundum) and bauxite brick. This last use is of very recent date. The chief value of the bricks lies in their resistance to the corrosive action of molten metal at high temperatures, and hence they find application in basic open-hearth steel furnaces, in furnaces for refining lead, in copper reverberatory furnaces, and in the linings of rotary Portland cement kilns.

The need for conserving the mineral fuels of the country for the use of future generations has been emphasized many times during the last few years, not only in numerous magazine and newspaper articles, but in a number of reports emanating from the government bureau especially charged with the investigation of the mineral resources of the national domain—the Geological Survey. The statements that the coal supply of the country is far from being inexhaustible, that the amount available is susceptible of measurement, and that no very long look into the future is required to see the end of the present known deposits are graphically supported by a map that has just been published by the Geological Survey. A somewhat similar map was issued by the survey in 1906, but the work of the geologists in the western coal fields in the last two years has added so much to the known extent of those fields that a new and revised edition has become necessary. The map now presented to the public is unique in several particulars. It not only shows the location and extent of the coal deposits of the United States, but also, by variation in color and depth of shading, the character of the coals in each of the great fields and the depth at which they occur beneath the surface. For the first time an attempt has been made to represent the coal in the deep basins, or "synclines," as the geologists term them, of the Rocky Mountain states, where there is every reason to suppose that coal exists, although it is so deeply covered by later sediments as to be accessible with great difficulty if at all. Other new features of the map are the explanation printed on the side margins, describing the character and geologic age of the coals, and the accompanying tables, which give estimates of the amount of coal originally present in the deposits, the quantity that has been removed, and the amount still available, subdivided into deposits easily reached and those accessible with difficulty.

UNIVERSITY AND EDUCATIONAL NEWS

Under the Minnesota state law of 1865 certain swamp lands were set aside to be sold for the benefit of state institutions. The state constitutional amendment which was adopted in 1881 acted to repeal the law of 1865 and the law of 1907 was passed to make effective the plain intent of the constitutional amendment of 1881. The fund from the sale of this land had grown to be $780,556.25 at the end of the fiscal year 1906. This fund must be kept intact and only its income apportioned for the benefit of the state institutions. One half of the interest, which now amounts to $62,145, goes to the common school fund and the balance to state institutions pro rata on the basis of the cost of maintenance. This brings into the university fund $16,542.92.

Owing to the contributions which have been made for the reendowment of Oxford University having reached a total of more than £100,000, the second munificent donation of £10,000 promised by Mr. W. W. Astor has now been received by Lord Curzon of Kedleston, the chairman of the fund.

The report of the Cambridge University museums and lecture-rooms syndicate records a gift of £500, made by Mr. Frank Smart, for additional fittings in the museum of botany. The library in the department of physiology has been increased by many books formerly in the possession of Sir Michael Foster; the library of the medical school has also received many additions, including a large number of pamphlets and books presented by Sir T. Clifford Allbutt.

Preparations are being made to celebrate the four hundredth anniversary of the founding of the University of Madrid, which occurred October 18, 1508.

Dr. David Franklin Houston has resigned the presidency of the University of Texas, which he has held for the past three years, to accept the chancellorship of Washington University, St. Louis, vacant by the retirement of Dr. W. S. Chapin. Dr. Sidney E. Mezes, professor of philosophy at Texas since 1894 and for the past five years dean of the university faculty, was on July 6 elected president of the University of Texas by the board of regents.

Mr. Frank Leverett, geologist of the United States Geological Survey, has been appointed assistant professor of glacial geology at the University of Michigan. He will devote only a portion of his time to university work, retaining his position on the survey. Mr. R. C. Allen, A.M. (University of Wisconsin), lately in charge of the Badger mines of the Cobalt District, has been appointed instructor in economic geology.

The vacancy caused by the resignation of Dr. L. J. Cole, at the Rhode Island Agricultural Experiment Station, has been filled by the appointment of Philip B. Hadley, Ph.D., of Brown University, as chief of the division of biology. The following appointments at the station have been made: J. Swett Irish, B.Sc., of the University of Maine, assistant in biology, and A. L. Whiting, B.Sc., of the Massachusetts Agricultural College, assistant in agronomy.

The trustees of the Thomas S. Clarkson Memorial School of Technology have appointed to the chair of chemistry Mr. L. Kimball Russell, S.B. (Mass. Inst.), A.M. (Columbia). To the newly established chair of physics the trustees have appointed Mr. E. B. Wheeler, B.S. (Missouri), candidate for the doctorate of philosophy, Columbia University.

Dr. John Cameron has been appointed lecturer on anatomy in the Medical School of the Middlesex Hospital, London.

Dr. Wülfing, of Kiel, has been called to the chair of mineralogy and geology at Heidelberg, vacant by the retirement of Professor Rosenbusch.

DISCUSSION AND CORRESPONDENCE

A CONTINUOUS CALORIMETER

To the Editor of Science: In the issue of Science of May 15 appeared a special article by H. T. Barnes, of McGill University, entitled, "A Simple Continuous Calorimeter for Students' Use." Permit me to call the attention of your readers to the description of similar apparatus appearing in "Electricity and Magnetism," by Francis E. Nipher, published by John L. Boland Book and Stationery Co., St. Louis, 1895.

The experiment as therein described has been for fifteen years in the hands of students at Washington University.

Lindley Pyle

Washington University

QUOTATIONS

ACADEMIC CONTROL IN GERMANY

The German university world has been stirred to its depths by the sudden creation of a fourth professorship of economics at the University of Berlin, and the immediate appointment to it of a young teacher at the University of Kiel. For years past the three professorships of economics at Berlin have been held by Professors Wagner, Schmoller, and Sering—men of world-wide reputation, who have been assisted by four or five "extraordinary" professors and a swarm of docents. There was, therefore, not the slightest necessity, from the teaching point of view, of creating a new professorship. But early in this month the university authorities were astounded to receive from the Ministry of Education the notice that a new chair had been founded, and that Professor Ludwig Bernhard, thirty-two years of age, had been appointed to it. The ministry explained that, owing to certain circumstances requiring haste, there had been no time to sound the university authorities, as was the invariable custom; nor had it either consulted or received permission of the Prussian Diet, but had used for this purpose certain emergency funds given to it for an entirely different purpose. The real reason, it appears, is that Professor Bernhard has published a study of the Poles in Prussia which supported the government in its anti-Polish crusade. Having received a call from a South German university, he was about to accept it and give up his Polish studies. Merely that he might continue them, he was given a full professorship in the foremost German university. Naturally, the world of scholars is up in arms at this use of a great institution for purely political purposes.[1]—New York *Evening Post.*

SCIENTIFIC BOOKS

Un problème de l'évolution. La théorie de la récapitulation des formes ancestrales au cours de développement embryonnaire. (Loi biogénétique fondamentale de Haeckel.) Par L. Vialleton. Montpellier, Coulet et Fils. 8vo. 1908.

This volume is a characteristic French production in that it gives with rare skill a comprehensive and clear summary of a complex scientific problem. To the American reader it will seem strange that no mention is made of Louis Agassiz, the most celebrated of all the defenders of the theory of recapitulation; and it is to be regretted that the article by Adam Sedgwick, "On the Law of Development, known as 'Von Baer's Law,'" which was published in the *Quarterly Journal of Microscopical Science,* 1894, should have remained unknown to the author. None the less, the work is very excellent of its kind. It is based upon a series of lectures delivered a year ago before the students of philosophy at Montpellier. The author gives an introduction and historical review, which deals with Meckel, his predecessors and followers, a résumé which biologists will surely welcome. He then passes in a series of chapters, IV.–VIII., to the presentation and discussion of the evidence in the structure and development of vertebrates, for and against the theory of recapitulation. This is certainly very well done; the selection of examples is apt, and they are laid before the reader in such a way that he is brought gradually to a clear understanding of the necessary limitations which must be put upon the law of recapitulation. These chapters deserve especially to be recommended to the attention of teachers and students of general biology.

The last chapter is devoted to presenting the ideas of Oskar Hertwig, and is essentially a critical analysis of Hertwig's essay in the concluding volume of his "Handbook of Comparative Embryology." Here, I think, the author is somewhat at fault in attributing so much originality to Hertwig. For many years embryologists have been familiar not only with the law of recapitulation, but with the

[1] The philosophical faculty at Berlin has voted that, while it has no personal objection to Professor Bernhard, it does not approve his appointment, owing to the fact it was not consulted. Thereupon Professor Bernhard declined the offer of the ministry of education.—Ed.

limitations which must be put upon it. Thus, in my own "Laboratory Text-book of Embryology," published in 1903, pp. 41–43, is given a brief outline of the subject. It seemed to me then that the general opinion was well established, although at that time no single comprehensive essay had been written upon the subject. Hertwig's essay is most creditable, but most of the views he presents were certainly current among embryologists before he wrote. This emphasis of the importance of Hertwig's essay is a most amiable failure, and we may welcome a fresh example of international scientific courtesy, but a critic may be pardoned if he notes that that courtesy is somewhat exaggerated in its expression.

In conclusion, one may recommend Professor Vialleton's work to American readers very cordially. It is a sensible, competent and interesting presentation of a great biological problem, and unquestionably the best we have had.

Charles S. Minot

The Common Sense of the Milk Question. By John Spargo.

This book is a layman's endeavor to provide for the average intelligent citizen a popular, easily understandable statement of the politico-social aspects of the milk problem. This being the case, it is unfortunate that the author has emphasized so strongly his opinion as to the cause of the decline of breast feeding and that he has so severely arraigned the public authorities for their supposed crimes of omission and commission with reference to the milk supply. The average reader will be too apt to accept the author's opinions without looking beyond them to determine the sufficiency or the insufficiency of the evidence upon which they are based.

It may be true, as Mr. Spargo hôlds, that physical disability on the part of the mother is responsible for the larger part of the cases of bottle feeding, but there is a very respectable opinion to the contrary. And so long as the question can not be answered with reasonable certainty and unanimity by the body of men best able to speak—the medical profession—it might have been better for a lay writer not to declare quite so positively concerning it. For many a mother may find in his teachings the very excuse she is longing for to justify her conscience in submitting her baby to the dangers of bottle feeding. Even admitting, however, that the decline of breast feeding is due to increasing frequency of physical incapacity on the part of the mother, it is not necessary to attribute the increase to racial degeneration; inadequacy of lacteal function in the individual, when it occurs, seems much more likely to be as yet the immediate result of the disuse of the mammary glands during the long period that now commonly ensues after their full anatomical development and before they are called into use, the result of late marriage and postponed child-bearing, rather than the result of racial deterioration.

Mr. Spargo should have submitted evidence to show "the dishonest connection between the manufacturers (of infants' artificial foods) and the health bureaus of the country" or else should have omitted the allegation of its existence. The records of births on file in the health offices of this country are commonly public records, and it bespeaks neither dishonestly nor graft on the part of the health officer if he refrains from denying to the citizen his right of access to such records, even though such a citizen be in the service of a manufacturer of one of the tabooed foods and desires to abstract for advertising purposes the names and addresses of the mothers of children recently born. The allegation, too, that "our civic authorities stand in the position of murderers and accessories to the murder of thousands of infants every year" is ill-advised, since it is not true. It seems remarkable that one who is endeavoring so earnestly as is Mr. Spargo to improve the milk supply should have overlooked the fact that the accomplishment of that end can not be furthered by holding up to public contumely officials who, as a class, are quite as sincere in their desire and quite as earnest in their effort to accomplish that result as is Mr.

Spargo himself, and many and possibly most of whom are doing all that can be done with the authority and money that the people have put at their command. What these men need, if they are to do efficient work, is more public sympathy and support, and more authority and more money wherewith to exercise it, and the publication of such statements as those quoted above will not help them to get any of these things.

With the author's working program no fault can be found: "Healthy herds, efficient inspection, insistence upon cleanliness and careful handling of the milk, municipal farms for providing public institutions, infants' milk depots for the sale of properly modified and pasteurized milk for babies, education of the mothers and the girls before they reach wifehood and motherhood." Too little consideration is given to the cost of producing and marketing milk, for after all it is reasonable to believe that milkmen will be found ready to provide just as good a product as the market demands, providing only that the market is reasonably steady and the market price yields a fare profit. The stress laid on the availability of the goat as a source of milk is unusual. The proper sphere of this animal seems to be, however, as a source of one family supply, so that the consumer can be in entire command of the situation and the milk, taken from the goat under ideal conditions, pass promptly from the udder of the animal to the stomach of the child. But with the prevalence of apartment house life, and with the backyard of the dwelling contracted almost to the vanishing point, there are serious difficulties in the way of introducing goats into the domestic establishment. As a competitor to the cow in the production of the general milk supply the goat does not need to be seriously considered.

The author has followed the common practise of adopting infant mortality as an index to the character of the milk supply. No death rate, however, for infants under one year of age, or for children over one and under five, is of material value unless calculated on the basis of the population of corresponding age, and too commonly no such basis is available. No general death rate for infants is of value as an index to the efficiency of milk control, since it is based in part on the deaths of infants due to difficult labor, premature delivery and other causes to which the character of the milk supply is in no way related, and is influenced by variations in the numbers of deaths from these causes. And while the death rate from diarrhœal diseases among children under one or under two years of age possibly forms the best basis for estimating the results of the improvement of the milk supply, the number of deaths from such diseases is so influenced by atmospheric temperature and humidity that a full and accurate knowledge of such conditions is necessary when interpreting such death rates unless the figures relate to periods of time of such considerable duration as to reduce to a minimum the effect of these factors.

It is to be hoped that when another edition of this book is published a more convenient system of references to authors consulted will be adopted. A less diffuse style and possibly the concentration of attention on fewer subjects would probably render the book of more interest and value to the general reader. The fact that a layman should write a book on the milk question for lay readers and that a publisher should expect to find a sale for it is a hopeful sign of the times and augurs well for the early solution of the problem, for people themselves will eventually have to settle all questions concerning it, either through commercial readjustments or through force of law, or probably through both, and the mere official can do only what the people authorize and empower him to do.

Wm. Creighton Woodward

Washington, D. C.

SCIENTIFIC JOURNALS AND ARTICLES

The June number (volume 14, number 9) of the *Bulletin of the American Mathematical Society* contains the following papers: Report of the April meeting of the society, by F. N. Cole; report of the April meeting of the Chicago Section, by H. E. Slaught; In Memoriam Heinrich Maschke; "Criteria for the Irreducibility of a Reciprocal Equation," by L. E. Dickson; "A New Graphical Method for Quaternions," by J. B. Shaw; "Logic and the Continuum," by E. B. Wilson; Shorter Notices (Picard's "Développement de l'Analyse and La Science moderne," by E. B. Wilson; Mathew's "Algebraic Equations," by F. Cajori; Bertini's "Geometria Proiettiva degli Iperspazi," by C. H. Sisam; Staude's "Analytische Geometrie des Punktes, der geraden Linie und der Ebene," by G. N. Bauer; Shepard's "Strength of Materials," by E. W. Ponzer; Hering's "200-jähriges Jubiläum der Dampfmaschine," by F. Cajori); Notes; New Publications.

THE July number of the *Bulletin* (concluding volume 14) contains: "The Inverse of Meusnier's Theorem," by Edward Kasner; "On the Distance from a Point to a Surface," by Paul Saurel; "On the Solution of Algebraic Equations in Infinite Series," by P. A. Lambert; "The Deduction of the Electrostatic Equations by the Calculus of Variations," by A. C. Lunn; "The Fourth International Congress of Mathematicians," by C. L. E. Moore; Shorter Notices ("Encyklopädie der Elementar-Mathematik," Bande 2–3, by H. S. White; Lebesgue's "Leçons sur l'Intégration et la Recherche des Fonctions Primitives," by D. R. Curtiss); Notes; New Publications; Seventeenth Annual List of Papers read before the Society and subsequently published; Index of Volume.

AT the sitting of the Paris Academy of Sciences on June 22, according to a report, M. Poincaré read a note from M. Jean Becquerel on the nature of positive electricity and the existence of positive electrons which have been found in a Crookes tube. Dr. Salmon, of the Pasteur Institute, announced that sleeping sickness had been cured in monkeys by means of a form of atoxyl. MM. Beorges and Gustave Laudet gave particulars of their success in photographing sounds. Those photographs are so clear that they permit of a study of sound far more precise than any hitherto known. The most delicate peculiarities of the voice, such as lisping, and even breathing, are produced with the greatest distinctness. The MM. Laudet, who have been pursuing those inquiries since 1905, when they first communicated their ideas to the Academy of Sciences, have been induced to give the present account of their success owing to the recent communication on the same subject by M. Devaux Charbonnel. The MM. Laudet, instead of having recourse to electricity, like M. Devaux Charbonnel, have employed a purely mechanical and direct means for securing the desired record.

SPECIAL ARTICLES

OBSERVATIONS ON CHANGE OF SEX IN CARICA PAPAYA

WHILE change of sex among the phanerogams is not unknown yet it is of such rare occurrence that any well-demonstrated instances as those shown by the Caricas under observation are worthy of careful study. This is especially true when that change can be brought about by cultural methods as seems to be clearly proved in the present instance.

Carica papaya is a tropical, rapidly growing tree-like form belonging to the Passifloreæ family. As found in Porto Rico it is distinctively diœcious, the monœcious form being very rare except when produced as were the ones under observation. The tree is non-branching, but will readily develop lateral buds if the terminal bud is destroyed.

The staminate trees bear the flowers in dense, dichotomously branched head-like groups on a very long helicoid dichotomous branched peduncle. The flowers in each group on the peduncle develop successively, continuing over a long period of time, so that there is no time during the year when flowers are not shedding pollen. The pistillate tree bears axillary flowers of a very different form from the staminate. The pistillate flowers are born in an unbranched peduncle and vary in number from one to five or even more; usually three. Of these only one, with rare exceptions, sets fruit. It is said that the flowers are sometimes perfect, but such have not come under my notice as yet.

The fruit varies in form from oval to a distinctively necked pear shape and in weight from three pounds to ten pounds or even more. The fruit in some varieties is very delicious and has many medicinal properties ascribed to it, so that the plant is of enough value economically aside from its botanical interest to be worthy of careful study.

The change of sex in the first tree noted was brought about accidentally. A staminate tree of some age had its terminal bud accidentally injured. The staminate flower clusters produced shortly afterwards contained pistillate flowers in the terminal group. These flowers set and developed good-sized fruits. When mature they had all the characteristics of normal fruits except that the fruits were not quite so well filled out, having a somewhat wrinkled appearance. The seeds are smaller than the normal seeds but seem to be normal in other respects. Time has not been sufficient to test their germinating power. The clusters later developing also contain pistillate flowers in the same position in the cluster as the first one, and now and then a cluster will contain two and even three of these fertile flowers, each one producing fruit.

On observing this peculiarity, investigations were begun to find the cause. Inquiry of the natives brought out the theory that the removal of the terminal bud in the new of the moon would usually cause this transformation. Other trees growing on the grounds were at once set aside for experimental purposes and the tops were removed at different phases of the moon to disprove the moon's having any effect and also to show, if possible, what were the necessary conditions, if any, outside of the mere removal of the terminal bud. Thus far it is clearly shown that the removal of the terminal bud does cause the change, but also that some other condition is necessary, as only a part of those thus treated have thus far developed any pistillate flowers. The moon's phase does not appear to have any control, though, strange to say, those treated at a fairly definitely recurring period are the ones that show change. It is possible that the plant has definite short cyclic periods of growth and that it is necessary to remove the tip at some definite phase of this cycle in order to produce the development of fertile flowers. If this be true and this cycle should accidentally coincide fairly well with the moon's phases, the belief in moon influence would naturally arise.

This view of an approximately monthly periodic cycle of growth has several things to support it. The chief of these is found in the continuous development of flowers and fruit. At no time during the year were the trees under observation without both flower and fruit. On the other hand, there are times when growth is more rapid, more flowers are developed and the terminal nodes elongate much more rapidly. The exact time of these periods has not yet been determined definitely, but data is being collected.

The habit of the plant is being closely studied to determine the characteristics of each change and at what point in this growth the tips must be removed to produce the changes under discussion. It is possible that the power to produce pistillate flowers is inherent in the plant, being dormant unless some shock is given to destroy the equilibrium of the growth forces. This inherent quality is indicated by the fact that in some countries the plants are sometimes found naturally monœcious.[1]

It may also be that certain varieties are monœcious. That there are variations in the plants is true, as noted under forms of fruits, but thus far no variation has been observed that was definite enough or of well enough fixed characters to warrant a well-defined division into varieties.

I recognize that as yet but little has been definitely settled and that the questions involved open up a wide field for investigation, but I present the facts, thinking they will be of interest and hoping that any discussion caused by them will bring out points that will aid in future investigations.

M. J. Iorns

Mayaguez, Porto Rico

[1] "Dictionary of Economic Products of India," Watt, Vol. II.

OBSERVATIONS ON MEDICAGO LUPULINA L.

OWING to the occasional adulteration of alfalfa seed with yellow trefoil, *Medicago lupulina,* this plant is of considerable interest to alfalfa growers in the eastern states. It is encouraging to note that such adulteration is less common than formerly. Of 491 samples of alfalfa seed examined by the writer at the New York Experiment Station during the past eighteen months, only seven showed evidence of adulteration with yellow trefoil.

In botanical works *Medicago lupulina* is sometimes described as an annual and sometimes as "annual or biennial." Careful observation has shown that in alfalfa fields in New York it is regularly a biennial. Even when the seed is sown in spring only occasional plants blossom and seed the first year. The great majority do not bloom until the second year in the latter part of May, shortly before the first cutting of alfalfa. At this time the plants are very conspicuous because of their yellow blossoms; but they do not reappear in subsequent cuttings of the alfalfa.

That the plants actually do live over winter is proved by the results of the following experiment: On March 29, 1907, nine plants suspected of being *M. lupulina* were transplanted into the station greenhouse. Six of these were taken from an alfalfa field and three from a lawn on the station grounds. They all blossomed and proved to be as suspected.

Except when the two plants are in bloom, *M. lupulina* so closely resembles alfalfa, *M. sativa,* that the two species are distinguished with difficulty. This is especially true in the early stages of growth. The writer has sought unsuccessfully for morphological or anatomical characters by means of which the two species may be separated with ease and certainty. In early spring the most reliable characters by which the two species may be separated are, (1) the habit of growth of the crown and (2) the character of the root system. The crown of *M. lupulina* is spreading, very similar to that of red clover, and the stems are procumbent; while the crown of alfalfa is upright in habit. The root systems offer a more striking difference. Alfalfa has a large tap-root with very few side roots. *M. lupulina* has a small tap-root nearly concealed in a mass of fibrous side roots.

In conclusion, it may be of interest to note the finding of a *M. lupulina* seedling having three cotyledons.

G. T. FRENCH
NEW YORK EXPERIMENT STATION,
GENEVA, NEW YORK

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 207th meeting of the society, on May 27, Mr. F. E. Matthes discussed informally "Refusion of Cinders by Camp Fires on San Francisco Mountains, Arizona." Mr. L. D. Burling also discussed briefly "Colored Photography in Geology."

Regular Program

The Coalinga, California, Oil Field: Mr. RALPH ARNOLD and Mr. ROBERT ANDERSON.

The Coalinga District is situated on the eastern flank of the Diablo Range, along the border of the central valley of California. This flank of the range is formed of an eastward dipping monocline that exposes the Franciscan (probably Jurassic) in the axis of the range and above this about 26,000 feet of strata representing a considerable portion of the time up to the middle Pleistocene. There are at least 12,000 feet of Cretaceous, including lower and upper Cretaceous, with a probable unconformity between, and 14,000 feet of Tertiary and Quaternary beds composing six mutually unconformable formations. These belong to the Eocene, lower Miocene, upper Miocene, Pliocene and lower Pleistocene. The youngest formation that has undergone folding comprises a thickness of at least 2,500 feet of unconsolidated coarse and fine sediments belonging to the Pliocene and lower Pleistocene, and has been correlated with the Paso Robles formation of the Salinas Valley. It is of freshwater origin at the base and in part marine above, but is thought to have originated in large measure subaerially as a filling in the Great Valley of California. Great orogenic movements took place in the Pleistocene and in places lifted the deposits forming the floor of the central valley into steeply dipping folds. These folds are topographic as well as structural arches and afford a rare instance of the preservation of the original domes due to warping of the surface.

The petroleum occurs in beds and lenses of sand and gravel in the Eocene, lower Miocene and upper Miocene formations. The petroleum from the Eocene varies in gravity from 20° to 42° Baumé and the production is usually light, varying from 4 to 75 barrels per day per well. The lower Miocene oil sands are the most important in the field, yielding oil of 14° to 31° Baumé. Individual wells produce as high as 3,000 barrels a day from the lower Miocene sands. The upper Miocene is petroliferous in the western part of the field, yielding oil of from 14° to 22° Baumé. Wells penetrating this formation seldom yield more than 600 or 800 barrels a day.

Water occurs in the formation above the oil sands and in some instances sulphur water is interbedded with the petroliferous strata. Little "bottom" or "edge" water has been encountered in the field. The oil is believed to be derived from the organic materials in the Eocene shale. There are nearly 400 productive wells in the field, these varying in depth from about 600 to over 3,000 feet. The production for 1906 was 7,991,039 barrels. The product is marketed by rail and through two long-distance pipe lines, much of it being refined.

Laramie Formation: Whitman Cross.

It has long been known that the Laramie of King and Hayden has been found to consist of two parts, a lower portion, corresponding to the original definition by King, which is conformable with the underlying Cretaceous section, and an upper portion, separated from the lower by a great unconformity and stratigraphic break in several localities. In earlier discussions of this question the author proposed to restrict the use of the term Laramie to such beds as constitute the upper conformable part of the Cretaceous section and to apply the term "Post-Laramie" in a tentative way to the group of formations separated from the Laramie by unconformity or stratigraphic break.

It has recently been ascertained by A. C. Veatch and others that the long-known formation at Carbon, Wyoming, on the Laramie Plains, is distinctly unconformable upon marine Cretaceous, no true Laramie beds being present at the best known exposures. Governed by the idea that the Carbon section is to be regarded as a type section of the Laramie, as defined by King, Mr. Veatch has proposed to restrict the term Laramie to the formations above the stratigraphic break up to the Fort Union formation. There are thus two directly opposing propositions for the use of the term Laramie. It is claimed by Mr. Cross that the term Laramie was not originally proposed especially for strata of southern Wyoming, but as a practical synonym for the term lignitic, and embraced formations known in many places in Montana, Wyoming, Colorado and New Mexico. The definition of Laramie by King mentions no type section and lays emphasis repeatedly upon the conformity of the Laramie with the underlying Cretaceous section. The Laramie was supposed by King to end with the Rocky Mountain revolution, which he assumed to take place preceding the Wasatch epoch. Mr. Cross repeats the proposition previously made to restrict the use of Laramie in accordance with the fundamental relations specified in the original definition, rather than to correspond with the local conditions which exist in the Carbon section.

For the various local formations separated from the Laramie, as thus defined, by unconformity or stratigraphic break, and older than the Fort Union beds, Mr. Cross proposes that a new term should be adopted.

Among the formations to be referred to the new group are the Arapahoe, Denver, Middle Park, Animas, and other local deposits of Colorado; certain beds of Carbon, Evanston and the Converse County Ceratops beds of Wyoming; the Livingston and Hell Creek beds of Montana. Certain features of stratigraphy and paleontology were considered and their bearing upon the assignment of certain beds to the Laramie or to the new group in certain cases discussed.

The assignment of the group to the Eocene rather than to the uppermost Cretaceous is advocated by Mr. Cross on the ground that such a division is particularly appropriate viewed from the standpoint of historical geology. The paleontological evidence is not believed to require the assignment of this group to the Cretaceous, and, indeed, much of the evidence is conceived to be in favor of the reference proposed.

Ralph Arnold,
Secretary

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION

The ninth regular meeting of the session of 1907–8 was held at the Chemist's Club, on Friday evening, June 5.

Professor Charles F. Chandler addressed the section on "Silk: Natural and Artificial." The lecture was illustrated by stereopticon and by numerous samples of raw and finished silk products.

C. M. Joyce,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Friday, July 31, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

THE TEACHING OF MATHEMATICS FOR ENGINEERS [1]

Mathematics, from the standpoint of the engineer, is a means, and not an end. It is an instrument or tool by which he may determine the value and relations of forces and materials.

The usefulness of tools depends upon the sort of work which is to be done, upon the kinds of tools which are available and upon the skill of the man who uses them. We may inquire, therefore, what are the uses to which the engineer may apply mathematics? What kind of mathematics does he need? And what skill should he possess in their use?

First, then, what work is to be done by the young men who are now taking engineering courses? A few—and only a few —will be original investigators or designers who will need mathematics as an instrument of research. A considerable number will regularly employ elementary mathematics in more or less routine calculations. Many will have little use for mathematics, as engineering courses are recognized as affording excellent training for various business, executive and other non-technical positions, particularly in connection with manufacturing and operating companies. It has been stated by the vice-president of a large electric manufacturing company that not over ten per cent. of the technical graduates employed by that

[1] Read before Sections A and D of the American Association for the Advancement of Science and the Chicago Section of the American Mathematical Society, at the Chicago meeting, December 30, 1907.

company are fitted by temperament or by education to take up with success the work of pure engineering. A recent classification of the graduates of Sibley College, Cornell University, shows that about half are in occupations which require no advanced mathematics and it is probable that many of the 36 per cent. classed as mechanical and electrical engineers seldom go beyond the rules of arithmetic. Hence a goodly proportion of engineering graduates do not need to be mathematical experts. Their mathematical studies need not aim to produce experts, but should have as a principal object the mathematical training which is a most efficient kind of training in an engineering course. On the other hand, the engineers who will have practical use for the higher mathematics will find their ability as engineers is in a large measure determined by their ability as mathematicians.

Second, the question, what kinds of mathematics does the engineer need? is closely related to the class of work he is to do. In general a great deal of engineering work is done with much less use of higher mathematics than most professors probably imagine; and furthermore, it may be remarked, with much less than could profitably be employed. Engineers are apt to use ordinarily the mathematical methods with which they are most familiar and which will bring the result with the least effort. One man employs calculus, another draws a diagram, another writes out formulæ, while another gets his results by mental arithmetic. The object is to get the result.

The fundamental idea that mathematics is something for the engineer to use finds many illustrative analogies in ordinary tools. Adaptation is the first requisite. Tools should be suited to the work to be done. An expensive machine tool with its refined adjustments is quite unnecessary for executing a piece of work which can be done with sufficient accuracy by a few minutes' application of a file. An ordinary calculating slide rule is infinitely better than a table of seven-piece logarithms in every-day work.

On the other hand, it is particularly wasteful to attempt to execute a difficult and intricate piece of work with inadequate tools. But more important than the tool is the skill of the man who uses it. A skillful workman can accomplish results with a few simple tools which others can not get with the most elaborate special equipment.

Third, therefore, skill in the use of mathematics is the really essential thing. A judicious use of arithmetic with a little algebra or a simple diagram often leads to more satisfactory results than others secure through elaborate processes involving lengthy equations and complicated operations. In the latter, errors are liable to occur, the common-sense import of the problem is apt to be overlooked, assumptions may be made to facilitate calculations which are physically unwarranted as one loses sight of the physical problem in the intricacy of the mathematical solution. Abstract mathematical studies, if pursued as a kind of intellectual calisthenics, may produce a pure mathematician, but they may unfit a man for practical engineering. A mathematician is not necessarily an engineer; nor is an elocutionist necessarily a good lecturer, nor is a tool expert a successful manufacturer.

Mathematics is used in engineering to express the quantitative relations of natural phenomena. The mathematician delights in the relations: he divorces them from the phenomena and gives them abstract expression, while the engineer is concerned with the natural phenomena; he demands the physical conception; the medium of expressing these relations is of secondary consequence.

The mathematician evolves the equation for a parabola and finds a convenient illustration in the law of projectiles. The engineer finds that a physical result follows from the application of certain forces, and uses the formula merely as a convenient method of expressing the law. The analogue in the case of mechanical tools is found by regarding a set of drawing instruments or a transit or a lathe, as something intelligently designed, properly proportioned, accurately made and finely finished, the merit of which lies in its own inherent excellence; or, on the other hand, by considering them as tools adapted for doing a certain range and character of work with a sufficient degree of accuracy and at low cost.

A manual-training school gives familiarity with mechanical tools and mathematical study gives familiarity with intellectual tools. In work with the manual tool the boy uses it for making something —he learns the principle on which it operates and the way to use it, by making something; if it is something useful it awakens a higher interest than does some fancy device. Likewise training of engineers in mathematics should be by doing something, by the solving of problems, by dealing with real rather than abstract conditions. Let this training be secured while applying mathematics to its normal and legitimate purpose as an auxiliary in the study of other branches.

In the teaching of mathematics for its own sake stress is apt to be laid upon the processes of deriving results rather than the real meaning of the results themselves. An engineer who uses logarithms has no more concern regarding their derivation than the ordinary user of the dictionary for finding the pronunciation of words has in their etymological derivation. The ability to reproduce demonstrations in higher mathematics from memory with the book shut is often not as important as it is to understand them with the book open. In general an engineer, who has occasion to use higher mathematics, will not be interested in evolving difficult equations, nor will he appeal to his memory, but with text-book or reference before him he will seek the things he wants to use. He should know where to find them and how to use them.

In emphasizing what a skilled mechanic can make with very ordinary tools, or the true engineer can accomplish with the parallelogram of forces and the rule of three, there is no intention of discrediting the value of fine equipments, either mechanical or mathematical, if there be the ability to use them.

Possibly the practical utility of mathematics may appear to be urged too strongly, particularly as the writer really believes in thorough mathematical training, but he has seen so many cases in which mathematical instruction has never been digested and assimilated, he has seen simple problems confused by unnecessary mathematical complications, he has seen men satisfied with results which are absurd because of some mathematical equations—sometimes quite unnecessary—which seem to obliterate common-sense perspective, and he recalls the new insight into mathematics which came through "Analytic Mechanics" under Professor S. W. Robinson at the Ohio State University, and "Problems in Mechanics," under Dr. Fabian Franklin at Johns Hopkins University, that he feels there is little danger in over-emphasizing the importance of concrete training in mathematical study.[2]

[2] Both of these teachers of mathematics had been trained as engineers and had practised the profession.

The practical questions which the discussion of this subject presents are these:

What mathematical subject-matter should be covered? And,

How should it be taught?

The first difficulty is that there is not, and can not be, a differentiation in technical education which is at all comparable with the wide range of occupations into which graduates will enter. We may assume, therefore, that we are considering the case of the average engineering student, taking for granted that options may be used by the best students for enabling them to take up the more advanced and difficult mathematics. Obviously the student should have enough mathematics to enable him to demonstrate the important engineering laws and formulas and to read intelligently mathematically written engineering literature. While only the relatively simple mathematics is commonly used by engineers, yet the ability to handle new problems with confidence requires a thorough understanding and appreciation of the significance of the mathematical and physical basis of the laws and phenomena he is to use. A man who is a thorough mathematician and knows how to apply his knowledge has a great advantage over the pure mathematician or the man without mathematical equipment. The better knowledge one has of the complex, the more certainty he has in applying the simple. A student should understand something of the power of the advanced mathematics and the field of its efficient application. Although he may not be expert in using it himself, he will know when to call for a mathematical expert.

An engineer of fairly wide experience remarked a short time ago: "The ordinary engineer does not use higher mathematics because he doesn't know how. He does not have the proper conception of the fundamental principles of the calculus because the subject has been taught by men whose ideals are those of pure mathematics."

If mathematics is something for engineers to use, let its use be taught to engineering students. After the fundamentals are learned, the students should attack the engineering problem at once and bring in mathematics as a means of solving it. Mathematics is often advocated for developing the reasoning powers and the ability to reason from cause to effect. There is danger, however, that mathematical machinery may make the mere process obscure the cause and the effect. Let them be foremost, with the process secondary or auxiliary to them.

The way mathematics is brought to bear on some engineering problems reminds one of the story of the old lady who greatly admired her preacher because he could take a simple text and make it so very complicated.

Old traditions have not wholly disappeared, the fear of degrading the pure science of mathematics by applying it to useful things still lingers—in influence, if not in precept. We must go further and adapt mathematics to engineering, not only in subject matter, but in method. A mathematical teacher with no patience for anything except mathematics will probably teach a kind of mathematics which has no connection with anything except mathematics. Engineering mathematics may be better taught as a part of engineering by an engineer, than as a part of mathematics by a pure mathematician. The maker of levels and transits who is expert in the construction of the instruments and an enthusiast over the accuracy of the surfaces, the excellence of the bearings, the near approach to perfection in the graduation and the general refinement and beauty of workmanship, may make a good instructor on instruments, but a poor teacher of civil engineering.

After all, it is not so much abstract courses as it is personal men with which we have to do, it is not mere knowledge of facts or facility in mathematical manipulation, but it is training. The young man is to be developed, his native individuality is to be the basis, he is to increase not only his knowledge, but his powers and the ability to use them. It is not mathematical skill so much as a mathematical sense, or mathematical common-sense, which is wanted. With pure mathematics as a science we have no quarrel—and little affiliation.

If you ask men who use engineering graduates what qualities they should possess, you will find that special prominence is given to "common-sense" and "the ability to do things." In mathematical training it is quality rather than quantity which is of first consequence. It should develop the facility for systematic and logical reasoning, thus furnishing a general method as well as a specific means of getting results.

We are concerned with applied mathematics. The ability to state a problem; to recognize the elements which enter into it; to see the whole problem without overlooking some important factor; to use good judgment as to the reliability or accuracy of the data or measurements which are involved; and, on the other hand, the ability to interpret the result; to recognize its physical significance; to get a common-sense perspective view of its meaning and the consequences which may follow; to note the bearing of the various data upon the final result; to determine what changes in original conditions may change a bad result into one which is practical and efficient—such abilities as these are of a higher order than the ability to take a stated problem and work out the answer. It may be urged that all this is not strictly mathematics. But it is just this sort of judgment and insight which makes mathematics really useful, and without them there is danger that they may be neither safe nor sane.

The trend in education is to a closer relation to the affairs of life. Science and applied science, scientific and engineering laboratories, are overcoming old ideas and prejudices. Modern engineering development brings its transforming influence to bear upon education as well as the utilities of modern life. The engineering school has had a phenomenal growth within the lifetime of the recent graduate—a growth in ideals and methods as well as students and equipment. It has raised and agitated broad questions as to what constitutes efficient education for producing effective men. It has aimed to combine not only the abstract with the concrete, the lecture room with the laboratory, and the scientific experiment with the practical test; but it has sought by various means to bring the work of the school into close relation with active professional and commercial practise. It has a definiteness of aim and purpose which other educational courses are apt to lack. It sets out to produce men who can deal with forces and materials according to scientific principles. It develops men whose contact with physical facts and natural laws at first hand and whose ability to reason logically fit them for dealing with new problems. The training which fits men for handling engineering problems is the kind that is needed for dealing with the organization and directing of men. The sphere of the engineer is one the scope of which will continue to increase as engineering education and training produce men whose contact with natural phenomena gives them an inherent respect for facts as their premises, who are able to think straight to logical and common-sense conclusions, who have an equipment of technical knowledge and who can produce results.

In discussing the teaching of mathematics to engineers, we should emphasize not the mathematics nor the engineers, but the teaching. Aside from the imparting of knowledge and technical ability, the teaching of mathematics gives opportunity for training in the use of logical methods and in the drawing of intelligent conclusions from unorganized data which will make efficient men, whether they follow pure engineering, or semi-technical, or business pursuits. Such teaching does not come from the text-book; it must be personal—it comes from the teacher. He must be in sympathy with engineering work and have a just appreciation of its problems and its methods. He must be imbued with the spirit and the ideals of the engineer.

Chas. F. Scott

THE POINT OF VIEW IN TEACHING ENGINEERING MATHEMATICS[1]

I hardly know why I should have been asked to address you at this conference. Possibly, however, the fact that I am a civil engineer by profession, without having been permitted ever to practise this profession, and the additional fact that I have been a professional teacher of mathematical physics, without having been permitted to continue in this work, have led your committee to think that I might furnish a conspicuous illustration of the failures to which colleges and universities may lead in these lines of endeavor.

Having listened attentively to the three formal papers just read, I find it essential to revise my program and instead of following similar lines to those of the preceding speakers, it seems essential to take direct issue with them. This I am disposed to do, not so much because I differ wholly from the views they have set forth, as because it seems necessary to have other sides of the questions they have discussed represented. The preceding speakers appear to me to have taken themselves somewhat too seriously. This is a general fault of both theoretical and practical educationalists. My own experience leads me to conclude that in educational affairs the teacher, the school, the college and the university play a much less important rôle than we commonly suppose. In fact, I have reached the provisional conclusion that the majority of our students turn out fairly well in the world not so much by reason of the academic instruction they receive as in spite of it.

My impression also is that in taking ourselves too seriously as teachers of one subject or another, we have, as a rule, quite underestimated the magnitude and the difficulty of the psychological problems with which we have to deal. We have, as a rule, quite overestimated the capacity of our average student, and have thus usually expected too much from him. It is, of course, desirable to set our ideal high and try to rise to an elevated intellectual level; but in doing so we have commonly neglected the influence of heredity as well as of environment. I am inclined to think Dr. Holmes was right when he said that it is essential in the generation of a gentleman to begin four hundred years before he is born. So also is it necessary, if we wish to develop a student into a first-class scholar, to begin back some generations before we take up the formal work of training in our colleges or schools of engineering. It is an important fact, also too commonly over-

[1] Extempore remarks before Sections A and D of the American Association for the Advancement of Science and the Chicago Section of the American Mathematical Society, at the Chicago meeting, December 30, 1907.

looked, that the fundamental ideas involved in the mathematics and in the mathematical physics essential to the preliminary training of a prospective engineer are far more difficult of comprehension than we are wont to suppose. As a rule, I think we begin our elementary mathematics somewhat too early for the average mind. The result is that our students acquire a mere literary knowledge of the subject without grasping the basic ideas essential to clear thought and especially essential to applications. I am going to give you some illustrations of this fact. They will show how difficult it is for the average mind to attain a proper understanding of mathematico-physical concepts. The difficulties here are much the same as the difficulties of grammar. As you know, children learn to speak, and often speak very well, long before they know anything of formal grammar, and this is the natural mode of development, for the logic and subtleties of grammar can be appreciated only by rather mature minds.

But if the concepts which belong to the study of language and of grammar are rather formidable, those which belong to the higher mathematics and mathematical physics are profoundly more difficult of adequate comprehension. Let me illustrate this point by a citation from experience furnished by the case of a graduate from one of our universities who presented himself to me a few years ago, while I was dean of a graduate school of Columbia University, as a candidate for a higher degree in mathematical physics. This student had studied mechanics and had attained a degree in engineering. In order to learn something of the breadth and depth of his knowledge, I asked him what it is that makes the trolley car run after the current is cut off. He answered, "It is the force of the momentum of the power of the energy of the car." There is no reason to suppose that he had not received good mathematical and physical training, and yet it is plain from the answer he gave me that he knew next to nothing of the meaning of the terms he used. I may cite another case of a successful practising engineer, who was a pupil of no less authorities in mechanics and engineering than Lord Kelvin and Rankine. This man wrote me a letter in which he sought to convince me that Newton and his followers are all wrong with regard to the parallelogram of impulses. "Thus," he said in his letter, "if a particle start out from a given point under the simultaneous action of two impulses, it will not move in the parallelogram of the impulses, but it will move in a tautochronous, brachistochronic, plane catenary curve of a resilient character."

These illustrations show how extremely difficult it is to master the fundamental ideas which belong to a great science; and the difficulties are so great that I am disposed to excuse, or at any rate palliate, the blunders made by our average student. He is, in fact, with all his blunders, not very far behind many of his teachers, for it is not uncommon for them to use in their lectures and text-books words not at all free from ambiguity. Witness, in fact, the loose use of such words as force, power, pressure, stress, and strain in some of the best text-books and treatises of the nineteenth century. The word "power," for example, is often used in two radically different senses in the same sentence.

These difficulties and ambiguities lead me to suggest, in opposition to the precepts laid down by a previous speaker, that we may well consider the desirability of printing mathematical books free from demonstrations but containing plain statements of facts. I have used such books myself and am disposed to think they are amongst the best books we may place in the hands of a student. The simple fact is that we do not follow a logical order of development in acquiring knowledge. We proceed rather by the method of "trial and error," and we often find out the facts with regard to an item of learning long before we become aware of the principle involved.

Hence I think the reason why few of our engineers know much about the formalities of mathematics and mathematical physics after they get through college is plain enough. They are driven over so many subjects during the four years of their college life that they have little or no time for reflection. This latter must come later in life when the mind has developed a sufficient degree of maturity to appreciate the more recondite principles which lie at the foundation of all the higher learning. This fact is well illustrated also by the case of our friends, the humanists, who have, as you know, for a long time proposed the study of geometry for "mental discipline." As a matter of fact, those who have acquired anything like a grasp of geometrical principles know that very few students of Euclidean geometry acquire anything like an adequate appreciation of the ideas involved, and it is only in the rarest instances that these students pursue the subject after leaving college.

I have not much sympathy with the engineers who would like to have their own kind of mathematics, and I am not disposed to commend very highly the works on calculus and other branches of pure mathematics designed especially for engineers. On the other hand, our modern mathematicians have generally failed to understand the needs of the engineer. Our more recent type of mathematician has devoted himself too largely to the refined questions of convergence and divergence of series and of existence theorems to properly equip him for the numerous and important applications which the ideal engineer should be able to make of his mathematical knowledge. The modern mathematician seems prone to make the engineer with some degree of mathematical talent afraid of himself. I have met some students whose early training had filled them with caution to such a degree that they would not use infinite series for fear that a divergent one might be encountered. It is known, however, as a matter of fact, that most series essential in the applications of mathematics to mathematical physics are safe in this regard, and one of the best ways for the elementary student to learn of the degree of convergence is to apply numerical computation to these series.

This leads me to say a few words concerning numerical computations, in which very few engineers and still fewer mathematicians show any degree of proficiency. It seems to me this is one of the most lamentable defects of our elementary teaching in mathematics, though here as elsewhere the intrinsic difficulties are much greater than we commonly suppose. This fact is in evidence at almost every meeting of our scientific societies, for it oftenest happens that the author of a paper involving numerical calculation will talk of the decimals involved instead of the significant figures. Thus, he will say, "this result is correct to five places of decimals," when he should say, "this result is correct to a specified number of significant figures," the latter form of expression being requisite to indicate the degree of precision attained. There is a grave defect in our elementary teaching in these matters; but it arises from the fact that almost none of our teachers of elementary mathematics are qualified to understand the refinements and the difficulties of precision in computation. Thus, it often happens that students will give results to five or seven significant figures when the data do not justify any such apparent precision.

To correct these evils we must have a convention of mathematicians, engineers and professional computers who will show authors how to produce elementary text-books giving adequate attention to these matters.

As regards numerical computation, there is in general need of more practise, since it is through the concrete that we learn of the abstract and the fundamental. No important formula in any text-book or treatise should go without an appropriate illustrative numerical example.

I would like to take advantage of this occasion to express a hope with regard to the future of our country and to the possibility of development which may come through suitable cooperation between mathematicians and engineers. Nothing delights me more than to attend a meeting of this kind where mathematicians and engineers have come together. It is an auspicious sign of the times. It is one of the results I have been looking forward to for the past thirty or forty years. Some of us here are old enough to have lived in two epochs, namely, the pre-scientific and the present epoch. We can remember a time when engineers could not have got a hearing such as they have to-day. The history of their rise and development, at least in this country, is well known to some of us. It dates back to a time only about forty years ago. During this time the engineers have fought their way forward to the position now accorded them in contemporary society. They have won a place in public esteem without which it would have been impossible to hold such a conference as we are holding to-day. This esteem has been won in spite of much opposition, coming especially from the older academic institutions; but now having attained adequate recognition especially as practising engineers, we have a much higher duty to perform, and this I trust we shall be able to meet adequately through cooperation with our friends the pure mathematicians. I know of no work more important to the general advancement of mathematico-physical science than that which may lead to the development of mathematical physicists, men who possess at once good mathematical knowledge and correspondingly adequate equipment in physical science. Here is a field greatly in need of concentrated effort and of adequate appreciation. It is a lamentable fact that while we can easily develop pure mathematicians of a high order and experimental physicists of an equally high order, it seems very difficult for us to develop minds possessing both qualities. To a large extent I think the development of pure mathematics in the future will depend, as in the past, on the stimulus furnished by mathematico-physical ideas; and in like manner success in the development of mathematical physics will depend equally in the future on mathematical ability of the highest order. In this line of work we Americans have not done our full duty, and it behooves us as mathematicians and engineers, now that we have got together on the plane of mutual interest, to give attention to this important field of work.

The French engineers led by Navier and followed by Lamé, Clapyron, and especially by the "dean of elasticians," Barré de Saint-Venant, have contributed to science the most important branch of mathematical physics, namely, what is commonly called the theory of elasticity. This is superbly difficult in its purely mathematical aspects and exquisitely beautiful in its physical aspects, and it stands as a splendid example of the possibilities which may result from adequate cooperation between mathematicians and engineers.

The chief difficulty in the way of developing mathematical physicists appears to lie in the inadequate appreciation of this type of work by contemporary society. Pure mathematics has a prestige of more than twenty centuries behind it, and the practical work of the engineer appeals even to the dullest of intellects; but we have failed thus far, in this country especially, to adequately esteem the worker in the intermediate field. We must look to it that more attention is given to this field in our colleges and universities. Every university should have two or three men eminent in mathematical physics as well as two or three men eminent in pure mathematics. Thus, while I would not advocate the pursuit of pure mathematics or the pursuit of practical engineering less, I would urge the pursuit of mathematical physics more. It is only by the cultivation of this branch of study and investigation that we can keep alive the sources of engineering knowledge. Important and indispensable as the practical work of the engineer is, the cultivation of investigation and discovery in his science is still more important and indispensable. Hence I would urge that when the more pressing questions of elementary instruction in mathematics and engineering have been adjusted, we give attention to the more inspiring and more important questions of the clarification and enlargement of the fundamental ideas of our sciences.

R. S. Woodward

THE CHICAGO ACADEMY OF SCIENCES[1]

In his historical sketch of the academy, published in 1902, Mr. W. K. Higley, late secretary of the academy, divides the history of the institution into three periods, first, that preceding the fire of 1871; second, that between the time of the fire and the erection of the present building in Lincoln Park, and third, the period dating from the occupancy of these new quarters. It is often of interest and value to cast a retrospective glance over a period of years in the history of an institution, in order that a clear idea may be obtained of the value of the operations. It is now thirteen and a half years since the building was first occupied and the intervening years have witnessed a steady growth in the collections and also in the interest of the academy's work among the citizens of the community and of the city. The collections which were turned over to the curator in July, 1894, were comparatively small in number, although containing some very interesting and valuable material. The records show an aggregation of about 55,000 specimens on this date. In the thirteen and a half years this number has been increased fourfold; the number of specimens in the museum January 1, 1908, being 226,781, or an increase of 171,781 specimens. It must be remembered that the majority of these additions were presented by the owners or collectors, as there has been no fund for the purchase of specimens. It must not be forgotten, however, that several members of the academy, like our deceased patron, Mr. George H. Laflin, have from time to time given money for the purchase of material, but the entire amount spent for such purposes has not exceeded $5,000. A part of the collections have been secured by the museum staff while on their vacations.

An analysis of the additions shows that three departments head the list in the number of additions:

Mollusca	89,757
Insects	33,914
Paleontology	21,145

The first named contains several types, a larger number of cotypes and a very extensive series of autotypes and locotypes, as well as many rare species and development series. The same is true of the fossil collection and to a less degree of the insect collection. The

[1] Extracted from the annual report of the secretary.

total collection of Mollusca now numbers over 140,000 specimens.

It is interesting to note that thirteen years ago the main museum floor was supplied with cases which were filled with very indifferent specimens, poorly installed. At the present time three floors are crowded with cases, which are filled with much excellent material, some of which is as good as can be obtained. The old strictly taxonomic system of installation has been replaced by one of a more or less ecological character, which is calculated to educate the visitor along nature-study lines. For this purpose eight large groups and forty-five smaller ones have been constructed, showing to a greater or less degree some of the interesting habits of native animals. The taxidermic work has all been accomplished by Mr. Frank M. Woodruff, with the rarely occasional assistance of an extra taxidermist in large group work. The taxidermist has also filled the positions of ornithologist and photographer, having prepared over 2,600 slides, negatives, etc., in the past seven years. The minerals, rocks, fossils and physiographic collections have been likewise arranged with the educational idea in view.

The library has shown comparatively as large an increase as the museum. Beginning in 1894 with 8,381 books and pamphlets, it has increased in 1907 to 26,821 books and pamphlets, or a growth of 18,440 in thirteen and a half years. It is also noteworthy that the exchange list of foreign and domestic societies has grown from 120 in 1894 to 542 in 1907, or an increase of 422. This increase has been made possible by the continued issue of the publications of the Natural History Survey. The gratitude of the academy is due to the many foreign and domestic societies who have so generously continued sending their large and valuable publications when those of the academy have been so few and their issue so irregular.

The satisfactory labeling and cataloguing of a museum is a subject of no small magnitude and the academy was not able until the year 1900 to secure the assistance and material necessary for the successful carrying on of this important work. At this time a printing outfit was secured and very satisfactory work has been carried on by this department in the eight years of its existence, during which time 20,433 labels have been printed, aggregating 100,000 impressions. In 1903 a new set of registration books was opened, and a card catalogue of the museum begun. During the four intervening years over 26,000 entries have been made. In comparing the work of this department with that of other institutions it must be remembered that it has all been accomplished by one assistant, a lady, whose duties in addition are to send all acknowledgments, typewrite all letters and manuscripts for publication, and attend to other office duties, besides assisting in the care of the library. She also learned to do the printing when that system superseded the old hand-written label.

The value of a museum of natural history is oftentimes measured by the attendance, although a large attendance is frequently due to the advantageous location of a museum, rather than to its interest for the public. It is interesting to note that if classed by its attendance the academy would stand well up among the larger museums of the United States. For a number of years the attendance was accurately kept at the Academy of Sciences, and during five years the smallest attendance was 245,214 and the largest 413,390, or an average of 338,352. It is believed that more than 4,567,000 people have visited the museum during the thirteen and a half years of its occupancy of the building in Lincoln Park. A comparison of the attendance of the larger institutions with that of the academy is significant:

American Museum of Natural History, New York City	467,133
U. S. National Museum and Smithsonian Institution, Washington	360,547
Chicago Academy of Sciences	338,352
Field Museum of Natural History, Chicago	254,516
Brooklyn Institute Museum, including Children's Museum	229,025

A notable feature of the academy's work has been the use of the museum and its staff in supplementing the nature work of the public schools. In addition to the usual classes which visit the museum as a special holiday occasion, several schools have devised a plan by which the museum exercise becomes a recognized part of the school work and counts in points as does any other part of the curriculum. Classes are taken to the museum in charge of the teachers who provide them with question blanks or direction sheets and allow the pupils a certain length of time for the completion of the work. The notable feature of this class of work is the discipline which prevails.

Several of the high school teachers have given Saturday morning lectures on bird study to their classes, in the lecture hall of the academy and for a time a series of lectures was given for children.

During two years a course of lectures on biology was given for the benefit of teachers interested in nature work. Laboratory and study facilities have also been freely placed at the disposal of those teachers who wished to carry on more extended studies.

Some of the museum collections have been largely used for loan purposes and much of the duplicate material has been freely placed at the disposal of those schools or teachers who expressed a desire to use a small hand collection in the class-room. Lantern slides and other photographic material have also been freely loaned for educational purposes.

It is noteworthy that a large per cent. of the museum visitors are of the more intelligent class of people, who visit the museum from a higher motive than that of mere curiosity, although it is unquestionably true that many visitors are of this latter class.

Since 1895 the academy has conducted yearly a series of popular lectures in addition to its regular monthly meetings. The effort has been made in these lectures to popularize the various branches of science and still keep them up to the highest standard of excellence. These lectures have been given in courses of from six to twelve each, two or three courses being given in a year. Two hundred and seventy-eight such lectures have been given during the past thirteen and a half years, at which the total attendance was 43,856. One hundred and twenty-five regular meetings have been held, at which 6,765 members and their friends listened to the reading and discussion of scientific papers. This phase of the academy's work has proved of great educational value.

A portion of the time of the museum staff has been consumed in the identification of material for other institutions, or for scientific workers, and during the past four years nearly 35,000 specimens have been thus cared for.

In making a retrospective study of an institution much depends upon the resources available in estimating the value of the work accomplished, and the results seem large or small as the income is small or large. For the past thirteen and a half years the only assured income for maintenance has been $5,000 per year, which is given by the commissioners of Lincoln Park for the privilege of having the museum in the park and free to the people at all times. In addition to providing this sum of money the commissioners heat, light and clean the building. This sum of $5,000 has been variously augmented through the generosity of friends of the academy and by the annual membership fees. The income has fluctuated, being the lowest in 1898, when it was $5,321.60, and the highest in 1895, when it rose to $14,190.48. During the thirteen years under consideration the total income has been $96,024.07, or a yearly average of $7,386.46. When compared with the princely incomes of such institutions as the American Museum in New York, the Field Museum in Chicago, or even the smaller Public Museum in Milwaukee, with its nearly $30,000 yearly income, the resources of the academy seem small indeed and it is remarkable that it has been possible to accomplish even the small amount of work herein detailed, with such scanty resources. It is encouraging to reflect that, with the additional endowment provided by the Moses Wilner Bequest, the yearly income will soon amount to $10,000.

In closing this very brief summary of the work accomplished during the past thirteen years, the fact should be emphasized that it is not so much the number of specimens which have been received nor the amount of detail work which has been accomplished which determines the success or failure of an institution, but rather the impression which may have been made upon the community in inciting to higher ideals of life, and the quality of the contribution to the advancement of science and education which has been made.

Frank C. Baker,
Acting Secretary

THE LLOYD LIBRARY AND MUSEUM

This institution is legally a stock company, the stock being owned and the institution supported by Curtis G. and John Uri Lloyd, of Cincinnati, Ohio. Mr. C. G. Lloyd has erected the buildings and supports the botanical section, and Professor John Uri Lloyd supports the pharmaceutical department. The buildings and contents are transferred to the stock company, and funds are provided for its continuance when the life work of its builders is finished. It will never be sold, and will always be a free and public institution for the benefit of science.

Building No. 1 was erected by C. G. Lloyd in 1902, and was designed to contain both the books and the specimens, the two upper floors being devoted to the books and the lower floor to the specimens. During the short time that has intervened the library has increased so rapidly that the building is inadequate for its purposes, and during the past winter a new building has been erected to be devoted exclusively to the library. The old building, now known as the Lloyd Museum, will contain the herbarium and the mycological collection. The herbarium of pressed plants is estimated at about thirty thousand specimens, chiefly obtained by exchange by C. G. Lloyd during his earlier years. The mycological department contains many thousand dried specimens of fungi, particularly of the Gastromycetes, estimated at not less than five thousand different collections. There are more specimens of this family ten times over than in all the other museums of the world combined.

Building No. 2 was erected in the winter of 1907 and 1908. It is four stories, 22½ by 72 feet. It is devoted exclusively to botany and pharmacy (with a section on eclectic medicine), and contains a collection of books among the largest on these subjects. The volumes have not been counted, but some idea of the number may be obtained from the following statistics: There are 6,253 linear feet of shelving, and the books now occupy 2,600 linear feet of this space. As a shelf is found to hold on the average 429 books to every 50 linear feet, the estimated number is 22,308 volumes. Cases have been placed in the upper floor, but the other three floors have only wall shelves, with provision made for floor cases in future as the needs of the library may require. When completely filled with shelving the library has a capacity of 11,413 linear feet, sufficient to shelve 98,000 volumes. If the collection of books continues to increase as it has in the past five or six years, the full capacity of this library will be taken in the next twenty years. The founders propose to make the Lloyd Library in time a practically complete library of its subjects.

LEHIGH UNIVERSITY AND THE UNIVERSITY OF LIVERPOOL

On July 3, the University of Liverpool, acting on behalf of Lehigh University, under letters of attorney duly authorizing the act, conferred on Horace Field Parshall, the well-known electrical engineer, of London, the honorary degree of master of science. Mr. Parshall is an American, a graduate of the electrical course at Lehigh University of the year '87.

The letter of Vice Chancellor Dale, of the University of Liverpool, to Dr. Henry S. Drinker, president of Lehigh University, accepting this duty, is pleasing in its hearty expression of international comity. He says:

"The Council and Senate of this University have agreed to act on the suggestions that you make, and to confer formally on Mr. Parshall the honorary degree that has been awarded to him by the University over which you preside.

When the hood and diploma have reached us I will then arrange with Mr. Parshall for his formal admission to the degree.

"So far as I am aware no precedent or parallel for such an act can be found in the history of British Universities. But it is our business to make precedents as well as to follow them, and we trust that in so doing our act will be regarded as an expression of fellowship and sympathy with kindred institutions carrying on similar work, established for similar services, and bound to us by many ties."

The degree was conferred at a special "congregation" of the University of Liverpool, attended by the United States consul general and many distinguished guests. The dean of the faculty of science presented Mr. Parshall for admission to the degree, and the vice chancellor duly admitted him.

SCIENTIFIC NOTES AND NEWS

Governor Guild, of Massachusetts, has appointed a State Conservation Commission to act in cooperation with the National Conservation Commission named by President Roosevelt after the recent conference on resources. It is composed of Professor F. W. Rane, state forester, chairman; Professor George F. Swain, of the Massachusetts Institute of Technology, and President Kenyon L. Butterfield, of the Massachusetts Agricultural College, Amherst.

Professor Wm. T. Sedgwick, of the Massachusetts Institute of Technology, has been appointed one of a commission of four to investigate the causes of typhoid fever in Pittsburgh, by Mayor Guthrie, of that city. The expenses of the investigation will be paid out of $10,000 appropriated by the Russell Sage Foundation. He was also offered by Mayor Hibbard, but felt obliged to decline, one of the vacancies in the Board of Health.

Dr. L. O. Howard, chief of the Bureau of Entomology of the U. S. Department of Agriculture, and permanent secretary of the American Association for the Advancement of Science, has been made an honorary member of the Société Nationale d'Acclimatation de France.

Professor Holland, K.C., has been elected a corresponding member of the "Reale Academia delle Scienze dell'Istituto" of Bologna, as also an honorary member of the "Reale Academia di Scienze Lettere ed Arti" of Padua.

At the annual general meeting of the Faraday Society, held in London, on June 23, Sir Oliver Lodge was elected president and the following vice-presidents were chosen: G. T. Beilby, R. A. Hadfield, Professor W. Hittorf, Professor A. K. Huntington, Lord Rayleigh, Professor A. Schuster and Professor J. J. Thomson.

The council of the Royal Society of Edinburgh has awarded the Neill prize for the triennial period 1904–7 to Mr. Frank J. Cole, lecturer on zoology, University College, Reading, for his papers entitled "A Monograph on the General Morphology of the Myxinoid Fishes, based on a Study of Myxine," published in the "Transactions" of the society, regard being also paid to Mr. Cole's other valuable contributions to the anatomy and morphology of fishes.

Dr. W. J. Holland, the director of the Carnegie Museum, has returned after three months' absence in Europe during which he installed in Berlin and in Paris casts of Diplodocus Carnegiei which were presented respectively to the emperor of Germany and the president of the French Republic. The latter on June 15 conferred upon Dr. Holland the order of Officier de la Légion d'Honneur "in recognition of his services to the science of paleontology," and upon his assistant, Mr. A. S. Coggeshall, he bestowed the order of Officier de l'Instruction Publique. On the evening of the same day a banquet in honor of Dr. Holland was given by the professors of the National Museum, which was attended by many of the leading scientific men of Paris. Addresses were made by M. Paul Doumer, M. Bayet, assistant minister of public instruction, Professor Edmond Perrier, Professor Gréhant, Professor Becquerel and others. On the evening of June 14, Dr. Holland delivered an address in the French language on the work of Mr. Andrew Carnegie on behalf of science, before an audience of fifteen hundred people assembled in the Grand Amphitheatre at the Jardin des Plantes. An abstract will shortly appear in the *Revue Scientifique*.

The Smithsonian seat in the Zoological Station at Naples, Italy, has been assigned for a period of from four to six months between October 1, 1908, and June 1, 1909, to Harold S. Colton, Ph.D., of the University of Pennsylvania.

Herbert Parlin Johnson, Ph.D. (Chicago), associate professor of bacteriology in St. Louis University, will return to his work in October much improved in health by two years leave of absence.

Professor Charles James, of New Hampshire College, is at present in Norway collecting a supply of the rare minerals for a continuation of his work on the rare earths. He has already secured several hundred pounds of euxenite and other minerals, which he will work up in his private laboratory at Kettering, England, and bring the crude oxides with him on his return to America. He has already about one hundred and fifty grams of lutecium and about fifty grams of thulium on hand, but is desirous of largely increasing the amount of these substances, as well as his already extensive supply of erbium compounds, in order that they may be separated in that special degree of purity which can only be secured when working with large quantities.

We regret to record the following deaths: Professor J. V. Barbosa du Bocage, director of the Zoological Institute, at Lisbon, at the age of eighty-four; Dr. Luiz Cruls, director of the Observatory of Rio de Janeiro; Dr. Heinrich Wilhelm Struve, known for his work in chemistry, at Tiflis, at the age of eighty-five years; and Dr. Erich Ladenburg, docent for physics at Berlin, at the age of twenty-nine years.

A movement is on foot to organize the Physical Section of the American Chemical Society as a Division of General and Physical Chemistry of that society as has been done by the industrial chemists and chemical engineers. The Physical Section at New Haven, under the chairmanship of Dr. F. K. Cameron, had an unusually extensive program consisting of some forty-eight papers. Greetings were received from Arrhenius, Emil Fischer, Roscoe, Ramsay, van't Hoff, Julius Thomsen, Lunge and von Baeyer, and papers were sent for the meeting by Svante Arrhenius on "Agglutination and Coagulation" and two papers by Emil Fischer on "Polypeptides" and on "Micropolarization."

In the new tower that is being built in place of the old stone tower at Blue Hill Observatory, the Massachusetts Institute of Technology will install its new seismograph. The tower is being made moisture-proof as far as is possible. When the seismograph is installed, it will be under the charge of the observatory force.

Pursuant to a recent decree of the government of Peru issued by President Pardo, the time of the seventy-fifth meridian west of Greenwich was on July 28 adopted as the national standard time for the whole of Peru. As pointed out by Professor Todd, in his address to the Geographical Society of Lima last August, the advantages of standard time would be specially marked as the proposed meridian is only a few minutes from that of Lima, and runs almost exactly through the middle of the country. Rarely is a country more favorably placed geographically for adoption of standard time, which has everywhere proved a great benefit in greater facility of commercial despatches, as well as precise regulation of internal affairs and international intercourse. All timepieces throughout Peru will now coincide with those in the United States where eastern time is kept. Peru is the first South American republic to adopt the world standard.

In connection with the celebration of the tercentenary of the birth of Evangelista Torricelli, an exhibition will be held at Faenza from August 15 to October 15. Included in the program, and associated with an international section for physical apparatus, in celebration of Torricelli a prize of 2,000 lire is offered for an instrument in connection with meteorology or physics of the earth. The instrument must be exhibited, and show real novelty, either in its principle or in its application of a principle already known. For further particulars application should be made to Dr. W. N. Shaw, F.R.S., Meteorological Office, 63 Victoria Street, London, S.W.

Nature says: "At the General Conference on Weights and Measures, held at Paris in October last, a resolution was unanimously passed urging the universal adoption of a metric carat of 200 milligrams as the standard of weight for diamonds and precious stones. This proposal, which received a large measure of support on the continent, especially in France, Germany, Spain and Belgium, was brought under the notice of the principal diamond dealers in this country by the Board of Trade early in the present year, but it has not met with a favorable reception from the trade, and unless the proposed new standard is generally adopted abroad it is unlikely that any further action in the matter will be taken by the government. The French Ministry is now introducing a bill to legalize the 'metric carat' of 200 milligrams in that country, and to prohibit the use of the word carat to designate any other weight. A recent resolution of the Bombay Chamber of Commerce shows that the proposal for an international standard carat is receiving favorable consideration in India."

Governor Hughes has signed a bill passed by the New York legislature declaring tuberculosis to be an infectious and communicable disease, dangerous to the public health, and providing for the reporting of all cases to the local health authorities. According to the *Journal of the American Medical Association*, it provides for the free examination of sputum by the health authorities, for the protection of the registration records from public inspection, and for the disinfection and renovation of the premises after the death of a person having tuberculosis. The occupation of premises vacated by a tuberculous person is prohibited until the directions of the health department providing for disinfection and renovation have been complied with. The bill was lengthy and some of the important sections follow: Section 8 makes it the duty of the physician to take all reasonable precautions for the protection of individuals occupying the same house with any one having tuberculosis. If there be no physician in charge of such patient, this section provides that this duty devolves on the health officer. Section 9 provides that the attending physician shall report to the health officer, on blanks to be furnished for this purpose by said officer, a complete statement of the procedure and precautions taken by him in a case of tuberculosis coming to his notice, and the physician shall receive for his services a fee of $1. If the physician does not desire to take these preventive measures and make this report, the duties therein stated shall devolve on the health officer, who shall receive said fee. The health officer is required to keep on hand and furnish suitable supplies and literature to physicians to aid in preventing the infection of others. Section 10 provides a penalty for the failure of physicians or others to execute the duties imposed by this act, or for making false reports, the penalty not to exceed $100, or six months in prison or both. Section 11 provides for the reporting by physicians of the recovery of the tuberculosis patients, and for their release thereon under the provisions of the law. Section 12 makes violation of any section of this act a misdemeanor, punishable by a fine of not less than $5 or more than $50.

A bulletin of the Forest Service calls attention to the fact that the supply of dogwood and persimmon shuttles in the southern states is nearly exhausted. This statement will not appear significant to the average man when he first hears it. But when he is told that the entire supply of shuttles, bobbins and spindles used in the cotton and woolen mills in all parts of the country is furnished by the dogwood and persimmon growing in the southern states, the seriousness of the situation is apparent. The textile mills of the country represent a capitalization of nearly a billion dollars, and bobbins, shuttles and spindles are just as necessary parts of these mills as the throttle is to the locomotive. Fortunately the shuttle manufacturers have found another source of supply in the dogwood stands in the far northwest part of the country. Two large companies manufacturing spindles, shuttles and bobbins have erected plants in the Cascades in Oregon, whose dogwood forests are the greatest in the world, the tree often attaining a height of 75 feet and a diameter of one to two feet. The southern dogwood is rarely more than 6 inches in diameter. Extensive stands of dogwood are also found in California and Washington. Up to the present time, lumber users in the Pacific northwest have found dogwood valueless except for fuel, and its utilization for the manufacture of shuttles will bring about a considerable increase in stumpage values of this tree. These companies, at their Oregon plants, will not only manufacture the articles named, but will utilize every part of the tree, turning to account the waste wood and producing such by-products as pyroligneous acid, acetic acid, protacetate of iron, acetate of lime, methylated spirits, solvent naphtha, wood tar, wood pitch, and various forms of charcoal. Dogwood is indispensable in the manufacture of shuttles, bobbins and spindles, because it is the only wood which takes a high polish and wears perfectly smooth by friction under water. The discovery of the adaptability of the Pacific dogwood, however, has not aided the eastern manufacturers, and they have been obliged to look for substitutes nearer home. The most promising of these are mesquite and tupelo gum. The wood of the mesquite is heavy and very hard, close grained, and has a compact structure. It is probable that it would be eminently adapted for the manufacture of shuttle blocks, as it appears to have all the requisite qualities of weight, hardness, and susceptibility to a high smooth polish. Already it has proved well fitted for the manufacture of spools and bobbins for which white birch is now so largely used. The tupelo gum is medium hard and heavy, and has a compact fibrous structure. It has not yet been utilized to much extent in the textile industries, though it is quite probable it will play an important part in the future, since it combines with several necessary qualities the exacting property of wearing smooth by friction.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Illinois, on July 3, let a contract for the erection of the physics building, for which the last legislature made an appropriation of $250,000. The building is to be of brick with Bedford stone trimmings, and is to be fireproof. Its length is 178 feet and depth 125 feet. The first floor is rectangular, and the three upper floors are U-shaped. The space between the wings on the first floor is used for the large lecture rooms, in which overhead lighting is used. In addition to the large laboratories and class-rooms for the regular undergraduate courses, the building contains twenty-four small laboratories specially arranged for research students. The university was fortunate in letting its contract at a time of lower prices, so that funds are available for satisfactory furnishing and equipment of the building. The building is to be completed in the summer of 1909. A contract has also been let for an addition to the natural history building, for which the last legislature appropriated $150,000.

A school of journalism has been organized in the University of Missouri, with Professor Walter Williams as dean. As a laboratory feature it has the *University Missourian*, a small but well-balanced daily newspaper, upon which the work will be done, under the direction of experienced newspapermen, by the students of the school. Courses will be given in the history and principles of journalism, in newspaper administration, in illustration, in the libel law, in news-gathering, in reporting, in editorial writing, in office equipment, and in other purely professional branches. In addition, courses will be given in English composition and literature, history, government, sociology, economics and other academic branches desirable for preparation for journalism. The course will cover four years, but a combined course will be offered, in which both the work in the College of Arts and Science (the academic department) and the School of Journalism can be taken in five years. Tuition in this school, as in all departments of the university, is free.

Commencing in 1909 students entering the College of Medicine of Syracuse University must have satisfactorily completed one full year, and on and after October, 1910, two full years in a science or arts course in a college recognized by the regents of the State of New York and in that course and in their preparation for it a competent course in physics, chemistry, Latin, one modern language and biology must be included. The equivalent of this requirement, that is, evidence of having passed college examinations for admission to the sophomore or junior class in a recognized college by a student possessed of a medical student certificate from the State Educational Department, will be accepted. Hereafter all chemistry except applied chemistry will be taught in the new Bowne Chemical Laboratory of the College of Liberal Arts instead of in the College of Medicine as heretofore.

Professor C. H. Eigenmann, professor of zoology, has been appointed dean of the Graduate School of Indiana University.

Dr. Frank D. Adams, Logan professor of geology, has been appointed dean of the faculty of applied science at McGill University.

Mr. H. F. Dawes, M.A., who has held the Wollaston research studentship at Gonville and Caius College, Cambridge, for the past two years, has been appointed lecturer in physics in his alma mater, the University of Toronto. Mr. C. S. Wright, B.A., of the University of Toronto, has been awarded the Wollaston research studentship in physics by Gonville and Caius College, Cambridge, England. This studentship has an annual value of £120, is tenable for two years, and is open to all graduates of British and American universities.

Appointments and promotions at the Massachusetts Institute of Technology have been made as follows: Arthur A. Blanchard, assistant professor of inorganic chemistry; Alpheus G. Woodman, assistant professor of food analysis; Ervin Kenison and Harry C. Bradley, assistant professors of drawing and descriptive geometry; Hervey W. Shimer, assistant professor of paleontology; Joseph C. Riley and Charles W. Berry, assistant professors of mechanical engineering; Harrison W. Hayward, assistant professor of applied mechanics.

The following changes have been made in the faculty and curriculum of the College of Medicine, Syracuse University: Frank P. Knowlton, A.M., M.D., associate professor of physiology, to be professor; H. S. Steensland, B.S., M.D., associate professor of pathology and bacteriology, to be professor; H. D. Senior, M.B., F.R.C.S., associate professor of anatomy, to be professor. Ernest N. Pattee, M.S., professor of chemistry in the College of Liberal Arts, has been made a member of the faculty of the College of Medicine. Richard H. Hutchings, M.D., medical superintendent of St. Lawrence State Hospital, Ogdensburg, N. Y., has been appointed lecturer on psychiatry; Ralph R. Fitch, M.D., of Rochester, N. Y., has been appointed lecturer on orthopedics; Charles V. Morrill, A.M., recently assistant in zoology in Columbia University, New York, N. Y., has been appointed lecturer on histology and embryology.

Dr. George Dock, professor of the theory and practise of medicine in the University of Michigan, has accepted the chair of the theory and practise of medicine, and clinical medicine, in the medical department of Tulane University, Louisiana.

Professor Ernest L. Ohle, B.S. '02, M.E. '05 (Case), who has been head of the department of mechanical engineering, and professor of steam engineering, at the State University of Iowa since 1905, has been appointed professor of mechanical engineering at Washington University. This professorship was made summer by the resignation of Fernald. Mr. William H. Roever, Washington, '97), Ph.D. (Harvard, '06), has been appointed assistant professor of mathematics to take the place of Dr. Wernicke, who has resigned. Dr. Roever has been for the last three years instructor in mathematics at the Massachusetts Institute of Technology.

DISCUSSION AND CORRESPONDENCE

MEANING OF THE SPANISH WORD GAVILAN

In a recent translation of a Spanish manuscript in the Bancroft Library of the University of California, entitled "A Mission Record of the California Indians," by Dr. A. L. Kroeber,[1] the following sentence occurs (p. 4): "They have a great desire to assemble at a ceremony regarding a bird called vulture (gavilan)." And in a foot-note it is stated that the bird "is more probably the eagle than the California condor, which the word gavilan properly indicates."

As a matter of fact the word *gavilan* means neither eagle nor vulture, but among Spanish and Spanish-Mexican people is the ordinary common every day word for hawk. In the same language eagle is *aguila* (pronounced *ag'-il-lah*), but the California condor has no name (because it does not inhabit either Spain or Mexico), although the Spanish-speaking people of southern California usually call it *vultur*, or *vultur grande*.

There is no doubt, however, that several of the early Mission Padres failed to distinguish the eagle from the large hawks, and used the name *gavilan* indiscriminately for both; hence Dr. Kroeber is entirely right in assuming that the ceremonial bird of the Mission Indians of Southern California is the eagle. It is the golden eagle (*Aquila chrysäetos*).

In another place in the same article (p. 7, foot-note) Dr. Kroeber states: "Boscana, however, describes the bird as much resembling the common buzzard, but larger, which clearly makes it the condor." This seemingly natural inference is entirely erroneous. Buzzards are large hawks—not vultures—and the bird we in America call "turkey-buzzard" is not a buzzard at all, but a vulture. Boscana's "common buzzard" is a large hawk closely related to our red-tail, and the bird he described as "much resembling the common buzzard, but larger," was of course the golden eagle. Had he meant the turkey-buzzard he would have used the Spanish-Mexican word *aura* (pronounced *ow'-rah*), which is the name by which the turkey-buzzard is known among the Spanish-speaking people of California.

C. Hart Merriam

[1] *Univ. of Calif. Publications*, American Archeology and Ethnology, Vol. 8, No. 1, May, 1908.

QUOTATIONS

PROFESSORS' SALARIES

The finger tips of that virgin science, comparative college economics, have again been kissed by the investigators working for the Carnegie Foundation. "The Financial Status of the Professor in America and in Germany" is the theme of that institution's second bulletin, and the statistics therein arrayed baptize the new field of research with the good old family name, "the dismal science." The scenes unrolled do not conduce to gayety or pride. About a third of all American colleges report that their full professors receive an average salary of less than $1,000 a year, while a scant half confess to paying between $1,000 and $2,000. Elaborate computations, based on fairly complete evidence, show "that an American teacher who has gone through college, taken a post-graduate course and prepared himself for the profession of teaching may hope to obtain at the age of twenty-eight a salary of $1,250, at thirty-one a salary of $1,750, at thirty-three a salary of $2,250, and at thirty-five—at which age the able man will have gained his professorship—a salary of $2,500." His German colleague, having survived the long ordeals of the *Privatdocent*, receives an income whose purchasing power is about 50 per cent. greater.

But such summaries bring few new griefs; everybody has long known in a general way that American college professors as a class have to seek odd jobs during vacation and evening hours in order to keep alive. The details, however, upon which this common knowledge is built must bring it home with a sting to the alumni of almost every *alma mater*. The policy of many colleges resembles only too faithfully that of the "university" which, while building a gymnasium with $400,000 raised by mortgaging its campus, pays its full professors an average yearly salary of $1,806 and employs only one instructor for every twenty undergraduates. On the other hand, Haverford College finds scarcely an imitator courageous enough to foreswear stadia and a hundred pompous "special courses" for the sake of paying its professors an average of $3,440 and having an instructor for every 6.5 students.

Every college man is invited to learn from the statistics how his old teachers are being treated. Publicity is the first step toward the overthrow of the painful policy which makes one professor give twenty-five lectures a week, forces another to house his family of four in a six-room flat five flights up and compels a third to do typewriting in order to pay for a small insurance policy. If the Carnegie Foundation could only send its bulletin to every man who ever emitted a class yell, college trustees might soon be dissuaded from building marble halls with teachers' salaries. In saying this we do not forget the many instances in which the almost necessary acceptance of a gift or legacy is embarrassing because of the expense which results from the conditions attached to it. College faculties might also abandon the fatuous plan of multiplying courses to allure freshmen and prevent professors from indulging in research and constructive work. Perhaps this would be attained still more easily if the bulletin were supplemented by a table showing what percentage of college instructors enjoy private incomes. If there is any evidence that the well-to-do, simply by virtue of their being well to do, have conspicuously superior chances of getting and holding academic places, the question of professorial salaries may have to be faced and answered as a problem of democracy.—*New York Tribune.*

SCIENTIFIC BOOKS

EVOLUTION OF NIAGARA FALLS[1]

The latest and most elaborate study of the physical history of Niagara is issued by the Geological Survey of Canada. Dr. J. W. Spencer, who decades ago had made important contributions to the subject, renewed his attention in more recent years and was commissioned by the Survey to give it monographic treatment. The outcome is an attractiv[2] volume of five hundred pages, illustrated by excellent and appropriate views and maps. It deals primarily with the history of the recession of the cataract from end to end of its gorge. As a foundation for that history it describes with much detail the local physical features, and discusses the contemporaneous distribution and discharge of waters in the region of the Upper Lakes, as well as the sequence of water levels in the Ontario basin. As a sequel to the history it computes in years the time that has elapst since the river and cataract came into existence. Subsidiary to the question of time are chapters on the present rate of recession of the falls and on the rainfall and run-off of the Erie and Huron basins. Less closely related to the central theme are chapters on pre-glacial drainage, the origin of the Laurentian Lakes, the utilization of the river for the generation of power, and the position of the international boundary line. There is a discussion of the present stability or instability of the land in the Great Lakes region, with the conclusion that no earth movements have occurred in modern times.

In the study of local features a series of soundings were made with apparatus of the Kelvin type—the only type adapted to the exploration of waters in violent commotion. These showed a depth in the Whirlpool of 126 feet and a maximum depth, near the foot of

[1] "The Falls of Niagara; Their Evolution and Varying Relations to the Great Lakes; Characteristics of the Power, and the Effects of its Diversion," by Joseph William Winthrop Spencer, M.A., Ph.D., F.G.S. 1905–6. Geol. Surv. Canada; Ottawa, 1907.

[2] The recommendations of the Simplified Spelling Board are followed in this paper.—G. K. G.

Goat Island, of 192 feet. Borings also were made, in the region of the pre-Niagara channel from the Whirlpool to St. David; and the crest of the Canadian fall was remapt.

The oldest view of the falls, a view based on the observations of Father Hennepin in 1678, represents a jet as pouring from the western shore athwart the face of the Canadian sheet. In a general way the sketch is crude, exaggerated and untrustworthy, but this particular feature is of so unusual a character as to encourage the belief that it corresponds to something that Hennepin actually saw—some peculiarity in the cataract which no longer exists. Spencer has been able to connect it with an old hollow or channel on the Canadian shore, a hollow now filled and effaced, and by means of this connection infers the approximate position of the cataract more than two centuries ago. He thus obtains an additional datum for the computation of the average annual recession of the falls in modern times and secures a rough but valuable confirmation of the result based on the definit surveys of later years.

There is wide interest, both popular and scientific, in the problem of the age of Niagara, or the time that has elapst since the cataract began, at the cliff near Queenston and Lewiston, the excavation of the gorge; and the fact of that interest is the reviewer's excuse for giving special attention to the author's discussion of this question. Spencer treats the subject at considerable length, and has much confidence in the result of his computations—an estimate of 39,000 years. "Slight variations on one side or the other are probable, but under the conditions, all of which are now apparently known, the error in calculations will not exceed ten per cent." (p. 11). The reviewer unfortunately finds himself unable to share this optimistic view.

The general plan followed in the computation is this: The present average annual rate of recession of the Canadian fall is estimated from maps made in 1842 and 1904–5. This rate is associated with a particular hight of the fall and with a particular volume, or discharge, of the river. At earlier stages in the history of the cataract its hight was different, and the discharge was different; and the computations make allowance for these differences. The differences in hight were connected chiefly with the southward dip of the strata, and with the variable altitude of the base-level afforded by standing water in the Ontario basin; and the range of hights was from 35 to 280 feet, the present effectiv hight being 180 feet. The differences in volume were all in one direction. During the early part of the period of recession the water of the Huron and higher basins reacht the sea by a different route, the Erie drainage only flowed thru the gorge, and the discharge was 15 per cent. of the present. At a later epoch there may have been a temporary diversion of a fraction of the Huron discharge, reducing the river to 67 or 75 per cent. of its present volume. To combine these various factors, the gorge is divided into sections, each section is computed by itself, and the whole is summed.

The principle on which allowances are made for differences in the hight and discharge of the cataract is thus stated (p. 350): "According to mathematical laws, erosion is proportional to the hight of the falls and the volume of the river, provided other conditions remain constant." The context interprets "erosion" in this formula to mean rate of recession, and "volume" to mean discharge; so that the law may be more definitly stated: Rate of recession is proportional to the hight of the falls and the discharge of the river. As the energy of the cataract (per unit time) is measured by the product of hight, or head, into discharge, it is implied that *the rate of recession is proportional to the energy of the cataract.* (In a footnote Spencer says "The erosion varies with the mass and square of velocity," which also implies that it is proportional to the energy.)

I put the law into this form for the sake of comparing it with the experience of mechanical engineers. The cataract is a natural engin, and the erosion and recession correspond to what Rankine calls "useful work" in the discussion of artificial engines. As the ratio of the useful work rendered by an engin to the energy it receives is the "efficiency" of the engin, so the quantitativ relation between the recession of the cataract and its energy is the efficiency of the cataract (in relation to recession). To say that the rate of recession is proportional to the energy is equivalent to saying that the efficiency of the cataract is constant, that it does not change with variation of energy. Now the efficiencies of engines of human construction have been elaborately tested, and they have been found to vary, and vary greatly, with the energy received. Usually the efficiency increases as the energy increases; and an engin with constant efficiency would be a striking exception. Not merely does Spencer's supposed law fail to find support in engineering experience; it is contradicted by it. If the Niagara engin corresponds in this respect to the great majority of man-made engines, the error introduced in the computations by the use of a false law is one tending toward undervaluation of the age of the cataract.

It would perhaps be more pertinent to compare the Niagara engin with other physiographic engines, but in general the efficiencies of such engines have not been investigated. The solitary exception is that of running water regarded as a carrier of detritus, and it happens that the unpublisht results of a study of this engin (SCIENCE, XXVII., 469) are in my possession. Drawing upon them, I am able to say that the efficiency of a stream in the work of transportation rises and falls as its total energy rises and falls, and not only that, but it rises and falls with each of the two factors of energy specified by Spencer, the head and the discharge. If the efficiency of Niagara in producing recession varies according to the same law as the efficiency of a river in transportation, Spencer's estimate of the age of the river should be multiplied by a factor larger than four (assuming, of course, that his other data are accurate).

If the quantitativ data were adequate, the question of the law of efficiency might be discust in a more satisfactory way by studying the American fall in comparison with the Canadian. The mechanical energy of the American is much less than that of the Canadian; and its rate of recession is also much less. By computing an efficiency factor for each fall it is evidently possible to obtain two points on an efficiency-energy curve and thus throw light on the way in which efficiency varies with energy; and the method is peculiarly applicable because the computed energy of the American fall does not differ greatly from the computed energy of the main cataract during the longest division of its history. Calculated from Spencer's data, the energies of the American and Canadian falls, respectivly, are as 1 to 14, and the rates of recession are as 1 to 7, the efficiency of the American being twice that of the Canadian. Had Spencer used this method, or had he based his earlier rate of recession on the American instead of the Canadian fall, his result for the age of the cataract would have been nearer 20,000 than 39,000 years.

But unfortunately the data needed to apply this method do not really exist, the most serious defect being in the measure of the rate of recession of the American fall. Spencer's estimate is 0.6 ft. a year, but is dependent on the map of 1842, which has been shown (Bull. 306, U. S. G. S.) to involve a serious error. The records made by relativly accurate surveys (1875 to 1905) indicate that the recession is so small that its amount is maskt by errors of survey; and a study of the fotografic record (1854–) yields no sure determination of an actual change in the crest line of the fall. It may with confidence be said that 0.06 ft. a year is nearer to the truth than 0.6 ft.; but no definit estimate is warranted. In the judgment of the reviewer, the rate of recession is so small as to indicate that the efficiency of the American fall is much less than that of the Canadian.

Thus in three ways—by comparison with man-made engines, by comparison with river work in the carrying of detritus, and by contrasting the Canadian fall with the American—it is suggested or indicated that the efficiency of the Niagara engin, instead of being constant, increases with increase of energy and decreases with diminution of energy. If the true law were known its application would probably enlarge the time estimate.

But while the discovery of the real law of efficiency would be a notable contribution to the problem, it would not remove every difficulty. In its proper application there would be need to take account of various qualifying conditions, not all of which are readily evaluated. Among them are: (1) The width of the gorge as affecting quantity of erosion. From a gorge 1,000 feet wide twice as much rock must be excavated as from a gorge 500 feet wide in producing a recession of the falls of one foot. (2) The depth of the gorge, from crest of fall to bottom of pool, as affecting quantity of erosion. (3) Concentration of flow as affecting efficiency. For the same discharge and the same hight of cataract, a narrow, deep river is a different engin from a broad, shallow river, and probably has a higher efficiency. If, for example, the cataract were now so broad that the depth of water on its crest was nowhere greater than in the American fall, the rate of recession would be only that of the American fall. (4) Thickness of the capping limestone as affecting efficiency. Where the cap was relativly thick, the quantity of fallen fragments, by serving as pestles for grinding, may have promoted erosion; or, when the river was small and feeble, the fragments may have cumbered the way and interfered with erosion. (5) The relation of the Medina sandrock to efficiency. When the pool hollowed by the cataract reacht only to the sandrock the primary erosiv attack was on the upper shales; when the cataract penetrated the sandrock the primary attack was on the lower shale, and the upper shales were partly protected by the sandrock. The change in method of erosion may have materially affected the rate. Spencer's computations do not include data dependent on these variables.

The determination of the volume of the river at various times involves the correlation of parts of the gorge history with stages of lake history in the Huron and associated basins, so that the lake history constitutes an essential factor. F. B. Taylor, from a study of certain features about the strait connecting Huron and Erie, inferred that the pass, after having once been crost and eroded by a great river, was for a time laid bare. Spencer, from an independent study, infers that from the time when Huron water first overtopt the divide it has been continuously tributary to Niagara. The facts adduced by Taylor (*Proc. A. A. A. S.*, 1897, 201–2) appear to the reviewer demonstrativ, but space can not be taken to discuss the matter. Quite recently Taylor, in summarizing the results of extensiv studies made in later years (Science, XXVII., 725), states that the St. Clair-Detroit channel is now occupied by a great river for the third time instead of the second. Pending the publication of his data the question may be regarded as open, but if his announcement is sustained—that Niagara has thrice instead of once carried large volume, and twice instead of once run small—Spencer's computation will need still further reconstruction.

The Niagara problem resembles other scientific problems in that the enlargement of knowledge leads to the recognition of complexity. It differs from many geologic problems in the great extent of its available data. In all the regions covered by the lakes with whose changes it is concerned, those changes were the latest geologic events, so that their evidences overlie all earlier records. They may not be so plain that "he who runs may read," but they are so clear and full that the patient observer can bring together a complete, coherent, demonstrativ body of data. As the facts are gradually assembled and interpreted an intricate history is developt, a history interwoven on one side with that of the oscillating and waning ice-sheet, and on the other with that of Niagara. The complete correlation of Niagara and the establishment of its chronology promis not only to tell us its age, but to give fairly definit dates to various events in the later Pleistocene history of eastern North America, and to assist the imagination in its broader conceptions of geologic time. Truly the problem is not an unworthy one.

G. K. Gilbert

The Dancing Mouse: A Study in Animal Behavior. By Robert M. Yerkes. New York, The Macmillan Co. 1907. Pp. xxi + 290.

The comparative anatomist, the zoologist and the human psychologist are rapidly accepting the belief that a fact of animal behavior can no longer be surely ascertained by incidental observation. The tendency, however, still to use the now often worthless "notes" of the nature lover and of the old-time naturalist has not completely passed away. For instance, whenever the psychologist needs to find facts concerning phylogenetic expressions of consciousness to illustrate certain well-marked lines of development discovered in the study of the growth of the human mind, he is tempted to resort to the use of this discredited material. The same tendency is exhibited by the anatomists whenever there is need for correlating structure with function.

There is growing a stronger and stronger inclination on the part of both the psychologists and the biologists, of this country at least, to wait patiently for the much needed information about the behavior of animals until the student of behavior can supply it by the use of experimental methods. The process of obtaining facts in this way is admittedly slow; but to those who doubt that there is growing up a body of studies, scientifically made and controlled, we recommend the perusal of Yerkes' book on the dancing mouse.

This book, while not broad in its general implications, is nevertheless a study valuable alike for its history of the development of special problems in the study of animals and for its account of the methods of solving them. Were the book written wholly for the benefit of the investigator trained in the field of comparative psychology, it would need criticism on the score of a too detailed description of methods and apparatus which, later on in the course of the study, are often discarded for better ones. But this manner of presentation has its advantages in that it shows to the novitiate the difficulties and discouragements which may lie in the way of the student of behavior.

The author begins his study of the dancer by an introduction to the literature on the origin and the life history of this interesting animal. The historical research into the origin of the dancer indicates "that a structural variation or mutation which occasionally appears in *Mus Musculus,* and causes those peculiarities of movement which are known as dancing, has been preserved and accentuated through selectional breeding by the Chinese and Japanese, until finally a distinct race of mice which breeds true to the dance character has been established." The age of the race is not known, but it is supposed to have existed for several centuries.

In following chapters, the dance movement is discussed in detail. After sifting the anatomical evidence, Yerkes concludes that no structural variations existing in the ear or in the central nervous system are sufficiently pronounced to account for the dancer's peculiar types of movement. Certain possible peculiarities of structure appear when the ear of the dancer is compared with that of the common mouse, but these variations, at least according to the researches of several prominent investigators, consist neither in the absence of certain of the semicircular canals nor in the presence of neural degenerations in the cochlea, vestibule and auditory pathways. Yerkes points out the fact that our exact knowledge concerning the structure of the auditory apparatus of the dancer is all too meager. What apparent facts have been brought out by certain investigators are hotly contested by certain other investigators.

The adult animals are totally deaf; the tests made in support of this point are complete and adequate. The young animals, on the contrary, do react to auditory stimuli during the third week of life. In a few individuals the response to such stimuli was not obtained either at this or at a later age. The deafness of the adults is especially interesting in view of the fact that the young animals can hear and that the cochlea even of the adults appears not to be degenerated.

The main contributions to the field accruing from Yerkes' book come from the tests of the brightness and color vision of the dancer. The dancer was found to be quite sensitive to changes in brightness. It can readily discriminate white from black and, with some difficulty, Nendel's gray paper No. 10 from No. 20. After many tests, Weber's law was found to hold approximately for the brightness vision of this animal. (The discussion leading up to the demonstration of Weber's law is prolix and not clearly written.) The results of the tests on the color vision of the dancer make it somewhat problematical as regards whether this form has the power to discriminate between chromatic stimulations on the basis of wave-length alone. The author thinks that there is some evidence at hand to show that the mouse differentiates the red end of the spectrum from the other regions. The red end of the spectrum seems to have a low stimulating effect. Whether this is true in the case of other mammals or not remains for further tests to decide. The experimental demonstration of the fact is difficult to make. The safest test to make, it seems to the reviewer, is to determine the reaction threshold of the animal to all the hues of the spectrum and on the basis of these determinations to construct the luminosity curve of the dancer's spectrum. The calibration of the white value of such minimal chromatic stimulations would be exceedingly difficult. The fact is dwelt upon at some length, because if it is true that the luminosity curve is different in different animals (and different even from that of the totally color-blind human being), then the inference that equality of brightness of certain hues in man means equality of brightness of those same hues in animals has no basis in fact. The results which Yerkes presents, however, make it extremely problematical whether any other investigator up to Yerkes has ever touched the problem of color vision in animals.

In the chapter on the rôle of sight in the daily life of the dancer, Yerkes makes tests to determine the relative importance of the various senses which are employed in learning the maze. The maze affords an almost ideal form of problem for this purpose. It offers control of the sensory-motor adjustments without at the same time introducing difficulties which are unsuited to the motor capacities of the animal. In learning the labyrinth, the author states: "It is safe to say, then, that under ordinary conditions habit formation in the dancer is conditioned by the use of sight, touch and smell, but that these senses are of extremely different degrees of importance in different individuals." The reviewer feels that this conclusion is not well grounded in experimentation. To his mind at least, Yerkes has not shown how and to what degree vision, smell and contact stimulations are essential factors in learning the maze. Such impressions, while possibly assailing the animal at every turn in the maze, might be as wholly extraneous to the learning process as is the impression of the flying bird to the hound hot upon the scent of his chosen quarry.

Under habit formation, Yerkes takes up in detail the dancer's ability to learn various forms of labyrinths, to climb ladders and to form discrimination habits (white-black). A satisfactory account of the learning process as a whole is given. Tables of times, errors, etc., are appended so that the learning processes of the dancer can be compared with those of other animals. Indeed, Yerkes's method of presentation might well serve as a guide for the work of future investigators who may deal with this part of the field of behavior. There is need all through our work of standard apparatus and standard methods of experimentation as well as of conventionalized forms of presentation of results.

It is of interest to note that the dancer's method of learning is one of trial and error; there is no tendency on the part of one animal to imitate the acts of another. Putting the dancer through does, however, seem to hasten the formation of an association.

An interesting account is given of the efficiency of training methods. Shall we give an animal at work upon, *e. g.*, the white-black discrimination test, two, ten, twenty or more trials per day? The index of efficiency is given as follows:

For 2–5 trials per day	81.7 ± 2.7
For 10 trials per day	88.0 ± 4.1
For 20 trials per day	91.0 ± 5.3
Continuous test	170.0 ± 4.8

Yerkes suggests that it would be interesting to compare the efficiency of training methods in terms of the duration of the habit. This would have to be done before we could state the general value to the organism of the various methods of training.

In determining the dancer's power of retaining discrimination habits, the author found that a white-black habit may persist during a period of from two to eight weeks of disuse, but that such habits are rarely perfect after an interval of four weeks. The retention of the color discrimination rarely persisted in perfect form for more than two weeks.

Having determined the periods of persistence of such habits, the author next undertook to find out whether training, the results of which have wholly disappeared so far as memory tests are concerned, influences the reacquisition of the same habit. It was found that the ten dancers tested had so lost the habit of the white-black discrimination at the end of a rest interval of eight weeks that memory tests furnished no evidence of the influence of previous training; retraining brought about the establishment of a perfect habit far more quickly than did the original training. Indices of modifiability are given both for the males and for the females, for the learning and for the relearning. The general conclusion issuing from this study is: that the effect of training is of two kinds, the one constitutes the basis of a definite form of motor activity, the other the basis or disposition for the acquirement of a certain type of behavior.

A chapter each is devoted to individual, age and sex differences, and to the inheritance of forms of behavior. Yerkes obtained satisfactory evidence from individuals of one line of descent pointing to the fact that, in their case, a probable tendency to whirl to the left is inherited. In regard to the inheritance of individually acquired forms of behavior, the author states that descent from individuals which had thoroughly learned to avoid the black box gives the dancer no advantage in the formation of a white-black discrimination habit.

In conclusion, we may say that aside from its general usefulness as a reference book for the research student, the book forms a valuable guide to the technique of experimentation upon animals. There is one defect in the book which certainly makes it lose in value for this latter purpose. This defect lies in the over-favorable emphasis given to the method which employs punishment rather than some form of reward (food, etc.) as an incentive. The reviewer feels that Yerkes has not fully justified its claims to priority even for use with the dancer, much less its value as a substitute for other forms of incentive in experiments upon higher mammals.

John B. Watson
The University of Chicago

SPECIAL ARTICLES

THE ESSENTIAL MEANING OF D'ALEMBERT'S PRINCIPLE

Newton's second law of motion is expressed in the fundamental form, using C.G.S. units,

$$\sum_0^X(\Delta X)_E=\sum_0^m(\Delta m\ddot{x}). \qquad (1)$$

The necessary range of the two summations is determined without ambiguity, by the conditions of the problem selected for discussion. The first sum must include every element of external force parallel to a fixed line brought to bear upon any portion of mass within the system, either by a process equivalent to surface distribution at the boundary, or by volume distribution. The second sum covers every part of the system's mass, and no mass external to the system. Equation (1) presents Newton's thought that the physical agencies active (forces) are measurable in terms of one particular result—accelerations produced in masses—other effects, if any, being ignored in the equation. What d'Alembert put into clear relief, when he announced his principle covering "lost forces," is the unimpaired validity of the equality, after eliminating all self-canceling elements from the force-sum. This removes from consideration all inner forces always, and items of external force in certain cases. The second member of the equation then measures the remainder of effective force only, and exhibits the necessary magnitude of the equilibrant that would change the conditions of the problem from those of acceleration to those of equilibrium, or zero acceleration. The "reversed effective force," if superposed upon the forces actually operative, says d'Alembert, would prevent the actual accelerations, and bring about equilibrium that did not in fact occur. This conception of equivalence between the differing modes of statement in the two members of such equations is prominent with d'Alembert and Lagrange, and entirely in accord with out every-day use of equations of motion to evaluate any one of the three quantities force, or mass, or acceleration, when the corresponding values of the two others are known.[1] The advance made by d'Alembert, therefore, is in the direction of devising a static measure for unbalanced forces by generalizing the procedure when we determine weight active by hanging a body from a spring balance. It is parallel to the zero method of the laboratory, that seeks the measure of any unknown quantity in terms of independent conditions adjusted to compensation of its effects. This point of view sets in a proper light the limited sense in which d'Alembert's principle brought dynamics within the scope of statical equations, and disposes effectually of the obscurity or confusion involved in "forces of inertia," or the recently substituted term "kinetic reaction." The extension of d'Alembert's principle to modern generalized dynamics does not modify essentially this conception of the method; we are still dealing with relations between force and inertia—the doing of work, and the quality of storing energy in a particular way. Clear thought in a new field is not furthered by meeting a paradox at its threshold; for nobody accepts literally the dictum that finite acceleration is, as a general statement, consistent with zero values of force, and force-moment, applied to a given system that has inertia.

[1] D'Alembert's "force of inertia" is merely a loose expression for (m); it does not denote $(-m\ddot{x})$. Lagrange uses the phrase "force resulting from inertia" as describing $(m\ddot{x})$, with unchanged sign. See d'Alembert, "Traité de dynamique," ed. 1758, p. x; Lagrange, "Mécanique analytique," ed. 1853, Vol. 1, p. 282.

Equation (1) may be recast mathematically in several ways; and some of its equivalents, being adapted more closely to certain aspects of physical thought, are obviously helpful as well as legitimate. But for clearness the name "equation of motion" shall be confined here to the above primary mode of formulating the idea. This was adopted by the old masters as segregating causes from results, terms of each class appearing by themselves in one member of the equation. We may describe these as "force terms" and "mass-terms" respectively. So soon as homogenousness in this sense is disturbed, the equation is altered in *prima facie* physical meaning. Even removing terms from one member to the other; so that a force-term is now interpretable as a mass-term, or *vice versa;* may be regarded as passing to a new problem, concerned with different masses, or modified forces, or a new classification of the effects of force. Some typical instances are the following, purposely taken on familiar and elementary ground:

1. Denoting by (P) and (R) the aggregates of positive and negative external force, respectively, thought of as acting on a single mass (m), for simplicity, we have the type

$$P = R + m\ddot{x}. \qquad (2)$$

Here the negative forces have been transferred to the second member, and the equation now expresses directly the fact that the forces (P) overcome the resistances (R), and produce acceleration as well. (R) may represent dissipative or conservative agencies. If the latter, equation (2) is preliminary to expressing storage of energy in both forms.

2. Subtracting (R) from both members of equation (2) gives

$$P - R = (R - R) + m\ddot{x}. \qquad (3)$$

This puts to the front the idea that the total force $(P - R)$ sets up static stress $(\pm R)$ to an extent determined by the resistances, the remainder becoming effective as a volume distribution of force producing local acceleration. The connection of equation (3) with the lost forces of d'Alembert is visible at once.

3. Separate the forces to which magnitude may be assigned arbitrarily from those whose magnitudes are fixed by conditions of the system like displacement, velocity, acceleration. Call the former group (A) and the latter (S). Then the form of equation

$$A = S + m\ddot{x} \qquad (4)$$

makes the second member a function of elements specified for the system, while the first member is independent of such elements. Such a segregation is convenient for mathematical handling of the differential equation, but (A) and (S) are both external forces, in the original sense of that term. We need, perhaps, to remind ourselves of this fact, when we find (A) alone described as external, in opposition to "forces exerted upon the system by itself," or inner forces.[2]

4. The effects of a force-aggregate (X) being in general to bring about changes of magnitude in some momenta, and of direction in others, that separation of results may be indicated by the notation in both members of the equation of motion, giving

$$X = M + D = m\ddot{x}_M + m\ddot{x}_D. \qquad (5)$$

According to that supposition, then,

$$X - D = X - m\ddot{x}_D = m\ddot{x}_M = M. \qquad (6)$$

One reading of equation (6) carries out the separation referred to; it measures explicitly the force devoted to producing change of magnitude in momentum. Another legitimate interpretation connects the change in force from (X) to $(X - D)$ with a definite change of reference system. But alongside of these we find surviving still a third, to the effect that (M) is the real force-total in this case (retaining the reference system and mass unchanged), resulting from the combination of (X) with centrifugal force. A similar unclearness allows the "centrifugal couple" of Euler's equations to masquerade as an external force-moment. These forms of confusion are reasonably looked upon as survivals from the days when the process of vector addition to momentum by force was grasped less completely. The changes in direction seemed almost a side issue, to be deducted before proceeding to the serious measurement of force. We still find the thought followed without flinching to the case where (M) happens to be zero, and leaves "equilibrium" between (X) and (D).[3]

The significance of such current forms, which may justify citing them in the present connection, lies in the mingling of force-terms and mass-terms common to them all. This encourages an undiscriminating attitude transferred from the field of mathematics, toward the terms included in equated expressions, which may easily obliterate certain phases of physical thought. To inquire whether a particular distinction of this sort is profitable is one way of exercising discrimination. It is proposed to raise this question presently, as regards mass-term and force-term, especially where those conceptions are employed with the wider meaning of recent usage. We may advance toward that end by considering first the form into which d'Alembert's principle is thrown, in preparation for the equation of virtual moments,

$$\sum_0^X (\Delta X)_E - \sum_0^m (\Delta m\ddot{x}) = 0. \qquad (7)$$

How is this to be understood from the physical point of view? If their original meaning is attributed to the summations, and equation (7) is nothing but a transposition of equation (1), the second sum can not represent forces actually applied to (m), since by supposition these are accounted for completely in the first sum. Neither can this be an equilibrium equation for the mass (m), so long as the second sum does not vanish. D'Alembert, however, detected in

$$-\sum_0^m (\Delta m\ddot{x})$$

a new sense, by associating it with the other force-terms as their equilibrant. Or, follow-

[2] See, for instance, Abraham and Föppl, "Elektrizität," Vol. 1, p. 195.

[3] Goodman, "Mechanics," p. 204; cf. Klein und Sommerfeld, "Theorie des Kreisels," p. 141, etc. These instances do not stand alone.

ing a more modern tendency, that sum, again recognized as force, is regarded as due to reactions of (m) upon bodies that transmit force to it. It is clear that neither view preserves the scheme of equation (1); the first uses the real equilibrium condition of equation (7) in order to exhibit the actual departure from that condition in equation (1), and the second includes forces acting, not upon (m) but upon surrounding bodies. Either view is of course tenable, both within the original scope of the principle and in the field of modern dynamics to which it has been extended. But it is only in this peculiar sense that d'Alembert made the criterion of equilibrium a basis for the measurement of unbalanced force.

Frederick Slate
University of California

SOME APPLE LEAF-SPOT FUNGI[1]

Since 1892 leaf-spot disease has been frequently reported as doing considerable damage in apple orchards in various parts of the United States. Its occurrence has been noted in fifteen different states. Very little seems to be known about the etiology of the disease. That it is a fungous trouble is indicated by the ease with which it is controlled in most localities by spraying. *Coniothyrium pirina*[2] (Sacc.) Sheldon, *Phyllosticta limitata*,[3] *Phyllosticta prunicola*,[4] *Sphaeropsis Malorum*[5] and *Hendersonia Mali*[6] have been variously reported as causing, or being associated with, the disease.

The number of fungi found fruiting on the leaf-spots is the most confusing thing in determining the real cause of the disease. In an examination of apple leaf-spot specimens belonging to the West Virginia Agricultural Experiment Station, the following fungi were found: *Coryneum foliicolum, Coniothyrium pirina,* an undetermined species of the Tuberculariae (found by Sheldon in the spring of 1907), *Sphaeropsis Malorum, Monochaetia Mali, Pestalozzia breviseta, Phyllosticta limitata, Torula?* sp., *Macrosporium* sp., *Ascochyta* sp., *Phyllosticta? piriseda?, Phoma Mali, Septoria piricola?, Metasphaeria* sp., and an undetermined species of the Leptostromaceae. Of these fungi, only the first four were common enough to indicate any economic importance. *Coryneum foliicolum* is probably the fungus which has been reported by different writers as a *Hendersonia* on apple leaves. *Coniothyrium pirina* will be better recognized as *Phyllosticta pirina* Sacc., from which it was recently transferred by Sheldon.[7] *Coniothyrium tirolense* Bubàk, a portion of the original collection of which was examined by the writer, seems identical with *C. pirina*. *Phyllosticta Mali* Prill. & Dela. var. *comensis* Tray, was found to resemble *P. limitata* in all characters except the shape of the spot, which in the former is decidedly angular. A part of the type specimen of *P. tirolensis* Bubàk on pear leaves differed from *P. limitata* by the slightly shorter spores and more gregarious pycnidia.

It seems to have been generally taken for granted that *Coniothyrium pirina* and *Phyllosticta limitata* are the most important fungi causing apple leaf-spot, exceptions noticed being the reports of Clinton[5] and Sheldon.[8] *Coniothyrium pirina* has, on the other hand, been declared by Stewart and Eustace[9] to be a saprophyte. A more detailed study of the fungus therefore became desirable.

Pure cultures of it were obtained and grown on the ordinary culture media, with varying success; they were also grown very success-

[1] Read before Section G of the American Association for the Advancement of Science, January 2, 1908.

[2] Alwood, W. B., Va. Agr. Exp. Sta., Bull. 17:62 (1892).

[3] Stewart, F. C., N. Y. Agr. Exp. Sta., Ann. Rep. 14:545 (1895).

[4] Tubeuf, Karl Freiher von, and Smith, W. C., Diseases of Plants induced by Cryptogamic Parasites, 463 (1897).

[5] Clinton, G. P., Conn. Agr. Exp. Sta., Ann. Rep. 27:300 (1903).

[6] Alwood, W. B., Proc. Am. Acad. Adv. Sci., 47:415 (1898).

[7] Sheldon, J. L., Torreya 7:143 (July, 1907).

[8] Sheldon, J. L., W. Va. State Bd. of Agr., Ann. Rep. 1:57 (1906).

[9] Stewart, F. C., and Eustace, H. J., N. Y. Agr. Exp. Sta., Bull. 220:228–230 (1902).

fully on fresh and sterilized twigs of apple, rose and plum. On sterilized twigs the pycnidia developed were often strongly flask-shaped, and in many cases hairy.

Repeated attempts were made to inoculate the fungus on the leaves of young seedling, Yellow Transparent, Ben Davis and York Imperial apple trees in the green-house, with spores taken from pure cultures on various media, and placed on the surfaces of leaves kept moist under bell-jars. Only negative results were obtained from this work, though it was continued for five months, and on leaves of widely differing degrees of age and vigor.

Inoculations were also attempted on leaf tissue which had been previously injured by various artificial means, scalding, abrasion of the epidermis, and punctures made with both hot and cold needles. Inoculation on scalded tissue was usually successful, and on abraded tissue always. Fruits of the fungus quickly appeared on tissue which had been kilied by abrasion and inoculated, but the area of the leaf killed by the abrasion was seldom appreciably enlarged by the fungus. Of a number of attempts to inoculate the leaves at punctures made with needles, only two were successful. Hot needles were then used in making the punctures, small areas of leaf tissue being killed by the heat of the needle; the leaves were then sprayed with the atomizer, as in previous work, the spores spread over the surfaces of the leaves with the platinum loop, and the plant kept moist under a bell-jar. Within three to five days after inoculation a large number of the inoculated spots produced by the hot needle enlarged to three or four times their original diameter, and fruits of *Coniothyrium pirina* speedily appeared, usually in a ring near the outer edge of the spot. The fungus fruited on almost every such puncture inoculated. Checks were obtained by making a row of the hot needle punctures on each side of the mid-rib of the leaf, but placing spores only on the row on the right-hand side. A very few of the check spots on the left-hand side were evidently inoculated by spores accidentally washed over from the other side in watering. The rest of the check spots did not develop fungous fruits, and did not spread beyond the limits of the area originally killed by the heat. Punctures were sometimes made with a cold needle at the same time and on the same leaves as successful inoculations at hot needle punctures, but at only two such punctures were spots ever produced by the fungus.

These results of inoculation make it seem that *Coniothyrium pirina* is a facultative or wound parasite only, able to produce spots on apple leaves provided it has a little killed or injured tissue in which to get a start. That it causes a considerable amount of leaf-spot under orchard conditions is quite possible, but not as yet demonstrated.

An inoculation was also made on the living twig of a seedling apple tree in the green-house by making an incision in the bark and inserting with platinum loop a drop of water containing spores from a pure culture of *Coniothyrium pirina*. The wound was then wrapped with absorbent cotton, and kept moist for a number of days. Forty days later several excellent fruits of the *Coniothyrium* were found breaking through the bark at the very edge of the area injured by the incision. There was no further development of the fungus, nor was there any injurious effect noticed on the health of the shoot above the point of inoculation. This seems to confirm the statement that *Coniothyrium pirina* is a facultative parasite only. A number of subsequent attempts were made to inoculate the fungus on living apple stocks kept moist under bell-jars but not wrapped with cotton; these were uniformly unsuccessful. The trees on which these inoculations were made were nearly all growing vigorously at the time of inoculation.

The readiness with which the fungus grew on dead twigs in the laboratory suggested that it could probably be found on dead twigs in nature. On May 15, 1907, a fungus morphologically identical with *Coniothyrium pirina* was found at Cassville, W. Va., on dead twigs of a quince bush, the leaves of which were known to have borne many spots containing the fungus two years previously. Pure cultures were easily obtained from these twigs by plating, and spores taken from one of these cultures were used successfully in producing spots on apple leaves which had been punctured with a hot needle. The fungus was later found on dead apple twigs in Morgantown, W. Va., almost touching a live branch whose leaves bore spots containing *Coniothyrium* fruits. There were but few spotted leaves on the remainder of the tree. Professor Alwood, in a letter to Dr. Sheldon which the writer was permitted to see, states that the fungus winters over on the fallen leaves. The writer has not so far been able to find fruits of the fungus on fallen leaves during the winter and spring.

Coniothyrium pirina, then, occurs in spots on living leaves of apple, cherry,[10] quince and pear,[11] and on dead twigs of apple and quince. It is able under certain conditions to produce spots on apple leaves, but nevertheless it is merely a facultative parasite, and probably does not cause the serious defoliation of apple trees in West Virginia, which has been attributed to it.[12] It seems able to winter over on twigs of apple and quince.

Since in the field *Coryneum foliicolum* gave more evidence of being important than *Coniothyrium pirina*, culture work with it was also done. The fungus was grown on the ordinary culture media, and on sterilized twigs of various kinds, including spruce twigs. On synthetic agar the hyphae at first bore conidia singly on short branches, and all the spores grown on agar were long, irregular, and with cells often subdivided, making the spores as many as seven-septate; this corresponds closely to the behavior of *Coryneum beyerinckii* recently reported by Smith. On some of the media cellular, subcarbonaceous structures developed, sometimes becoming flask-shaped with long necks. In August the fungus was found fruiting on a canker on a young apple trunk. Apparently the spores were borne inside subcarbonaceous pycnidia, but the immaturity of most of the fruits prevented definite determination of this point. A pure culture made from spores from this canker grew on agar just as did the cultures taken from leaf-spots.

[10] Alwood, W. B., Va. Agr. Exp. Sta., Bull. 24: 23–40 (1893).

[11] Jennings, H. S., Tex. Agr. Exp. Sta., Bull. 9:26 (1890).

[12] Corbett, L. C., W. Va. Agr. Exp. Sta., Bull. 66:202 (1900).

Some inoculation work with *Coryneum foliicolum* along the same lines as that with *Coniothyrium pirina* gave similar results, except that the *Coryneum* gave even less evidence of vigorous parasitism than did the *Coniothyrium*. It is not likely, therefore, that it is any more important as a cause of disease.

Acknowledgments are due to Professor F. C. Stewart, Dr. Fr. Bubàk and Dr. G. B. Traverso for sending specimens, to Dr. C. H. Peck for identification of a specimen of *Phyllosticta limitata*, to Mrs. Flora W. Patterson for determination of a specimen of *Coryneum foliicolum*, and to Dr. J. L. Sheldon for advice and the use of data and specimens previously obtained by him.

Carl P. Hartley
Minneapolis, Minn.

A CYCAD FROM THE UPPER CRETACEOUS IN MAVERICK COUNTY, TEXAS

In the fall of 1905 I found a cycad in the Upper Cretaceous of Texas. The locality was three miles north and one and one half miles west of the station called Paloma, on the Eagle Pass branch of the Southern Pacific Railroad, and about twenty miles south of Spofford. At this place the Upson clay is exposed on the east side of Sauz Creek, which joins with Cow Creek to form Elm Creek a half mile to the south. The exposure runs for a quarter mile north and south and is considerably cut up by gullies. At the north end the clay was dark and it contained a *Radiolites*, a small *Ostrea*, an *Anomia* and *Exogyra ponderosa*. This last shell is frequent over the whole exposure. Eight fragments of presumably the same silicified trunk were noted. Three of these matched by their fractures and showed a stem about ten inches wide, flattened considerably, and hollow. These three and one more fragment were all that I could carry, and they have been turned over to a specialist for study.

The clay containing these fossils has been by Dumble called the Upson clay and is described in Augustana Library Publications, No. 6, p. 68. It is from 500 to 600 feet thick in this vicinity and the stratum of this particular exposure is included somewhere in the upper 150 feet of the formation. Some sandstone ledges appearing a mile and a half south contain *Ostrea larva* and impressions of Halymenites, and these ledges mark the beginning of the change to the overlying San Miguel beds. This trunk comes from at least 1,400 feet above the base of the Upper Cretaceous in this state. The Upson clay is underlain by about 750 feet of limestone of the age of the Austin chalk, and below this there are here some 250 feet of sediments corresponding to the Eagle Ford shales. So far as I am aware this is the only known cycad yet found in the Upper Cretaceous of America.

J. A. Udden

Rock Island, Ill.

SOCIETIES AND ACADEMIES

THE TORREY BOTANICAL CLUB

The club was called to order on May 27, 1908, at the Museum Building of the New York Botanical Garden at 4 P.M. by Vice-president John Hendley Barnhart. Eight persons were present. After the reading and approval of the minutes for May 12, 1908, the announced scientific program was presented. The following abstracts were prepared by the authors of the papers:

The North American Species of Zygodon: Mrs. N. L. Britton.

Attention was called to the fact that *Zygodon viridissimus* is a rare species, having been found only a few times in the high mountains of the southern Alleghanies and northern New York. It is usually sterile and propagates by septate brood-bodies, borne in clusters in the axils of the leaves. Fruiting specimens, collected by Dr. J. K. Small on the summit of White Top, Virginia, showed that the peristome is absent, though all the capsules found were either too young or too old for satisfactory determination. A comparison with specimens collected by Drummond near Hudson Bay shows that the latter belong to *Zygodon rupestris*, which is variously placed by European authors as either a species or a variety of *Z. viridissimus*. Sterile specimens of *Zygodon gracilis* have been recently discovered in North Carolina by Dr. A. J. Grout. *Zygodon excelsus*, whose fruit is also still unknown, appears to be more closely related to *Leptodontium* than to *Zygodon*.

The Acceleration of the Period of Senescence by Radium Rays: C. Stuart Gager.

In view of the fact already well known, that, as old age approaches, the size of the cell-nucleus becomes less relative to that of the cell, measurements were made to see if this relation was affected by exposure to radium rays. It was found that in cells near the root-tip of *Zea Mays* the diameter of the nucleus was 35.5 per cent. that of the cells in unexposed plants, but only 33.33 per cent. in roots exposed to radium rays. This is some evidence that exposure to radium rays accelerates the approach of the period of senescence.

A Collection of Philippine Fungi: W. A. Murrill.

A splendid collection of fungi, six hundred and thirty-seven packets in all, was recently received from the Bureau of Science, Manila, through Mr. E. D. Merrill, botanist. Previous work upon the fungi of this region was briefly sketched, and the collections of Philippine fungi in various institutions compared.

This paper will be published in full, with notes and description of interesting species, in a future number of the *Bulletin of the Torrey Botanical Club*.

An announced paper, on "Botanical Supplies in the Public Schools," was not given, on account of Dr. Hollick's unavoidable absence.

At the close of the stated program Dr. Gager exhibited some photographs of flowers, etc., taken in natural color at the New York Botanical Garden by the Lumière process. The process was briefly explained.

Dr. Murrill exhibited a specimen of "Tuckahoe," and called attention to the fact that the sporophore of a *Polyporus* had been obtained from a form common in parts of Canada, the "Tuckahoe" being a sclerotium, or a resting stage of the mycelium in mass. He would be glad to receive specimens of these sclerotia, either fresh or dried, from any locality, so that the various species, if more than one exists in this country, may be properly distinguished.

Dr. Barnhart exhibited for Mr. Nash a flowering specimen of the lace-bark tree, *Lagetta Lintearia*, a native of the West Indies. This tree is known to have flowered only once before in cultivation. An article on the specimen, and the peculiarities and uses of the lace-like bark appeared in the June, 1908, number of the *Journal of the New York Botanical Garden*.

C. Stuart Gager,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 7, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING[1]

FROM THE STANDPOINT OF THE PRACTISING ENGINEER

I am honored by being asked to say a few words to you about the results of my experience as to the needs of the teaching of mathematics to students of engineering from the point of view of a practical engineer. I have had the good fortune of receiving quite a thorough mathematical training in the École des Ponts et Chaussèes of France, and I have also had the good fortune of developing into a fairly practical engineer; my remarks will therefore be backed by actual experience.

Mathematics is to an engineer what anatomy is to a surgeon, what chemistry is to an apothecary, what the drill is to an army officer. It is indispensable. I think we all agree on this point.

There is a considerable agitation at this time in France and Germany, especially the former, favoring the limitation of the

[1] What is Needed in the Teaching of Mathematics to Students of Engineering? (*a*) Range of Subjects; (*b*) Extent in the Various Subjects; (*c*) Methods of Presentation; (*d*) Chief Aims. A series of prepared discussions following the formal presentation of the subject by Professor Edgar J. Townsend, Professor Alexander Ziwet, Mr. Charles F. Scott and President Robert S. Woodward. (See SCIENCE, July 17, 1908, pp. 69–79; July 24, 1908, pp. 109–113, and July 31, 1908, pp. 129–138.) Presented before Sections D and A of the American Association for the Advancement of Science and the Chicago Section of the American Mathematical Society, at the Chicago meeting, December 31, 1907.

present mathematical program of the engineering schools on the ground that it is unnecessarily extensive. From personal observation, I can say that the program there covers a considerably wider range than in the average American college. In the first place, a student entering an engineering college on the European continent must already know the analytical geometry, the descriptive geometry, the rudiments of differential and integral calculus, none of which are taught here until the student enters college. The average length of a college engineering course abroad is four years, one of the exceptions being the École Centrale, of Paris, France, where the course is only three years, but where the entering examinations are of a comparatively high standard and the students must be above the average in ability and application in order to hold their own during the college course. It is obvious, therefore, that in American colleges, time is spent on pure mathematics which could be devoted to practical study. I believe the time will come when only applied mathematics will be taught in colleges, and all necessary abstract mathematics will form a part of the conditions for entering.

As time goes on, every profession tends more and more towards specialization. This tendency is quite marked in the engineering profession. It would take too long to enumerate all of these special branches of engineering, but nearly every branch demands a somewhat different mathematical training. The time may come when this specialization will extend over the study of abstract mathematics, differing with each student according to the branch of engineering he intends to follow. For instance, a railway engineer who may aspire to become a railroad official requires less knowledge of calculus than an electrical or a bridge engineer; on the other hand, he requires a greater knowledge of geology than the electrical engineer, and a greater knowledge of common law than the bridge engineer. As my remarks are merely intended to furnish topics for discussion, I will put the following question: In view of the fact of the steadily growing scope of special education will it be desirable and possible to specialize mathematical courses in colleges and adapt them to each branch of engineering? This, as I understand, is done at present only to a small extent in applied mathematics.

Bridge engineering, of which I have made a specialty, requires probably as high a mathematical training as any other branch of the profession, and yet, I find that part of the higher mathematics which I have studied in college, apart from the drilling features of such studies, has been entirely useless; for instance, the theory of differential equations. The time I spent on it, though considerable, was not sufficient to make me understand it thoroughly, and would have been better employed in the study of the methods of least work, for instance, which no bridge engineer should neglect to study.

On perusing the elementary books used in high schools, I have been often struck with the dry, uninteresting manner in which the various subjects are being treated. The examples are mostly abstract, very few practical problems to work out. Unless the student is very intelligent, his mind retains nothing beyond a chaos of formulæ hard to remember and a few mechanical means of solving abstract problems. He is incapable of applying an equation to a practical problem. The methods of presentation should, therefore, be such that the student knows the why and wherefore of each operation—in other words, that he learns to *think mathematically*. This training in mathematical thinking should also be the chief aim: one does not know a foreign language unless one is able to think in that language; one does not know mathematics unless one is able to think mathematically. It is not necessary for that to go up into the highest mathematics, but it is necessary to be thoroughly drilled in elementary principles of each subject. These elementary principles should become a second nature to the student, just as a language becomes a second nature when it is thoroughly acquired. Problems arise every day in the practise of an engineer, which a mathematical mind can solve without going into calculations, such principles as those of maxima and minima, those of least work, of cumulative effect of forces and others are invaluable in assisting to arrive at a logical solution of many problems without the use of a scrap of paper; but in order that they may be applied, one has to be able to think mathematically. With a proper foundation, the engineer's mind becomes so trained that he applies those fundamental principles unconsciously; they direct his line of thought automatically, so to speak. How to secure such a foundation in a student must be left to those who make a life-study of teaching.

Ralph Modjeski

Chicago, Ill.

The methods of teaching mathematics to engineering students in vogue twenty years or more ago, while often sufficiently strenuous, were invariably far from satisfactory, in that they failed to show the application of the subjects to engineering practise and to explain that mathematical quantities represent something real and tangible, not merely abstractions. Possibly methods have changed of late years; but nothing that the writer has seen or heard indicates to him that any fundamental improvement has been effected. Most people continue to believe that mathematical subjects are taught mainly for the purpose of training the mind, and that the manipulations involved in this branch of science are simply mental gymnastics. Moreover, even among engineers and professors, only a few recognize adequately the great importance of mathematics in engineering and that it is something real and substantial instead of fictitious and imaginary. It is true that higher powers than the third are not conceivable entities; but the mathematician recognizes them as temporary multiples for future reduction to entities.

The engineering student in his pure-mathematical classes is not taught what equations really mean, nor what are their denominations or those of their component parts. All that he learns is how to juggle with quantities in order to produce certain results. It is left to the professor of rational mechanics to teach engineering students the reality of mathematics; and too often he fails to do so, sometimes, perhaps, because his own conception thereof is rather vague.

Concerning the teaching of pure mathematics by the professor of rational mechanics the writer speaks from personal experience; for more than a quarter of a century ago he taught that branch of engineering education in one of America's leading technical schools. Notwithstanding the fact that the courses in pure mathematics then given there were rigid and even severe, the students, as a rule, had no idea of how properly to apply the knowledge they had accumulated; nor did they know what the mathematical terms employed really meant. It was necessary for the writer not only to teach his own branch, but also to supplement the students' knowledge of pure mathematics by explaining such things as limits, differential coefficients, total and partial differentials, and maxima and minima.

Throughout the entire course in rational mechanics the writer either demanded from the students or gave them demonstrations of all difficult or important formulæ; and the students in explaining their blackboard work were repeatedly asked to state the denominations, not only of the equations as a whole, but also of their factors and component parts. The answers to such questions evidenced clearly whether the student had a true conception of the mathematical work he was doing, or whether he had merely memorized certain manipulations of quantities.

It was the writer's custom also to supplement as much as possible all analytical work by graphical demonstrations; and if he were to resume the teaching of mechanics, he would adhere to this method.

In teaching technical mechanics the writer followed only to a certain extent the manner of instruction just described; for by the time his students had reached the technical studies, they were so well drilled and weeded out that constant quizzing on fundamentals was no longer necessary; nevertheless the question, "what is the denomination of that equation or of that quantity," was one that was very likely to be asked any student who gave his demonstrations haltingly or who evidenced at all a lack of conception of the principles involved.

In the writer's opinion, the manner of teaching pure mathematics to engineering students should differ materially from that usually employed in academic courses; for while in the latter case it suffices if the instructors be good mathematicians, in the former they should also be engineers, and should have taught, or at least should have studied specially, both rational and technical mechanics.

Some institutions still adhere to the antiquated custom of teaching pure mathematics by lectures. This method has always appeared to the writer to be perfectly absurd; for the primary benefit to be obtained from the study of mathematics is mental training; and the student can get this only by severe effort, and not by having another man's mind do the reasoning for him. Midnight oil and the damp towel are for most students necessary accessories to the courses in pure mathematics.

The writer believes that the only legitimate lectures in pure-mathematical courses for engineering students are as follows:

First: A short opening lecture to outline the work that is to be covered in the course and to explain how best to study the subject.

Second: Frequent informal talks to indicate the application of the mathematics studied to engineering practise, to explain clearly the meaning of all equations, factors and terms, and to show the true *raison d'être* of all that is being done.

Third: A concluding lecture in the nature of a résumé to call attention to what has been accomplished during the entire course and to the importance thereof.

Fourth: Personal and forcible lectures to lazy students so as to give them clearly to understand that they must either study harder or drop out of the class.

All mathematical work done by engineering students should be so thorough and complete that the subject shall be almost as much at command as the English language or the four simple rules of arithmetic. Only such thorough knowledge will enable the engineer to use mathematics readily as a tool, rather than as a final resource to be employed solely in extreme need.

Analytical geometry should be taught graphically as well as analytically in order that the student shall comprehend it fully and shall realize that the work is real and tangible and that the equations represent lines, surfaces, and volumes, and are not the results of mere gymnastics. A knowledge of the graphics of analytical geometry is especially valuable in mechanical work, in the investigation of earth pressures, in suspension, bridge work, and in many other lines of engineering.

The proper conception of the meaning of the calculus is rarely carried away by the student. He knows the rules and can perform the operations, but their significance is beyond him; consequently he does haltingly and bunglingly the original work which facility in the use of the calculus should enable him to perform easily and well. This state of affairs is a crying evil which should be corrected in all schools that aim to give first class engineering courses.

Descriptive geometry is of very large value in the preparation of drawings; but, in addition, a thorough knowledge of it greatly aids in the conception of an object in space, and, consequently, is of large assistance in the evolution of original designs. A knowledge of it prior to the study of the courses in pure mathematics assists materially in the conception of what the latter really mean; consequently descriptive geometry should be one of the earliest courses in an engineering curriculum.

A sound knowledge of mechanics, the foundation of engineering, is impossible without a thorough understanding of mathematics. It is true that mechanics may be learned by rote or by so-called common-sense methods; but the "rule of thumb" or "pocket-book" engineer never rises to noticeable heights. Such an engineer almost invariably fails at the critical moment, when a decision must be supported by fundamental principles. It is true that the actual use of analytical geometry, calculus, least squares, or even higher algebra and spherical trigonometry, is rare in the practise of most engineers; but an engineer's grasp of technical work depends upon his knowledge of these subjects; and it is generally conceded that a heavy structure can not be continuously supported on a weak foundation.

Mathematics higher than the calculus is of small value to the engineer, except possibly as a training for the mind; but the writer is of the opinion that any such further study of mathematics is a detriment rather than a help, in that it tends to a desire to reduce all work to mathematical calculation and thus to weaken the judgment. In other words, excess of mathematical development sometimes produces an unpractical engineer.

Most graduate engineers immediately after leaving their *alma mater* drop forever the study of mathematics, both pure and applied, except in so far as they are forced to use them by their professional work. No greater mistake than this can be made, for it takes very few years of nonuse of these subjects to cause one to forget them utterly. Every young engineer should make it a point to devote a certain portion of his time to the reviewing of the mathematical studies of his technical course so as never to become rusty in them; and the writer believes that it is the duty of every professor of mathematics and mechanics to impress this fact continually upon the minds of his students, even up to the very day of their graduation.

J. A. L. Waddell
Kansas City, Mo.

FROM THE STANDPOINT OF THE PROFESSOR OF ENGINEERING

When I come to think of what the Mathematical Society has brought upon itself, I fear that it may feel something like the football when it is kicked back and forth upon the field. On the one hand we have the trade-school element demanding more knowledge of rules and, on the other, the engineer demanding more knowledge of principles. No fair discussion of this subject can be had without considering for a moment the conditions and definition of engineering itself. The most common definition was promulgated more than half a century ago by Thomas Tredgold, to the effect that civil engineering, which was the only branch of engineering then known, so the definition may be considered as being general, that "civil engineering is the art of directing the great sources of power in nature to the use and convenience of man." I should say that "civil engineering to-day is the art *and science* of directing the great sources of power in nature to the use and convenience of man," and from that standpoint I am willing to discuss the question as to how much and how far mathematical instruction should enter.

If engineering is merely an art, then mathematics as a science has no place in the training of the engineer, but if engineering is a science, then mathematics has a place. Engineering stands to-day in the act of rising to the status of a science, but is still hampered by the tradesman. On the one hand, we have the demand that the student's training be such as primarily to make him useful to some one to-morrow; and, on the other side, that it make him useful to the world perhaps ten years hence. The two requirements are inconsistent and do not belong together. One is that of the trade school, and many should not go farther than that because they have not the mental capacity, and the other is the demand of the profession into which a smaller number are qualified to enter. The trade school has caused most of the trouble with the teaching of mathematics because those who are products of the trade school have no use for mathematics as a science. The complaint about the teaching of mathematics does not come from engineers; they are ready to use mathematics as a science. In civil engineering it is fortunate that the profession has developed along lines laid down by Rankine rather than by Trautwine. Both have had their use, but one of them produced the scientist and the other produced the tradesman.

It is maintained in the institution which I have the honor to represent that they who would teach engineering must practise it, and by analogy we might say that those who teach mathematics to engineers should themselves be engineers. It seems to me that a time may come when such a condition will be desirable, but let me say now that there are few engineers to-day who have had sufficient training in mathematics to teach it themselves, much less to tell mathematicians how it should be taught. We can perhaps judge of the deficiency of the student who comes to us, but my feeling is that the remedy is not a question of *what*, but of *how*. Men in my institution are sending us students well prepared in mathematics. Others do not seem to be so fortunate. Both are teaching the same subjects. We have to realize that the student himself is a factor in this question. Some students become mathematicians under any *one;* others would not under *any* one. To be taught mathematics properly, the point at which engineering minds must begin, is a long way back. I am inclined to think they must begin some generations before birth. The mathematics of grammar schools needs overhauling more than the mathematics of any other part of our educational system, and probably the mathematics of high schools stands next. The essential thing that we ask of mathematics is that it should develop the quantitative reasoning power, and the student must be able to think mathematically. If he has not acquired that, then he should drop out of engineering and take up a trade. It was mentioned by a previous speaker that a relatively small percentage of the graduates from a certain engineering school were engaged in occupations in which mathematics was of importance. From a somewhat intimate acquaintance with the graduates of that institution, I may add that a much less proportion had sufficient mathematical training to take positions in which mathematics was an important requirement. Until recently, that college has stood for hardly more than a highly developed trade school, and it is not fair to cite its statistics as showing conditions of *engineering schools.* The director of that institution stated many years ago that he did not consider descriptive geometry necessary for mechanical engineers, and his students, having had their course in machine design in the junior year were frequently found taking their only course of descriptive geometry when seniors.

The question has been raised as to the increase of mathematics for entrance to engineering schools. My view of that is that it would not be wise to raise the requirements at this time. Cornell has, it is true, increased the requirements, but at the sacrifice of both physics and chemistry, and to my mind it is best that physics and chemistry be taught at the age of high school students, rather than analytics and trigonometry. If you can not do both it is better that the young mind have impressed upon it some physical science rather than encounter the more abstract demands of mathematics. In the training of students in mathematics I would wipe out formulæ. We want principles. There is generally taught too much of the formula, as that is what the trade school has demanded. Some have objected to the statement that mathematics should be a tool. To my mind it is certainly an instrument. It is one of the things that the engineer must use, and in order that he may use it, he must be sufficiently familiar with it, so that it will respond to his use when he desires it. The question of election in mathematics has been suggested. I am certainly favorable to elections in that subject, but I question the advisability of such opportunity in any subject for the ordinary student, before the fourth year. My own observation leads me to conclude that very few students are able to elect intelligently before that time. The remarks relative to the employment of inexperienced instructors instead of competent professors show a fault to lie with the heads of the various departments themselves. If they are willing to accept, for the purpose of instructing students, the men who have been unable to find positions elsewhere, and employ only such as will work for seven to nine hundred dollars per year, the unsatisfactory results are their own fault. The responsible parties, the trustees and regents of educational institutions, will furnish what is shown to be necessary. If it is necessary that you have better men, then say so and get them, but if you are satisfied with what you now have, then you can expect to see decorative cornices and stained glass windows, rather than intellect and culture, the characteristics of our universities.

Gardner S. Williams
University of Michigan

It may save time to state briefly at the beginning my thought on what is needed in the teaching of mathematics to engineering students. It seems to me that, outside of the general cultural and developmental purpose of the study of mathematics, the instruction of engineering students may be discussed under three different phases, which for want of better terms may be named: (1) theory, (2) practise, (3) philosophy; that successful teaching of mathematics to engineering students depends upon giving the right relative proportion or emphasis to these three phases of instruction; that the content of the instruction, within the limits of present usage in engineering schools, is of minor importance; that thoroughness is essential, and that it is better to cut down the extent of the matter gone over if thereby a more thorough grasp of the subject is secured; and that the instructor must always keep in mind that he is training an average boy of average preparation with a view to using mathematical principles and methods of attack and mathematical operations and conceptions in the mastery of his engineering studies and in the treatment of the varied problems which will arise in his later engineering experience.

The great mass of our engineering students, like the great mass of our engineers, are not mathematical geniuses. In the discussion of the subject we must keep ever in mind that the average engineering student is not of strong mathematical bent. Many of those with only mediocre mathematical ability make successful engineers, and the student of strong mathematical turn may lack in some direction or may have a disproportionate measure of the importance of his analytical powers and drop behind his less mathematical classmate. I want to make a plea for the average student, the boy whose analytical powers have to be encouraged and developed. The methods of presentation must be made elastic enough to include this great class of students, or we shall fail to do our duty as teachers.

I have mentioned three phases in the presentation of mathematical subjects. These may be considered in order. It must be understood that these phases are not mutually exclusive.

1. *Theory.*—Analysis, demonstration and the general derivation and presentation of mathematical principles. The derivation and exposition of mathematical principles and operations and the appreciation of mathematical concepts are universally accepted as important elements in the education of an engineer. The use of mathematical forms of attack, the training in processes of reasoning, the formation of logical habits of thought, are hardly secondary in importance. And yet much less emphasis is placed on formal demonstration and reasoning than formerly—frequently this element is overlooked or treated in a slipshod way. The student comes to feel that he is after facts and that the derivation and proof of principles involves useless effort—he is willing to accept their authenticity. It may be that years ago our instructional methods carried formal processes to an extreme and that as a result mathematical work became meaningless lingo or memorized facts to many students. This does not furnish argument for the abandonment of training in formal reasoning. For the young mind, practise in analysis, in formal demonstration is illuminating and developing. Even the repetitive forms of analysis in the old-time mental arithmetic had great mathematical educational value. The speaker feels that in the effort to avoid barren formalism the pendulum has swung too far the other way, and that both in high school and in technical school, and in the applied engineering subjects as well, the training in analytical methods and formal processes is weak. He believes that good results would follow putting greater emphasis on this phase of instruction than now seems to be the trend.

2. *Practise.*—The use and applicability of mathematical principles and processes in the solution of problems, drill on these principles, and the acquisition of facility in their use. To the average student the working of examples is illuminating. Without it the concept is but vaguely comprehended, the derivation only faintly

understood, the process may seem merely verbal legerdemain. Properly used, this phase of mathematical instruction is of great advantage to the student of average mathematical ability. It opens up the view; it clears away uncertainties; it fixes principles and concepts; it gives life to the subject. The problems used should be within the field of the students' experience and comprehension and may well bear some relation to his future work, both in the engineering class-room and beyond. And the second part of this heading is not less important. Mathematics is a tool for the engineering student, and he must acquire facility in its use. This does not mean that the instructor should attempt to make him a finished calculator or an expert workman—time is too short—but mathematical principles and processes must be more to the student than a vague something which he recognizes when his attention is directed thereto. Instead, he must have a mastery of at least the fundamentals and he must be able to use such principles and proccsses in his later studies without having to divert his attention and energy too much from the engineering features involved. To acquire this facility requires drill and repetition, and this drill must constitute a part of the mathematical training of the engineering student. The multiplication table had to be learned, and many other important things have to be acquired in the same way.

But it seems that this important side of instruction may be abused. The student who thinks that to accept facts and work problems is sufficient and the instructor who thinks that illustrations and practise work alone constitute mathematical training or that mere laboratory methods suffice are greatly mistaken. The mere substitution in formulas is only rule-of-thumb work, so much decried in engineering; and the mechanic who knows how to use tools, and no more, is not an engineer. There must be a direct connection with the theory and the philosophy of the subject to make the practise side serve its proper purpose. In teaching mathematics years ago, expressions of approval came to me because I was so "practical," but the underlying purpose of the practical part was not always understood, though this lack of understanding did not affect the results of the method. Inside the "sugar coating" there should always be a principle to fix, a concept to illumine, a process to exemplify, a derivation to expound. There seems to be a tendency among some to overdo this side of the work to the detriment of the first side. While the practise feature is a valuable auxiliary in mathematical instruction, it should never be the leading motive. Student and instructor alike should recognize this.

3. *Philosophy of the Subject.*—The basis on which the science rests, the underlying meaning of the mathematical processes used, a philosophical study of the method of treatment and of the concepts used, their connection with related things. This is difficult to discuss in a general way, and of course this phase is intimately connected with the first and second. To my mind this phase should not be neglected. It must be apportioned according to the ability of the student. An understanding of the philosophy of the subject will widen his field of view and lessen the chances of error. The better grasp of the meaning will be advantageous. Its presentation involves difficulties, and text-books generally disregard it. It must not be overemphasized, as is illustrated by the treatment in a recent text-book in applied mathematics, where it is used largely to the exclusion of analysis and demonstration.

Effective methods in mathematical subjects involve, then, the skillful selection in proper proportion from these three phases, and the best teacher will make for himself the best selection. The derivation and elucidation of mathematical principles, facility in their use and application, and an understanding of the basis on which principles and methods rest are all essential. A good text-book—one properly proportioned—aids greatly in the work of instruction. However, it is the teacher on whom reliance is placed in the end, and for the student of average mathematical ability the teacher's influence constitutes a large element. It is highly advantageous for the teacher to have a fair knowledge of the applications of mathematics which the student will make in later work and to have sympathy and interest in such work. Let us also emphasize the importance of having the best of teachers for mathematical instruction.

Let me add to this that it is my belief, growing stronger after many years of observation, that the average engineering student gets relatively little from lectures on mathematical subjects; that many instructors talk too much themselves; that the student must have the opportunity to express himself and must be required to use the mathematical language and to try his own skill, and this in other than formal quizzes; and that recitation and drill work are essential factors in giving training to this average student.

Little can be said in the time at my disposal on the ground which should be covered in mathematical instruction. Two classes of matter are studied: (1) fundamental principles forming the skeleton of the work, and (2) the more complicated topics, involving further detail and insight. There will be little difference of opinion on the first class. There will be more on the second. I have found in the teaching of mechanics and of various engineering subjects that certain topics and methods not ordinarily given in mathematical instruction may advantageously be used in the presentation of the work. The teacher of thermo-dynamics or of electro-dynamics has other topics to suggest, and still other topics will come from other sources. Not all of these may be allowed. In fact, it makes little difference what particular topics are included so long as the student has thorough training in some of the more complex work. The difficulty of giving instruction in complex work lies not so much in the time required, as in the obstacle that the concepts lie beyond the student's experience and that he is not ready to comprehend their meaning. If he had the opportunity to study these topics after he has reached the subject in which they are to be used, or if he could go back over a part of mathematics after his study has taken him into their field of application, as indeed his instructor has done for himself, the result would be more satisfactory. All these limitations must be considered in choosing the ground to be covered in mathematical instruction.

Arthur N. Talbot
University of Illinois

GRADUATE SCHOOL OF HOME ECONOMICS

The Graduate School of Home Economics held its second session at Cornell University, July 13–24. Representatives were present from eleven states and Canada. It is the purpose of this school to consider some of the results of the latest investigations in science, economics and art with their applications to work in home economics; the program, therefore, covered a wide range of subjects.

Practical demonstrations of household appliances were given by Misses Van Rensselaer and Rose, of the department of home economics in Cornell University. "Biology in its Relation to Home Economics" was discussed by Dr. J. G. Needham, of Cornell University; "Political Economy in its Relation to Home Economics" was discussed by Professor Fetter and Professor Kemmerer, of the department of political economy of Cornell University. "The Cost of Efficiency" was the topic of a series of lectures by Mrs. Ellen H. Richards, of the Institute of Technology, Boston, Mass. Some original work on "The Digestibility of Starch as affected by Cooking" was presented by Miss Edna D. Day, professor of home economics, University of Missouri; "Public Work for the Home" was discussed by Miss Caroline L. Hunt; "Some Problems in the Teaching of Dietetics" were presented by Miss Isabel Bevier, professor of household science in the University of Illinois; "Illustrative Material for Teaching Dietetics" was the subject of a lecture by Dr. C. F. Langworthy of the department of agriculture; "Dairy Bacteriology" and "Some of the Milk Products" were the topics treated by Dean Russell, of the College of Agriculture of Wisconsin, and Professor Stocking, of Cornell University. Moreover, the school enjoyed the privilege of a lecture by Professor L. B. Mendel, Sheffield Scientific School, on "Foods and Dietary Standards" and one by Professor N. Zuntz, of the Royal Agricultural College, of Berlin, on "Food Values."

Another feature which added to the profit and interest of the session was the fact that the members were able to avail themselves of the lectures given to the Graduate School in Agriculture then in session at Cornell. Those of particular interest to the members of the Home Economics Conference were those given by Professor Mendel, Dr. H. P. Armsby and Professor Zuntz, on the general subject of nutrition. Excursions to the hills and lakes in the immediate vicinity of Ithaca contributed much in the way of recreation and pleasure.

CAVERNS IN THE OZARKS

Early in May, the department of archeology, Phillips Academy, Andover, Mass., sent an expedition to Benton and Madison Counties, Arkansas, to explore certain caverns. These had been seen by Mr. E. H. Jacobs, who had been sent on a preliminary trip through the White River country. Mr. Jacobs reported more than thirty caverns in an extent of country eighty by forty miles.

Dr. Peabody, the director, and W. K. Moorehead, the curator, took the field for five weeks. From Fayetteville, Ark., they examined the country south and east through a region never before visited by archeologists. Four caverns were explored, one of these being in limestone and the rest in sandstone. The largest, Kelley Cavern, is about seventy meters in extent, with an overhang of thirty meters. The bluff is about fifteen meters high. The ashes range from one to three meters in depth. A force of twelve to fifteen men was employed for more than two weeks in removing the ashes from Kelley Cavern.

The character of the cave material differs essentially from that found on the surface of the surrounding village sites. Shallow metates are very numerous in the ashes of the cavern, thirty-seven having been found in Kelley Cavern alone. The peculiar character of the artifacts of the region deserves mention. There are no grooved axes—save one or two—no celts, no slate ornaments or problematical forms, no grooved hammers, no hematite implements, none of the spades and hoes common east and north, and only two pipes have been discovered in the entire region. These facts present an archeological problem of interest and importance to be solved at some future time.

The country is difficult of access, most of the caverns lying twenty to thirty miles from the railway. The elevation ranges from 1,300 to 1,600 or 1,700 feet. The collection brought to Andover totals about 1,200 specimens. On the fields throughout the entire region are great quantities of chips, spalls, hammerstones, knives and projectile points—a larger quantity than either Dr. Peabody or Mr. Moorehead ever saw in other portions of the United States.

Judging from the reports brought in by the mountaineers, there are large numbers of caverns in the region. These will be explored by Phillips Academy from time to time, permission having been secured from the Granger Kelley Lumber Company which controls upwards of 30,000 acres of land in the cavern country.

PRESS BULLLETINS OF THE FOREST SERVICE

A clause in the Agricultural Appropriation Bill affecting the Forest Service has been the subject of a recent opinion by the Attorney General. The clause provided that no part of the appropriation for the Forest Service "shall be paid or used for the purpose of paying for in whole or in part the preparation or publication of any newspaper or magazine article, but this shall not prevent the giving out to all persons without discrimination, including newspaper and magazine writers and publishers, of any facts or official information of value to the public."

The question was submitted to the Attorney General by the Secretary of Agriculture, whether this provision of the law prohibited the sending to newspapers, writers, and others of such statements as it has been distributing in the past. To this inquiry the Attorney General replied: "You express the view that in distributing such information as is compiled and sent out by the Forest Service, especially to persons engaged in the practise or study of Forestry, and generally to the public at large through the newspapers and magazines, you are fulfilling the primary and fundamental duty imposed upon the Department of Agriculture by section 520 of the Revised Statutes. Information thus given out will be accompanied by a notice that it is sent in accordance with the proviso to the appropriation act of 1908. There will therefore be no discrimination; and you say, further, that no money will be paid on this account to any newspaper or magazine or to any newspaper or magazine writer or publisher, or to any person not regularly employed in the Forest Service. Obviously, such information as has been collated and distributed heretofore and will continue to be sent out is of value to the public, and certainly your determination that it is so, as head of the Department of Agriculture, is conclusive. Under this state of facts I can see no reason to doubt that your conception of your official duty in this respect is legally correct, and that the Forester may lawfully distribute information as proposed; and I am also of opinion that information requested by a newspaper or magazine writer or publisher may lawfully be sent in the form of a letter."

SCIENTIFIC NOTES AND NEWS

Professor George E. Hale, director of the Solar Observatory of the Carnegie Institution, has been elected a foreign correspondent of the Paris Academy of Sciences in the place of the late Asaph Hall.

The Chemical Society of the Netherlands has elected as honorary members Professor J. H. van't Hoff, of Berlin, and Professor J. van Bemmelen, of Leiden.

The Vienna Academy of Sciences has awarded its Lieben prize of 2,000 crowns to Professor P. Friedländer, of Vienna, for his work on thioindigo, and its Heidinger prize of 2,500 crowns to Professor M. Smoluchowski von Smolan, of Lemberg, for his work on the kinetic theory of molecular movements in liquids and gases.

Count Zeppelin, on the occasion of his seventieth birthday, has been awared an honorary doctorate of science by the University of Tubingen. He has also been made an honorary citizen of the cities of Constance and Stuttgart, and has been given the gold medal for art and science by the King of Wittemberg.

Professor A. Stodola, of the Zürich Polytechnic College, has been awared the Grashof gold medal of the Society of German Engineers.

M. Bouchard has been elected president of the Paris Academy of Sciences to fill the vacancy caused by the resignation of M. Becquerel to become permanent secretary. M. Picard succeeds M. Bouchard in the vice-presidency.

At the Massachusetts Institute of Technology Mr. Waldemar Lindgren, of the United States Geological Survey, has been appointed lecturer in economic geology, to succeed Professor James F. Kemp, of Columbia University.

A portrait photograph of Mr. Thomas A. Edison, showing him in bust length and nearly one half size, has been hung in the electrical engineering reading-room of the Massachusetts Institute of Technology. It was presented for the purpose by Mr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston.

Dr. Aleš Hrdlička, of the U. S. National Museum, is at present in field work among the Indians of the western states. He expects to return to Washington in September.

A caravan that has arrived at Lhasa from Leh, in the valley of the Indus, brings a report that Dr. Sven Hedin, the explorer, is in good health.

The monument in honor of Robert Bunsen, designed by Professor Volz, of Karlsruhe, was unveiled at Heidelberg on August 1.

Mr. Aniceto Garcia Menocal, who was born in Havana in 1839 and had served with distinction as an engineer in the service of the United States, died in New York on July 20.

Dr. Otto Pfleiderer, professor of systematic theology in Berlin and eminent for his work on the philosophy and the history of religion, has died at the age of sixty-nine years.

Sir Thomas Stevenson, M.D., scientific analyst to the British Home Office, known for his work in forensic medicine, died on July 28, at the age of seventy years.

Dr. Karl Han, professor of chemistry at Buda Pesth, has died at the age of seventy-four years.

Dr. H. Joly, professor of mathematics at Lausanne, has died at the age of forty-eight years.

The French Association for the Advancement of Science will hold its thirty-seventh annual meeting this year from August 3 to 10 under the presidency of M. Paul Appeil.

The eighth meeting of the Association of Economic Biologists was held in Edinburgh on July 28, 29 and 30, under the presidency of Mr. A. E. Shipley, F.R.S., who delivered a presidential address on "Rats and their Parasites."

Attention is again called to the approaching meeting of the first International Congress for the Repression of Adulteration of Alimentary and Pharmaceutical Products to be held in Geneva on September 8, 1908. A large number of members from the United States have already joined, but it is desirable to have the largest representation possible from this country. The congress is held under the auspices of the White Cross Society and the Swiss government. The fee for membership is $4. Dr. H. W. Wiley, of Washington, D. C., chairman of the American committee, will undertake to forward names of members and their subscriptions. Reduced rates will be given on steamship lines and on European railroads. Information will be sent by Dr. Wiley to all persons who desire to be apprised regarding the details of the Congress. Intending members are urged to send in their subscription at once.

The Philadelphia Academy of Surgery announces that essays in competition for the Samuel D. Gross prize of fifteen hundred dollars will be received until January 1, 1910. This prize is awarded every five years to the writer of the best original essay, not exceeding in length one hundred and fifty printed octavo pages, and illustrating some subject in surgical pathology or surgical practise, founded upon original investigation, the candidates to be American citizens.

The Board of Agriculture and Fisheries of Great Britain states that the presence of American gooseberry mildew on gooseberry bushes in commercial gardens in Kent has been confirmed. An order of the board requires all occupiers of premises on which the mildew exists to report the presence of the disease, under a penalty of £10. Gooseberry growers are advised to apply to the board for a leaflet describing the appearance of the disease, and giving the precautions that should be taken.

The *Journal of the American Medical Association* states that in Austria-Hungary, with a population of about 45,000,000, the annual mortality from tuberculosis is 750,000, or 14 per cent. of the total deaths from all causes. The northern parts of the empire show a ratio of 38 to 48 per 10,000 inhabitants, while the southern parts have only about 22 to 30 deaths from tuberculosis to each 10,000 inhabitants. The highest mortality is found in Bohemia, with a mean of 54 in the north and 36 in the south, per 10,000. Vienna also has a high average mortality from this disease—42 per 10,000—but the hospitals as a center for a large area are largely responsible for this high rate.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. D. K. Pearsons, of Chicago, has paid $25,000 to Beloit College and to Pomona College. Dr. Pearsons has now given more than $4,000,000 to small colleges.

Work is being pushed rapidly upon the engineering laboratory of the University of Nebraska, the foundations being laid and the workmen now having begun the walls of the lower story. It is to be completed during the coming year.

Professor Alfred D. Cole, of Vassar College, returns to the Ohio State University as professor of physics and head of the department, which now numbers eleven men. Professor B. F. Thomas, who has conducted the department for more than twenty years, will give up the executive work, but remains as professor of physics.

Professor Edwin M. Wilcox, of the Alabama Polytechnic Institute, has been elected to the position of botanist of the Experiment Station and professor of agricultural botany in the University of Nebraska. He has accepted the tender made him by the regents of the university, and will assume the duties of his new position the first of September, at which time his predecessor, Professor Heald, closes his work in Nebraska.

Dr. C. H. Shattuck, of Washburn College, has recently been called to the chair of botany and forestry in the State Agricultural and Mechanical College, at Clemson College, South Carolina.

In the University of Virginia Medical School, Dr. H. T. Marshall, formerly professor of pathology in Philippine Medical School, has been elected professor of pathology. Dr. J. A. E. Eyster, associate professor of physiology at Johns Hopkins has been elected professor of pharmacology and materia medica, and Dr. Carl Meloy, formerly instructor at Johns Hopkins in pathology, has been elected adjunct professor of pathology.

Dr. Aron, of Berlin, has accepted the position of professor of physiology in the Philippine Medical School.

C. W. G. Rohrer, B.Sc., M.D., M.A. (Wesleyan), has been appointed associate professor of pathology and assistant in genito-urinary diseases at the College of Physicians and Surgeons, Baltimore.

Dr. Clifton Durant Howe has resigned his position of associate director of the Biltmore Forest School, Biltmore, North Carolina, to become lecturer in forestry in the University of Toronto.

The following promotions were announced at the recent commencement exercises of the St. Louis University School of Medicine: Warren P. Elmer, M.D. (Michigan), and William Engelbach, M.D. (Northwestern), assistant professors of medicine; William W. Graves, M.D. (Washington University), assistant professor of nervous diseases; M. G. Seelig, A.B. (Harvard), M.D. (Columbia), assistant professor of pathology; James M. Wilson, Ph.B. (Cornell), M.D. (Rush), associate professor of embryology.

Dr. James Walker, of University College, Dundee, succeeds Professor Crum Brown in the chair of chemistry at the University of Edinburgh.

Dr. H. Dold, of Tubingen, has been appointed lecturer in bacteriology and comparative anatomy in the Royal Institution of Public Health, London.

Professor Volhard will retire this year from the directorship of the chemical laboratory at Halle. It is understood that he will be succeeded by Professor Daniel Vorlander, at present one of the heads of a division of the laboratory.

Professor Hans Horst Meyer, the pharmacologist, who was called to Vienna about three years ago, has been asked by the senate of the Berlin University to accept the chair of pharmacology in that institution. The *Journal of the American Medical Association* states that in order to dissuade him from accepting this offer a deputation of ten of the most eminent members of the profession, all professors of the Vienna medical faculty, waited on him and asked him not to desert Vienna, both for scientific and national reasons. This unusual act not only caused a widespread sensation in the profession, but also reminded the government that it is its duty to retain such eminent men at any cost. Professor Meyer will not leave Vienna.

Professor Harms, of Jena, has declined the call to Kiel in succession to Professor Bernhardt, in order that Professor Bernhardt may be free to remain in Kiel. It will be remembered that Professor Bernhardt was offered a chair at Berlin by the Ministry of Education, but declined because this action had been taken without consultation with the faculty.

DISCUSSION AND CORRESPONDENCE

A PROTEST

To the Editor of Science: From the announcements made at the recent college commencements in this country I learned with regret the surprising and disappointing fact that at various medical colleges the chairs of physiology were filled by foreign appointments. Two Englishmen were called to fill the chairs of physiology and of physiological chemistry at the medical department of Cornell University. The chair of physiology at Tulane University was also filled by an Englishman. And a recent cable informs us that a young German was called to fill the chair of physiology at the school of medicine now in process of formation in the Philippines, presumably an institution of the United States government. Permit me to say that this is an anomalous state of affairs, and is disheartening to those who are interested in the development of an active scientific spirit among the younger medical men in this country. How can the talented men among the medical students in this country be persuaded to devote themselves to research, to a scientific career in the face of the tendency to fill desirable places with foreigners? The objections are not raised simply because the men called to the above-mentioned places are foreigners. Newell Martin who was called some thirty years ago to fill the chair of physiology at Johns Hopkins, or Jacques Loeb who was called some fifteen years ago to Bryn Mawr, were then also foreigners, and fortunate would this country be if again another Loeb or another Martin could be added to its store of first-class investigators and teachers. Indeed, all of us, old and young, would have been only too glad if one of these colleges would have made a serious effort to bring over from England such men as Sherrington or Starling. The objections are raised because the men called from abroad are not better than some of our own younger physiologists. Furthermore, in one instance the appointment to a chair of physiology is puzzling indeed. It is true the appointee is a meritorious histologist and microchemist and recently translated a book on the chemistry of the proteids. But one searches in vain through the English literature for an original contribution to physiology which is associated with his name. Why then was the preference given to him over such American men who have identified themselves with physiology and contributed meritoriously to its literature?

In conclusion I wish to emphasize that the above comment is made solely in the interest of the younger generation of physiologists of this country and to obtain justice for them, if possible, on future occasions. But under no circumstances should these remarks be interpreted as being derogatory to the scientists who have accepted these positions. It is no offence to them to assume that we have in this country physiologists who can bear comparison with them. Their coming here is an accomplished fact and they may be sure of a hearty welcome from the members of the scientific community of this country.

S. J. Meltzer

Rockefeller Institute for
Medical Research

A CONTINUOUS CALORIMETER

To the Editor of Science: In your issue of July 24 Professor Lyndley Pyle refers to the use of the continuous calorimeter by students of Washington University for the past fifteen years. It is gratifying to learn that the method has been so thoroughly tested elsewhere for this purpose. In taking up your valuable space in my article of May 15 I described a particular type of simple calorimeter that we have found most suitable for the elementary work. That this method is not generally used in place of the older and more troublesome method of measuring Joule's heat appears to be because sufficient attention has not been drawn to it. The directness, accuracy and ease of manipulation will appeal I think to all those who have charge of laboratory classes.

The method itself, is, of course, not new. Callendar used it more than twenty-two years ago at Cambridge for comparing the thermal and electrical units, but it was not until he came to McGill University in 1893 that steps were taken to thoroughly investigate the merits of the method. A continuous method was used by Graetz as early as 1882 for measuring thermal conductivities.

H. T. Barnes

McGill University,
July 29, 1908

SCIENTIFIC BOOKS

Publications of the Jesup North Pacific Expedition. Edited by Franz Boas. Leiden, E. J. Brill Limited; New York, G. E. Stechert & Co. 4to.

During the past year the following numbers of this publication have been issued:

The Lillooet Indians. By James Teit. (Vol. II., Part V.)

In this book Mr. Teit describes the customs of the Lillooet, a branch of the Salish Indians, who inhabit the valleys of the Coast Range of British Columbia, from Harrison Lake to the upper reaches of Fraser River. Mr. Teit visited the tribe twice, and describes in some detail the customs of both its lower and upper divisions. The plan of description is similar to that of Mr. Teit's well-known book on the Thompson Indians of British Columbia; the habitat and divisions of the tribe, material culture, warfare, games and pastimes, social organization and festivals, birth, childhood, marriage and death, and religion being taken up in detail. On the whole, the Lillooet resemble in their culture the tribes of the interior, but they form an interesting link between them and the coast tribes, having adopted many of the industries and a considerable part of the social traits of the coast tribes. Mr. Teit describes in detail how the influence of the coast culture gradually diminishes towards those divisions of the Lillooet that reside farthest away from the coast. Of special interest in the descriptions is the discussion of the imbricated basketry and of the basketry designs of the tribe, a subject which has received considerable attention in recent literature. The houses of the division of the tribe living near the coast were similar in structure to the large wooden houses of the Coast Salish, while the tribes of the interior lived in underground dwellings and in tents. Weaving like that produced by the Salish Indians of the Gulf of Georgia was confined to the Lower Lillooet. The tribe has been so much influenced by the whites that very few of the old specimens remain, and consequently not many of the objects in use among them formerly could be illustrated. The transitional stage in the social organization of the tribe is interesting from a theoretical point of view, in so far as it shows clearly how a semi-totemic organization may influence a people that in previous times was organized only in very loose village communities. At the present time the influence of the totemic organization may be observed particularly in grave-monuments which are still preserved, many of which represent figures of ancestors and of totemic beings. The religious concepts of the people differ only slightly from those of the Thompson Indians. The numerous rock-paintings in the Lillooet country have reference particularly to the puberty ceremonials, and are explained in a manner similar to those of the Thompson Indians. The principal difference between the Salish tribes of the interior and the Lillooet in regard to their religious beliefs is based on the introduction of some of the secret societies of the coast. Mr. Teit's paper is the first fairly exhaustive description of the Lillooet, and supplants the earlier brief description given by Mr. Hill-Tout.

Archeology of the Gulf of Georgia and Puget Sound. By Harlan I. Smith. (Vol. II., Part VI.)

Mr. Smith's description of the archeology of the southern coast of British Columbia and the northern coast of the state of Washington is a continuation of his paper on the shell-heaps of the Lower Fraser River, published in Vol. II., Part IV., of this series. In the first part of the paper, which is fully illustrated with text figures reproduced from pen and ink drawings of specimens found in the region under discussion, the archeological finds between Comox in British Columbia, and Olympia, state of Washington, are described in some detail. The locations of shell-heaps, fortifications and village sites, are given; and wherever excavations were undertaken, the character of the site and the remains are described by the author. On the whole, it would seem that the culture of the area was quite similar in type to the culture of the modern coast tribes. However, some striking differences were found in various localities. Perhaps the most important of these is the proof which seems to have been definitely given by Mr. Smith of the close relationship of the prehistoric culture of southern Vancouver Island with that of the mainland and presumably the interior; so that it would seem that at an early time a wave of migration passed over the Coast Range westward to the coast, and across the Gulf of Georgia to Vancouver Island. This culture is characterized particularly by the occurrence of numerous chipped implements, of tubular pipes, and of other objects characteristic of the culture of the interior. In other places along the coast of British Columbia chipped implements are very rare, while on Puget Sound and on the outer coast of the state of Washington chipped implements begin to appear in greater number, and are apparently related to the types of Columbia River. Mr. Smith has also made full use of local collections, and has thus brought together an extended amount of material bearing upon the archeology of this region. Here are also found curious clubs of bone of whale and of stone which have often been claimed to be related to the clubs of New Zealand. Mr. Smith has succeeded in collecting illustrations of almost all the clubs of this kind that are known; and a discussion of this material shows very clearly that almost all of them may be referred to one single type, showing a bird's head surrounded by a head mask, which at the present time is characteristic of the western coast of Vancouver Island. Thus the theory of a foreign origin of this type would seem to be finally disposed of. Mr. Smith treats in a similar way the simpler forms of slave-killers from this coast and the peculiar single and double-bitted axes which are characteristic of Oregon. Another very peculiar type of specimens which is fully discussed in this book are the dishes from southern British Columbia and the Delta of the Fraser River, which have attracted the attention of archeologists. Mr. Smith has illustrated not less than nine of these, all of which show characteristic uniformity of type, and the provenience of which is restricted to a very small area. While the shell-heaps of the Fraser Delta have yielded a great many skeletons, skeletons are, on the whole, rare in the shell-heaps on the coast. Apparently this is related to the fact that in early times burials were not made in the shell-heaps, but in the cairns, while later on burials in canoes, and tree burials, seem to have been customary. Attention may also be called to the illustration and discussion of the interesting petroglyphs of the region between Comox and Nanaimo.

Kwakiutl Texts—Second Series. By Franz Boas and George Hunt.

The second series of Kwakiutl texts, so far as published, contains traditions of the more southern Kwakiutl tribes, and particularly the important "Mink Legend" and the "Transformer Legend." The former occupies about eighty-five pages, and the latter about seventy pages, of the series. The texts, so far as published, were recorded by Mr. George Hunt, and were revised from dictation by F. Boas. Thus it happens that the whole series of texts published in the Jesup Expedition are recorded by Mr. Hunt. That the bulk of this work was intrusted to Mr. Hunt is due to the fact that the Kwakiutl mythology is enormously extensive, and must be obtained from representatives of all the different families to whom the family traditions belong. The writer of these lines, who is responsible for the collection, could not undertake this work himself, and for this reason he taught Mr. Hunt to write Kwakiutl, and, by carefully controlling his work, trustworthy material has been gathered.

From a broader ethnological point of view a series of this kind collected by a single native recorder is of course unsatisfactory, because the critical insight into style and contents require more varied material. For this reason I have collected a considerable amount of material from various sources, largely intended to control the results obtained by Mr. Hunt, and also to present different styles of story-telling and differences of dialect. It is a matter of regret that this material has not been included in the present volume which thus would have gained very much in scientific value.

Franz Boas

The Psychology and Pedagogy of Reading, with a review of the history of reading and writing, and of methods, texts, and hygiene in reading. By Edmund Burke Huey, Ph.D., Professor of Psychology and Education in the Western University of Pennsylvania. Pp. xvi + 469. New York, The Macmillan Co. 1908.

The experimental studies of the last dozen years in the physiology and psychology of reading constitute an interesting and an important line of advance in experimental psychology. Motived partly by logical, partly by linguistic, partly by pathological, and partly by pedagogical, as well as by purely psychological interests, the investigations of the reading process have materially increased our knowledge of the visual processes, both central and peripheral. They have enriched our experimental technique, and have furnished unusually satisfactory data for an investigation of the higher mental processes. Historically, physiological psychology received one of its most important early impulses from an investigation of speech defects. The lamented Wernicke found a discussion of the linguistic processes a convenient introduction to the more general discussion of mental life, and many another teacher of related disciplines has found it convenient to follow his example. It is not uninteresting that language seems destined to supplement its former services to psychology by furnishing us with the best available technique for an experimental analysis of the more complex elaborative processes.

Reciprocally it would be surprising if any real advance in our knowledge of the linguistic processes should be without influence on language itself and the teaching of language. I regard it as fortunate that, as far as reading is concerned, these practical deductions have been drawn thus far mainly by those whose experimental work guaranteed real information and a scientific attitude.

The present work is made up of four parts: Part I. is a résumé of experimental and analytic researches in the physiology and psychology of the reading process. It occupies about one third of the book. Part II. is a compact account of the history of reading and of reading methods, pp. 76. Part III. contains an illustrated discussion of the more important theories and practises in teaching reading, pp. 119. Part IV. discusses the hygiene of reading, fatigue in reading, suitable type, length of line, etc. The conclusion contains some interesting speculations as to the future of reading. The book closes with an excellent bibliography and an index.

One of the most striking characteristics of Huey's style is his unusually careful recognition of the work of others. Writing for general as well as for scientific readers, he has ventured to set a standard of intellectual integrity quite unusual in popular works. I believe the general reader will appreciate the innovation. The author has further maintained a fine impartiality of statement. Few of us, doubtless, would have used exactly the same material. All must recognize the candor of his selections and his effort to discover the points of advance.

It is obvious from the nature of the contents that the different parts of the book must represent very different degrees of scientific assurance. Of this the author himself is thoroughly aware. Our present experimental knowledge of the reading of children does not warrant the psychological investigator in giving the weight of his investigations to any system of teaching reading, to any selection of material, or to any definite answer to the questions when, or how much. For the sake of psychology as well as for the sake of a possible science of experimental pedagogy, it seems prudent to make a sharp distinction between the results of scientific experiment and the empirical generalizations of educators. No other science has so many poor relatives urging extravagance. Probably in no other science is there greater need of guarding our work against premature popular exploitation and misrepresentation. Since many of the processes of adult reading are still imperfectly understood, while accurate knowledge of the reading of children and its development is conspicuously fragmentary, it seems probable that school methods in reading must rest, for the present at least, on empirical generalization rather than on scientific law. This, however, is the opportunity of experimental science rather than its reproach. The reviewer joins with the author in the hope that the present work will not only indicate possible lines of attack, but will also stimulate to renewed and if possible coordinated investigation.

Meantime it seems clear that the success or failure of any method rests quite as much on the insight of the teacher into the mental life of his pupils as on any of the formal details of his method. I believe that an adequate knowledge of the mental organization he is supposed to develop, as well as of the material and mental conditions of its realization, is one of the invaluable factors of a teacher's equipment. This factor it is the present privilege of the experimental psychologist to increase. On these grounds I venture the conviction that the book as a whole and in its several parts is an unusual contribution to pedagogical literature. I believe it should be in the hands of every teacher of reading. But the psychologist will welcome its careful summaries and its broad outlook as heartily as the teacher will welcome the new insight into the processes with which he must deal.

The book brings together an immense amount of material in unusually readable form. It seems destined to arouse interest and stimulate investigation in an important field.

Raymond Dodge
Wesleyan University

SCIENTIFIC JOURNALS AND ARTICLES

The contents of the June issue of *Terrestrial Magnetism and Atmospheric Electricity* are as follows: Portrait of E. van Rijckevorsel (frontispiece); "Magnetic Declination and Latitude Observations in the Bermudas," by J. F. Cole; "On Earth-currents and Magnetic Variations," by L. Steiner; "Return of the *Galilee* and Construction of a Special Vessel," by L. A. Bauer; "Magnetic Observations by the New Zealand Expedition to the Southern Islands," by H. F. Skey; "The Earth's Residual Magnetic Field," by A. Tanakadate, L. A. Bauer; "Biographical Sketch of E. van Rijckevorsel." Letters to Editor: "The Solar Eclipse of August 30, 1905, and Magnetic Phenomena," by C. Chree; "Regarding the Magnetic Effects of the Total Solar Eclipse of August 30, 1905," by Ch. Nordmann; "Principal Magnetic Storms recorded at the Cheltenham Magnetic Observatory (January–March, 1908)," by O. H. Tittmann. "Recent Determinations of the Solar Constant of Radiation," by C. G. Abbott and F. E. Fowle, Jr. Notes: "Activity in Magnetic Work"; "Personalia." Abstracts and Reviews: W. van Bemmelen on "Registration of Earth-currents at Batavia," by L. Steiner; Cirera et Barcells on "Activité solaire et les perturbations magnétiques," by J. A. Fleming; Meyermann on "Korrektion der Reduktionsconstanten eines magnetischen Theodoliten," by J. A. Fleming. List of Recent Publications.

THE LIQUEFACTION OF HELIUM

Information communicated by Sir James Dewar to the London *Times* from Professor Kamerlingh Onnes, of Leiden, shows that helium is a liquid having a boiling point of 4.3 degrees absolute, which is not solid when exhausted to a pressure of ten millimeters of mercury, at which pressure the temperature must have been reduced to within three degrees of the absolute zero—*i. e.*, about one fourth of the temperature of hydrogen in corresponding conditions, as that again is about one fourth of the corresponding nitrogen temperature. If we could obtain another similar drop by the discovery of a gas still more volatile than helium we should have a liquid boiling about one degree above the absolute zero. The *Times* also gives a few notes upon the steps by which the liquefaction of helium has been reached. In 1895, by the application of the method of sudden expansion from high compression, Olscevski, starting from the temperature of exhausted air, failed to get any appearance of liquefaction. In 1901, Dewar, in the Bakerian lecture, described his repetition of that experiment, using liquid hydrogen under exhaustion instead of liquid air, again without obtaining any trace of condensation. Reasoning from the analogy of his experiments on the liquefaction of hydrogen, he showed that by regenerative cooling starting from the temperature of liquid hydrogen, we might expect to liquefy a gas whose boiling point might be as low as four or five degrees absolute. In his presidential address to the British Association in the following year he gave reasons for placing the boiling point of helium at that figure, showing at the same time how great are the experimental difficulties of getting within five degrees of absolute zero. In 1905 Olscevski repeated Dewar's experiment of 1901, using higher pressures, and reached the conclusion that the boiling point of helium must be below two degrees absolute, and that after all the gas might be permanent. The same experiment was repeated early in 1908 by Professor Onnes with a much larger quantity of helium than had previously been available, and he at first thought he had obtained solid helium, but found that the appearance was due to impurity in the gas. Dewar again repeated the experiment by circulating helium in a regenerative apparatus, but though he got cooling, he was baffled by the inadequacy of his supply of helium to maintain the cooling process sufficiently long to reach liquefaction. At last, by the experiment of July 10, Professor Onnes has definitely settled the matter. As new and richer sources of helium have been discovered, and its separation has been enormously facilitated by Dewar's charcoal method, it is possible that helium may become sufficiently abundant in cryological laboratories to be used as liquid hydrogen is now used in physical research.

SPECIAL ARTICLES

ELECTROMAGNETIC MASS

The variations of meaning attached to d'Alembert's principle, that depend upon what we may call the genesis of the terms involved in its expression, has been insisted upon in a previous article.[1] We find a similar double chance open for instructive interpretation in many other equations of theoretical physics, among which we now select that important result in hydrodynamics which may be regarded as furnishing the original suggestion of "electromagnetic mass." For a solid of mass m moving in the line X through an ideal liquid free from boundary conditions, the familiar power equation is

$$Xu = d/dt(\tfrac{1}{2}mu^2 + \tfrac{1}{2}m_1u^2). \qquad (1)$$

Here X denotes the aggregate of force *external to the system* consisting of m and the

[1] Science, Vol. XXVII., p. 154.

liquid, and acting on m. The term $\frac{1}{2}m_1u^2$, then, is seen to express, in the first introduction of it, the kinetic energy associated with the liquid as a necessary consequence of moving m through it. The ratio of m_1 to m is calculable for various special assumptions.[2] Executing the differentiation with m_1 constant gives directly

$$X = (m + m_1)\,du/dt. \qquad (2)$$

If we accept this as an "equation of motion," just as it stands, and in the strict sense of d'Alembert, it is obviously not such for m alone, but for that mass plus liquid of constant volume, it is true, but of varying identity. That feature of elusiveness in the mass denoted by m_1 has undoubtedly favored the interpretation of the parenthesis as representing the "effective mass" of m under the conditions, among which must be included that X does not really comprise the total of external force acting on m, in conformity with the suppositions underlying equation (1). The completed equation of motion for m, in which any resistance R—frictional or not—offered by liquid must appear, is

$$X - R = m\,du/dt. \qquad (3)$$

Since $R = m_1\,du/dt$, therefore, because du/dt denotes the actual acceleration in both cases, we have before us another instance of change in reading, from mass-term to force-term, by transposing in the equation. And, from the point of view of equation (3), the power equation (1) can be adapted to the mass m exclusively, by placing $-\frac{1}{2}m_1u^2$ in the first member, as the negative work of the force R. As noted in connection with d'Alembert's principle, each view is justified so long as the proper context is retained, and we do not lose sight of the mental device that harmonizes them. A complete presentation includes both views, and does not overlook, either, the possibility of like alternative statement applying to any equation of motion with corresponding artificial basis. For example, if a mass m is acted upon by forces X_1 and X_2 that would produce separately accelerations a_1 and a_2, it is mathematically correct to write either form:

$$X_1 + X_2 = ma; \quad X_1 = (m - m_1)\,a; \qquad (4)$$

if $a = a_1 + a_2$ is the actual acceleration for the reference system used, and $m_1 = m\,a_2/a$. The "effective mass" of m when the force X_2 is ignored (or unrevealed by first analysis of the phenomena), would be greater or less than m according to the sign of a_2 determined by X_2. The fiction indicated here would serve no useful purpose in many classes of problems, but it offers a certain convenience in treating motions of bodies through media. The effect due to inertia of the medium, or its equivalent, finds adequate recognition by abolishing the medium, and at the same time adding to the inertia of the immersed body. The somewhat vaguely dispersed quality of the medium finds definite location in the bulk of the body.

Wherever the circumstances are thus thoroughly understood, the matter of choice in presentation is controlled completely by our preference; it is enough that the equivalence of two such modes of statement really covers the points aimed at, the confessed fiction being ranged with others like it in mathematical physics. But it is clear that different types of the external agencies called forces lend themselves to calculation as pseudo-inertia of the moving body itself with greater or less facility, the change of front being easiest when a resistance is involved whose magnitude is proportional to the acceleration of the body, as in the well-known hydrodynamical case cited above. Another side of these differences in the mathematical situation is the possibility that they afford for making conditions of unascertained physical nature reveal themselves experimentally as arising from force rather than from real inertia. Thus a resistance proportional to displacement might be identified by adjustment to equilibrium, as in stretching a spring, or charging a condenser; "terminal velocity" is characteristic of other forms of resistance, which prove to be proportional to various powers of speed. This second group includes the obstructive electromotive force of conductors to the passage of current through them, beside the more visible instances of such action. But a resistance pro-

[2] See for example, Lamb, "Hydrodynamics," p. 85, p. 130.

portional to acceleration would evade detection by methods of this kind, since it influences the motion of a body just like a mass measured numerically by the proportional factor. Considered as mass-term or force-term, the sign is reversed as required, and accurate balance with other impressed forces is never brought about. The acceleration that would be produced otherwise is reduced, but steady conditions enter at a finite value of actual acceleration. Supposing, however, that the density of the body falls off, and the "ballast" of real mass is thus diminished, equation (3) approaches a limit $X - R = 0$. And if the proportional factor m_1 of equation (2) be now increased, the acceleration corresponding to equality of X and R will grow less. Equilibrium of the body m can be approached asymptotically, therefore, somewhat as in the case of resistance (proportional to speed) due to eddy currents set up by motion in a magnetic field. For the hydrodynamic problem, the limiting condition $X - R = 0$ would correspond to a rigid massless shell forced through the liquid. The energy supplied would go directly into the latter, the shell transmitting the force X applied to it, undiminished by any distribution throughout its own volume. It is interesting to compare this with the application of the "equilibrium theory" to problems in acoustics.

Every essential aspect of the ideas connected with the equation of motion and the forms derived from it by transposition of terms is found repeated in the parallel electrical statement. The more fundamental form, for a circuit with impressed electromotive force, resistance, capacity and self-induction, is, with obvious notation,

$$E - E_c - IR = L\, dI/dt. \qquad (5)$$

Equation (5) is immediately consistent with the scheme devised by Newton and d'Alembert for the dual measure of forces, in terms of the favoring and hindering agencies themselves on the one hand, and their net result on the other. The former arise externally to the system moved, and the latter affords a mode of calculation in which no exciting stimulus appears directly. The recognition of the coefficient L as "electric inertia" is well rooted; and the proper sense in which the terms of the first member are all "external" is seen readily enough, even in its application to IR, though obscured here, to a certain extent, by the habitual elementary expression of Ohm's law in the form $E = IR$, without explicit recognition of it as involving terminal velocity and equilibrium. It is further apparent how the equation

$$[E - E_c - IR] - [L\, dI/dt] = 0 \qquad (6)$$

presents the idea of d'Alembert's principle, with considerations parallel in detail to those governing its use elsewhere. The proper establishment of these particular analogies is far-reaching enough to excuse their discussion with so much elaboration of emphasis on exceedingly simple conceptions. But there are some indications that original meanings here have become a little incrusted with the formalism of mathematics. A deliberate effort to restore them is not superfluous, if there is any habit of indifference toward fictitious forms of statement to be checked. However harmless such habits may be on familiar ground, they must tend to magnify the difficulties inseparable from attempts to explore and subdue new territory; and, on the other hand, the slightest improvement in giving natural and direct expression to essential phenomena is likely to find quick reward in more rapid advance or deeper insight. At this junction-point of the older mechanics with the modern dynamical treatment of electricity, the transfer of methods from one line of thought to the other calls especially for all precision of ideas that is possible, in view of the inevitable margin of vagueness associated with equations that have been generalized and extended so far beyond their first application.

With the introduction of electrons, an added element of definiteness is infused into electric inertia, and the new suggestion reacts also upon the finality of previous conceptions regarding all mass. We are asked to entertain the possibility that mass is everywhere expressible quantitatively in electromagnetic terms; and to acknowledge as an illusion any former conviction that mass is necessarily constant. Until now, mass has been attributed to a body in the full sense of locating the mass entirely within the volume of the body, and measuring it by means of phenomena exhibited there. The essential property of mass may be put as its power to store energy in the kinetic form, receiving and retaining the energy passively; that is, acquiring and losing it only under the control of external influence. If we distinguish between "real mass" and "effective mass" in ordinary mechanics, they have in common the passive storage of kinetic energy, definite in amount for a given value of speed; but in using the latter, we assign to the body a certain amount of kinetic energy that is in fact not stored there. This part of the energy is obtainable *through* the body, perhaps, but not precisely *from* it. It happens that the effective mass is constant, under the conditions supposed to govern equations (2) and (3); but that type of supposition does not limit the entire range of the conception. This is evident from equation (4) in which m_1 may be variable. Neither is it essential, when we enter the field of generalized dynamics, that the storage of energy connected with inertia is demonstrably of a nature that would be described accurately as kinetic. The energy must indeed be stored; that is, be conservatively regainable; and this storage must be of passive character in the sense explained above—not accompanied by anything corresponding to resilience, nor automatically convertible like potential energy. These two conditions are sufficient as well as necessary; and the storage of energy ascribed to electromagnetic mass being in fact parallel with kinetic energy to this necessary extent, only one vital inquiry remains. This is concerned with what we may call the *location* of the energy. The generalized inertia will be effective rather than real, in proportion as the energy absorbed is not all stored in the body to which it is assigned conventionally; but is distributed throughout some region—or field—surrounding that body. And it is not excluded, as a limit, that the fraction of the total energy to be found within the boundary of the body itself is a negligible part of the whole.

It is of course nothing more than a commonplace to remark that the energy here in question, in the case of an ordinary electric circuit, is dispersed through a field, though the inertia is spoken of figuratively in association with the conducting track. It is also true that the factor L in equation (5) may be variable. But the electromagnetic theory of electrons is built on models supplied by finite circuits; and the more novel aspects of that theory modify nothing that is for our present purpose essential. Without going further into detail, it is sufficiently evident that the mass of an electron is "effective"; part of it, or perhaps all, attaching really to the electron's own magnetic field—of indefinite extent—though attributed to the diminutive bulk of the electron itself. In writing out dynamical equations for application to electrons, therefore, the inertia belonging to the region outside the boundary of an electron will register its influence on the equation of motion for the electron itself in a force-term, according to the general scheme of equation (4), the electron being the channel for transmission of energy to or from the medium. And if it should be finally established that the inertia of the electron proper is negligible or zero, the transmission would then be of perfect efficiency, corresponding to the condition $X = R$ in the text above. And on that supposition, again speaking of the equation of motion for the electron itself, the application of d'Alembert's principle becomes merely formal, since the terms corresponding to "forces of inertia" have vanished, leaving a zero of force in the first instance, instead of a zero resulting from the introduction of an equilibrant. The term R may indeed be read as a "kinetic reaction," but in a modified sense; it is no longer a reaction excited immediately in the electron by whatever applies the force X, but is the reaction of the medium against the attempt to move the electron according to certain laws. The term R may be more or less approximately proportional to the acceleration of the electron; and differently proportional for different types of acceleration. Hence arises the idea that the electromagnetic mass of an electron is not constant.

The consideration that saves the situation is that the entire effective inertia, no matter what may be its source, and where it may be located, is, as a fact, included in the calculations when mass, momentum, kinetic energy, etc., are regarded as attaching to the electron. This process of expression becomes feasible in terms that involve a physical property of the electron itself (its electric charge) and its kinematical elements (acceleration, velocity, etc.); so that to this extent the parallel is preserved with the mass-factor and the kinematical factors of ordinary mechanics. But it may be well, at intervals, while we take advantage of the undoubted convenience in these methods of presentation, to remind ourselves of their artificial nature, and then to employ their fictions consciously.

Should the suggestion prove true that all mass is an electromagnetic phenomenon, we shall be brought to confess that we have been using some fictions unconsciously; for example, in attributing kinetic energy to a mere cannon-ball which is more nearly a clearing-house for energies spread through cubic kilometers of medium. This would add only one item to a list already long enough, where the result of completer analysis is to substitute a complex process for the superficial and simple one. The tendency to identify quantities of energy with limited volumes of "bodies" seems strong enough to carry a good load of artificial convention. Witness potential energy, entropy, specific heat for constant pressure.

Frederick Slate
University of California

THE THIRTY-EIGHTH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY

I.

The thirty-eighth general meeting of the American Chemical Society was held at New Haven during June 30, July 1 and 2, in North Sheffield Hall, of Sheffield Scientific School, Yale University. President Hadley welcomed the visiting members and extended the buildings and accessories for their use and general convenience.

On Tuesday and Thursday afternoons, invitations were extended to the chemists to visit the rubber Works of L. Candee & Co., in New Haven, and the works of the New Haven Gas Light Co. Wednesday afternoon a special excursion was made to Ansonia to visit the works of the Ansonia Brass and Copper Company and the Coe Brass Manufacturing Company; at all of these places the visitors were courteously received and shown through the works in a very thorough and painstaking manner.

On Tuesday evening the local members of the society extended a complimentary smoker to the visitors at the Graduate Club House. On Wednesday a subscription shore dinner was given at the "Momanguin" on the east shore. Many of the visitors made use of the excellent salt-water bathing facilities at this place.

The attendance at this meeting was about 250. Greetings were received from Arrhenius, Emil Fischer, Roscoe, Ramsay, Van't Hoff, Julius Thomsen, Lunge and von Baeyer. A paper on "Agglutination and Coagulation" was presented by Savante Arrhenius, of Nobel Institute, Stockholm, and two papers were presented by Emil Fischer, one on "Polypeptides" and one on "Micropolarization."

The following addresses were given before the general assembly:

A. L. Winton, "Official Inspection of Commodities."

Philip E. Browning, "The Increasing Importance of the Rarer Elements."

Wm. D. Richardson, "The Analyst, the Chemist and the Chemical Engineer."

Thos. B. Osborne, "Our Present Knowledge of Plant Proteins."

Frank K. Cameron, "Some Applications of Physical Chemistry."

W. A. Noyes, "Chemical Publications in America in Relation to Chemical Industry."

Wm. Walker, "The Electrolytic Corrosion of Iron as Applied to the Protection of Steam Boilers."

W. E. Whitney, "The Research Chemist."

Wm. McPherson, "A Discussion of Some of the Methods used in Determining the Structure of Organic Compounds."

The following papers were read before the sections:

AGRICULTURAL AND FOOD CHEMISTRY

A. L. Winton, *Chairman*

The Determination of Cottonseed Hulls in Cottonseed Meal: G. S. Fraps.

The method consist of boiling two grams of the material, after extraction with ether, with 200 c.c.

of fiftieth normal caustic soda. The residue is filtered off, dried, weighed, ignited and weighed again. Cottonseed meals of high purity may yield 10 per cent. residue; hulls give 75 per cent. The freedom of the meals from hulls is judged from the percentage of the residue.

The Production of Active Nitrogen in the Soil: G. S. Frais.

This is a brief statement of results, which will be published in full elsewhere. It is impossible to condense the article more, but the author sees promise of securing a method for determining the needs of the soil for active nitrogen.

The Estimation of Dry Substance by Refractometer in Liquid Saccharine Food Products: A. Hugh Bryan.

The paper records results of comparative determinations of dry substance, by loss of weight at 70° in vacuum oven and from refractive index of the substance, using a table for transforming to dry substance. Samples of maple syrup, cane syrup, glucose, honey and cane and beet molasses were used, and results tabulated. In all the above substances except honey, the dry substance by refractometer agrees very closely with actual dry substance. Individual cases may show as high as two per cent. difference. With honeys the differences are larger, exceeding two per cent. in many cases. It is not certain whether the method for actual dry substance gives reliable results. For most liquid saccharine products the refractometer can be used for this determination and the results will be more nearly the actual dry substance than that derived from specific gravity.

The Determination of Sugar in Meats: A. Lowenstein and W. P. Dunne.

The purpose of the paper is to point out an error in the method for the determination of reducing sugar in meat, as outlined in the Official Methods of Analysis of the A. O. A. C. and in various government bulletins, to show the cause and magnitude of this error, and also the difficulties encountered in the manipulation of the method. A simple method is proposed which avoids the error referred to; avoids the use of lead acetate as a clarifying agent and permits of the determination of reducing sugars, succose and nitrates (saltpeter) in one portion of the sample. The method is rapid and accurate, its accuracy being indicated in several tables in the article.

Spanish Paprika: A. Lowenstein and W. P. Dunne.

This article furnishes data on the composition of a number of samples of pure Spanish paprika, of known origin and also on the ground commercial article imported from Spain. It points out the adulterants commonly employed and their means of detection, and particularly the detection of olive or other added oil. The presence of added oil is revealed by the determination of the iodine number and refractometer reading of the non-volatile ether extract, and also by the alcoholic extract, all of which are materially lowered by the addition of oil. It is convenient to make a tintometer reading of the alcoholic extract and thus record the color, the paprika usually being graded according to its color.

The Determination of Diastatic Power: A. W. Meyer and H. C. Sherman.

This was a preliminary notice of a somewhat extended investigation of the methods for the quantitative determination of the activity of amylases of different origin. The saccharification of soluble starch by taka-diastase and pancreatin has been studied. The work is still in progress and will be reported in detail later.

The Detection and Identification of Certain Reducing Sugars by Condensation with p-Brom-Benzyl-Hydrazide: E. C. Kendall and H. C. Sherman.

Under the conditions which have been worked out this reaction affords a fairly delicate method for the detection and identification of glucose, galactose, mannose or arabinose.

The Composition of Known Samples of Paprika: R. E. Doolittle and A. W. Ogden.

As indicated by the title, this paper is a statement of the results obtained in the examination of a large number of paprikas obtained in the whole pods direct from producers. A method for detection of added oil by means of determination of iodine number of ether extract is given.

Gluten Feeds—Artificially Colored: Edward Gudeman.

The paper gives processes of the manufacture of gluten feeds, by-products in the corn starch, glucose and starch sugar industries. Methods for examinations of gluten feeds for added colors given. Examination of a large number of gluten feeds, sold in the United States (62 samples from agricultural experiment stations), showed over 75 per cent. to have been artificially colored with coal-tar colors. The author considers the artificial coloring of feed stuffs as contrary to the federal food act and many state food acts, unless such products are specifically labeled as artificially colored. The purpose of adding color to gluten feeds is only for deception, to make them appear better than they really are or to hide some inferiority, such as the use of rotten, burnt or fermented corn.

The Detection of Small Quantities of Turpentine in Lemon Oil: E. M. Chace.

The method is based upon the different forms shown by the nitroso chlorid crystals of pinene and limonene when examined under the microscope. The nitroso chlorids of the terpenes of the sample to be examined are prepared from the first 5 per cent. fractionally distilled by means of a Ladenburg 3-bulb flask or with a Glinsky fractionating column, the latter giving the better results. The crystals are purified by solution in chloroform and recrystallization from methyl alcohol. Olive oil is used for mounting.

The Manufacture of Lemon Oil in Sicily: E. M. Chace.

The location and a brief description of the principal centers of the production of lemon oil in Sicily were described. Three methods of production are used in the island. The two-piece method in which the lemon is cut in half, the pulp removed and the oil extracted by means of pressure within a sponge is used in the Messina, Etna and Syracuse districts. The three-piece method, in which the lemon is pared, the skin being removed in three pieces, leaving the pulp with a small portion of the skin adhering to each end, the parings being pressed against a flat sponge for extraction, is confined to the Barcelona and Palermo districts. The use of machines in the production of oil is confined to the province of Calabria upon the mainland, less than 5 per cent. of the total output being thus manufactured.

The Influence of Environment on the Composition of Wheat: J. A. LeClerc and Sherman Leavitt.

Crops grown from the same seed at three points of widely different climatic conditions, such as Kansas, California and Texas, forming a so-called triangular experiment, and similarly at South Dakota, California and Texas, showed a marked difference in the protein content, the weight per bushel, the percentage of starchy grain and total sugar content. Kansas produced invariably a high protein and California a low protein and high sugar content wheat. Wheat grown in California one year was found to double its protein content when grown in Kansas the next; the reverse was found to be true when Kansas seed was grown in California. These differences are due to climatic conditions. The composition of the seed seems to exert no influence on the composition of the crop.

The Analysis of Meat Extracts and other Meat Preparations: John Phillips Street.

Twenty-two paste extracts, 13 fluid extracts, 4 meat juices and 3 meat powders were very completely analyzed. The determinations made were water, alcohol, ash, fat, chlorin, phosphoric acid, potash, acidity to phenolphthalein and litmus, total nitrogen, insoluble and coagulable nitrogen, syntonin, ammonia, nitrogen precipitated by tannin-salt and by zinc sulphate, meat bases, creatinin, creatin and total purins. In general the extracts contained excessive amounts of added sodium chlorid, in one case over 25 per cent. The biuret reaction failed in the zinc sulphate filtrate in all the pastes, but as tannin-salt in every case precipitated much more nitrogen than zinc sulphate, on the average about 2 per cent., it is suggested that this difference may be largely due to Fischer's non-biuret-reacting polypeptides. Attention is called to the false and misleading claims made by many of the manufacturers for the extracts. The methods of analysis used are given in detail, and a bibliography of the subject from the analytical standpoint, with 221 titles, is appended.

Commercial Preservation of Flesh Foods: W. D. Richardson.

The means used at the present time for food preservation may be classified under four principal heads: (1) heat sterilization, (2) desiccation, (3) low temperatures, (4) the use of antiseptics. Any of these processes may be carried out in the absence of air or oxygen. All of these methods have been used by primitive man singly and in combination from times of greatest antiquity, and are used by primitive tribes to-day. Modern science has extended the means of carrying out the various methods of preservation, but has made only one original contribution to the art, namely, the use of small quantities of non-condimental antiseptics. Of the various methods of preservation the application of low temperatures would seem to be the best, inasmuch as little or no alteration in composition occurs under this application and at most there is a change in physical structure which does not affect composition or nutritive value.

Chemistry of Frozen Beef and Poultry: W. D. Richardson.

Analyses of fresh and frozen poultry and of fresh and frozen beef (in the latter case the cruror triceps was used on account of its leanness, size and uniformity of structure) were made at intervals for a period of one and a half years. The determinations were: moisture, ash, fat, ammoniacal nitrogen (by two specially devised methods), and on the cold-water extract, total solids, ash, organic solids, total nitrogen, coagulable nitrogen, albumose nitrogen, meat-base nitrogen and acidity calculated as lactic acid. From these determinations no alteration was discovered for the period mentioned in the composition of either beef or poultry. These results were borne out by practical cooking tests. The work will be continued for an indefinite period.

Histology of Frozen Beef and Poultry: W. D. Richardson.

Histological examination of frozen beef and poultry for a period of one and a half years failed to detect any progressive alteration in the structure of the muscular tissues. The samples frozen for a short period of time, when properly thawed, appeared to have the same structure as those frozen for a longer period. When muscular tissues freeze, the water which begins to separate as ice at — 0.4° C. solidifies outside the muscle fibers, and by progressively accumulating between the fibers as it freezes, causes them to appear much smaller than normal and of irregular form. in fully frozen samples, temperatures below — 9° C., the ice areas are usually greater than the areas of muscle fiber, either in cross or longitudinal sections. On account of these ice areas it is impossible for bacteria to penetrate into frozen meats. From the laws of cryoscopy, the solution which remains after the freezing out of so much ice must be very concentrated, and it is altogether likely, from experiments already conducted, that microorganisms are unable to multiply or remain active in such a medium. On the other hand, it is probable that microorganisms if artificially inoculated into meats under these circumstances would certainly lose their vitality and die. Experiments on this point are not yet concluded. If frozen muscular tissue is thawed rapidly, the normal appearance is not resumed. On the other hand, if thawed sufficiently slowly, a histologic picture very close to the normal is obtained.

A Method for Detecting Synthetic Color in Butter: R. W. Cornelison.

The clear fat is shaken with glacial acetic acid, and the acid, after being separated from the fat, is tested by the addition of a few drops of mineral acid, particularly nitric. A pink color developed in samples containing the several azo colors which were tried. The color of the acetic-acid extract is also noteworthy. Reactions of several vegetable colors also are given. The writer makes an earnest plea for the use of the true chemical names of colors in place of the fanciful and much-confused names in use in the trade.

The Composition of Milk from Dutch Belted Cows: Hermann C. Lythgoe.

The Dutch belted cattle are all jet black with the exception of a broad belt of pure white encircling the body. No white is admissible in the black, and the belt must be free from black. There are but few herds of this breed in this country, although single cows in mixed herds are not uncommon. There has been examined in the laboratory of food and drug inspection of the Massachusetts State Board of Health the milk of 23 registered, and of a few unregistered, Dutch belted cows. In general this milk is better than that produced by the Holsteins, being characterized by a much higher fat and refraction of the milk serum. The cows were milked in the presence of an inspector or analyst of the state board of health. The analyses of the twenty-five samples of milk reported may be summarized as follows:

Per Cent.	Total Solids
14	1 sample
13 –14	2 samples
12.5–13	3 samples
12 –12.5	8 samples
11.5–12	4 samples
11 –11.5	6 samples
10.93	1 sample

Per Cent.	Fat
Above 4	2 samples
3.5–4	11 samples
3 –3.5	12 samples

Per Cent.	Solids not Fat
9 –9.75	4 samples
8.5 –9	8 samples
8 –8.5	9 samples
7.73–8	4 samples

Studies on the Action of Heat on Milk: R. R. Renshaw and J. C. Ware.

The following determinations were made every one fourth hour on milk heated at different temperatures between 60° and 85° C. for two and a half hours with and without varying amounts of formaldehyde: sugar, polarimetrically and gravimetrically, acidity, alkalinity, total nitrogen and total phosphorus on clarified filtrate. Lactose in a mixed citrate-phosphate solution having an alkalinity of 19° to lacmoid was not changed on heating to 85°. The authors conclude that the decrease in sugar is not due to caramelization, but to a greater bacterial activity throughout the first stages of the heating.

The Status of Silicon in Certain Plants: W. E. Tottingham.

Evidence has been secured which points strongly to the presence of organic silicon compounds in certain plants. Moist oxidation of 20 per cent. acetic acid and 95 per cent. alcohol extracts from green Gramineæ (mostly barley) has shown the presence of forms of silicon which are lost upon incinerating such extracts. Of the total silicon in the acetic-acid extract, 31.73 per cent. was lost in this manner. With the alcoholic extract 18.42 per cent. was lost in the same manner. The silicon in young fruiting fronds of *Equisetum arvense* was found to be 26.7 times more soluble in 95 per cent. alcohol than in distilled water. Evidence has been obtained of the existence of silicon as a constituent of volatile compounds in plants. The distillate by vacuum distillation of 95 per cent. alcohol extract of Gramineæ contained .0123 gram SiO_2. A current of air was passed over green fruiting fronds of *Equisetum arvense* while drying at 97° C., and then was drawn through an absorbing train. By oxidation, .0023 gram SiO_2 was recovered from the water condensation and .0039 gram from the conc. H_2SO_4 absorption. These data strongly suggest the occurrence of organic and volatile silicon compounds in plants. They further open the field for future study on the relation and importance of silicon in plant nutrition.

Abstracts have not been received for the following papers:

The Determination of Reducing Sugars: Fritz Zerban.

Determination of Volatile Fatty Acids: Edward Gudeman.

Effect of Heat upon Physical and Chemical Constants of Cottonseed Oil: Elton Fulmer.

The Determination of Total, Fixed and Volatile Acids in Wine: Julius Hortvet.

The Chemistry of Durum Wheat Flour: E. F. Ladd.

Water and Starch in Meat Products: Floyd W. Robison.

The Determination of Tin in Canned Apple Juice: H. C. Gore.

The Toxicity of Ferrous Sulphate and of Acids to Rye and Barley Seedlings: Burt L. Hartwell and F. R. Pember.

ORGANIC CHEMISTRY

Wm. McPherson, *Chairman*

The Anhydrides of Meta- and Para-phthalic Acids: John E. Bucher and W. Clifton Slade.

When meta-phthalic acid is dissolved in acetic anhydride and the excess of reagent distilled a viscous oil is obtained. On heating this in vacuo at 200° C., a solid residue of meta-phthalic anhydride is obtained. This substance is insoluble in dilute sodium carbonate but dissolves rapidly in sodium hydroxide solutions. Water converts into the corresponding acid very easily in the presence of solvents. The method of preparation and the properties of para-phthalic anhydride are similar to those of the meta compound.

The Formation of Naphthalene Derivatives from Phenylpropiolic Acid and its Substitution Products: John E. Bucher.

Phenylpropiolic acid heated with acetic anhydride gives a quantitative yield of 1-phenylnaphthalene-2, 3-dicarboxylic anhydride. This saturated compound on oxidation yields o-benzoylbenzoic acid, diphenyltetracarboxylic acid, 1-phenyl-phenyl-o-glyoxyltricarboxylic acid and probably benzenepentacarboxylic acid. The above polymerization has been shown to be a general reaction as piperonylpropialic, o-chlor-, m-chlor-, m-nitro-, p-chlor-, p-iodo-, p-nitro- and p-methoxy-, phenylpropiolic acids all yield saturated anhydrides and nearly all of these have already been shown to be derivatives of 1-phenylnaphthalene. A number of practical applications of this synthesis were pointed out.

Chemical Publications in America in Relation to Chemical Industry: W. A. Noyes.

The American Chemical Society is the only large chemical society in the world which attempts to provide adequately both for the needs of those who are engaged in the applications of chemistry to the industries and to chemical engineering and of those who are engaged in teaching and in the prosecution of researches which have no immediate practical bearing. The dues of the society were increased by only three dollars when the *Chemical Abstracts* was established, while it costs between five and six dollars per member. The expenditures of the society somewhat exceed its receipts, but the rapid growth in membership indicates that the policy which has been adopted will be permanently successful. The new *Journal of Industrial and Engineering Chemistry* is to be sent to all the members of the society. Only by uniting in the support of all the publications can we succeed in fulfilling the purpose of the society, which is to care adequately for the interests of all classes of chemists. The benefits of the society are extended freely to any one who is willing to pay the dues. This has not, however, caused the membership of the society to be non-professional. There are only a few members who are not actually engaged in chemical work.

Rearrangements in the Camphor Series: the Structure of Laurolene: W. A. Noyes and C. G. Derrick.

An attempt is being made to gain a better insight into the nature and cause of some of the puzzling rearrangements which occur so frequently among the derivatives of camphor. The oxidation of laurolene, C_8H_{14}, has given a diketone, $C_8H_{14}O_2$. It seems almost certain that this ketone must contain two groups of the structure CH_3CO. The melting point of its disemicarbazone indicates that it is not 2, 7-octanedione, which would be formed if laurolene were tetrahydro-ortho-xylene. The activity of laurolene also excludes that formula. The formula of Eykmann, according to which laurolene is 1, 2, 3-trimethylcyclopentene, is now the most probable.

Studies in Nitration, VI. Melting Points of Mixtures of Ortho- and Paranitraniline: J. Bishop Tingle and H. F. Rolker.

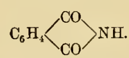
The authors have shown previously that the melting points of mixtures of o- and m- and of m- and p-nitranilines form regular curves, whereas the mixtures of o- and p-nitraniline melted at highly irregular temperatures. A fresh series of mixtures of these two isomers has been prepared with additional precautions to secure homogeneity and also constancy of composition. The m.p. of each mixture was determined, the material was allowed to solidify and it was then melted once more. The results have been plotted in the form of two curves which do not exhibit a very simple relationship and which are both highly irregular. Moreover, the melting points of mixtures of the o- and p-nitranilines are not nearly so sharp as those mixtures of the other isomers. Suggestions were made as to the possible cause of these phenomena which are probably due to polymorphism.

Action of Sodium on Certain Esters: J. Bishop Tingle and Ernest E. Gorsline.

According to Claisen's hypothesis, which was adopted subsequently by Nef, the formation of ethyl acetoacetate, $CH_3C(OH):CHCO_2C_2H_5$, from ethyl acetate, $CH_3CO_2C_2H_6$, depends upon the previous production of sodium ethylate, which is the active agent in producing the condensation. A. Michael, on the other hand, considers that sodium reacts directly with ethyl acetate, forming such a compound as $NaCH_2CO_2C_2H_5$ or $CH_2:C(ONa)\cdot CO_2C_2H_5$. We have purified ethyl acetate with great care by a new method and find that the specimens obtained in this way react very readily with sodium, either alone or in the presence of ether. Experiments have been carried out on the interaction of sodium and certain esters. It is found that ethyl malonate, $H_2C(CO_2C_2H_5)$, ethyl chlormalonate, $Cl(CO_2C_2H_6)$, and ethyl dimethylmalonate, $(CH_3)_2C(CO_2C_2H_6)$, react with 2, 1 and 4 atomic proportions of sodium, respectively. Ethyl phthalate and the metal react, but an insoluble coating is formed over the surface of the wire so that the action quickly ceases. Our study of the catalytic effect of ether, pyridine and quinoline in promoting the Claisen reaction (acetoacetic ester condensation) has been extended. The results of our work support Michael's explanation of the reaction and show that the Claisen-Nef hypothesis is open to the gravest doubt.

Intramolecular Rearrangement in the Phthalamidic Acid Series: J. Bishop Tingle and H. F. Rolker.

In conjunction with Messrs. Cram and Lovelace, the senior author has shown previously that phthanilic acid, $C_6H_5NHCOC_6H_4CO_2H$, changes very readily in the presence of amines to phthalanil,



It was suggested that the change in the equation was preceded by the formation of a salt, $C_6HNHCOC_6H_4CO_2NH_3R$. This hypothesis has been confirmed by the preparation of several such salts, the stability of which is found to vary according to the nature of the amine and also to that of the group R in the parent acid $RNHC_6H_4CO_2H$. In addition to this reaction a second one occurs which consists in the replacement of the group R in the original acid by a different complex R′ derived from the amine thus, $RNHC_6H_4CO_2H + R'NH_2, R'NHC_6H_4CO_2 + RNH_2$. This new acid may then pass into the imide (anil). Finally there is evidence showing that occasionally some diamide, $C_6H_4(CONHR)_2$, may be formed. The reactions have been studied in detail with a considerable number of acids and amines, and the influence of various solvents and also the temperature effects have been determined.

A Wax Acid from Soils; Agroceric Acid: OSWALD SCHREINER and EDMUND C. SHOREY.

In the examination of a black clay loam from North Dakota there was obtained by treatment with boiling 95 per cent. alcohol a colored extract from which a micro-crystalline precipitate separated on cooling. By washing with cold alcohol and recrystallizing, this can be obtained free of color. On drying this purified precipitate and treating with cold ether it is divided into two portions. The ether soluble portion crystallizes on evaporation of the ether in minute leaflets, melting at 72–73° C. The physical and chemical properties of this body place it among the fatty acids found in waxes. Elementary analyses correspond with the formula $C_{21}H_{42}O_3$, the hypothetical acid of a lactone found in carnauba wax. The name agroceric acid is proposed for this body.

A Cholesterol Body in Soils; Agrosterol: OSWALD SCHREINER and EDMUND C. SHOREY.

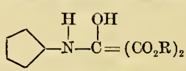
When the alcoholic extract of the soil referred to in the first paper is separated from the precipitate, which forms on cooling, and is evaporated to small volume, a resinous dark-colored mass is obtained. Cold ether dissolves a portion of this, including the coloring matter. Spontaneous evaporation of the ether leaves again a resinous dark-colored mass. Treatment of this with cold absolute alcohol removes the coloring matter and leaves a white crystalline residue. Purification of this by recrystallization yields a body crystallizing in plates resembling those of phytosterol, melts at 237° and gives the cholesterol reaction with acetic anhydride and sulphuric acid. Elementary analysis gave figures corresponding to the formula $C_{26}H_{44}O$. The name agrosterol is suggested for this compound.

Studies in Catalysis; Some Practical Results and their Application to the Synthesis of Some Esters: ISAAC K. PHELPS.

A study of the quantitative yields of various esters in a special form of apparatus under known conditions of temperature and in the presence of various substances as catalyzers. From the present evidence, it seems that each individual catalyzer has its own individual effect. Zinc chloride in the presence of alcohol and hydrochloric acid is the most efficient chloride studied; next in catalytic effect come stannic, cupric and mercuric chlorides, followed by bismuth and antimony chlorides. Potassium chloride appears inactive; the following chlorides act as negative catalyzers, sodium, lithium, ammonium, aluminum and calcium. The list for sulphates in order of efficiency is sulphuric acid, acid sodium sulphate, ammonium, potassium, aniline and pyridine acid sulphates. Zinc bromide and hydrobromic acid act less efficiently as ester-forming catalyzers as the temperature rises. In esterifying malonic acid, 96.1 per cent. yield was obtained: cyanacetic acid 97.1 per cent. of the theory; applying these results to the synthesis of malonic ester from chloracetic acid, it appears that conditions of quantitative reactions are found with a yield of 87 per cent. from chloracid of 95 per cent. purity; or in synthesizing similarly cyanacetic ester a yield of 85 per cent. from acid of the same purity.

Addition Reactions on Methyl Oxomalonate: RICHARD S. CURTISS and F. G. C. SPENCER.

Methyl oxomalonate can only be made perfectly anhydrous by distilling methyl dihydroxymalonate with phosphoric anhydride. It gives with ammonia and its derivatives compounds more or less unstable, which represent the class of hypothetical intermediate addition products, supposed to be first formed when amines, etc., act on aldehyde or ketone groups, and which pass into the final stable end product by loss of the elements of water. Thus aniline gave



Urethone reacts in like manner. More positive ammonias add on two oxomalonate radicles. Alcohols and even the acids add on the carbonyl group of these esters. The products which are tartronic ester derivatives are unstable and readily dissociate into their constituent parts, in moist air or simply by heating. The studies on these and similar substances are being continued.

Methods for the Determination of Salicylates: ATHERTON SEIDELL.

In looking for a reaction upon which to base a quantitative method for the determination of the salicylic acid radicle, the author found that bromine acting upon a concentrated hydrochloric acid solution of salicylic acid yielded di-brom-salicylic acid (m. pt. 220°) and in the presence of relatively small amounts of H_2O and at 80–90° the reaction proceeded quantitatively, although rather slowly. The suggested method is as follows: The weighed sample of 2–3 grams of salicylate is dissolved in 100 c.c. of water. 3–5 c.c. portions of this solution measured accurately from a burette are mixed with 10–20 times the volume of concentrated hydrochloric acid in a glass-stoppered bottle. Standard 0.2 normal potassium bromate solution is run in slowly until a persistent pale yellow color remains, the solution then warmed and shaken until the color disappears, more bromate then added, and the color discharged by further heating and shaking; this alternate adding of bromate and heating continued until the temperature has reached 80–90° and the pale yellow color produced by two to three drops of the bromate remains at least fifteen minutes. Four atoms of bromine per one molecule of salicylic acid are used. The reaction is slow and patience is required, but with care satisfactory results may be obtained.

Abstracts of the following papers have not been received:

On Certain Derivatives of Tetrachlororthoquinone: C. Loring Jackson and H. A. Flint.

On the Reactions of Tautomeric Acids and their Salts with Diazoalkyliden and with Alkyl Halides: S. F. Acree.

On Furoyl Acetic Ester and its Pyrazotone Derivatives: Henry A. Torrey and J. E. Zanetti.

On Rosocyanine: C. Loring Jackson and Latham Clarke.

The Nitration of p-Tolylglutaric Acid: S. Avery.

The Action of Phosphorus Trichloride on Organic Acids: Wm. McPherson and Howard J. Lucas.

Comparison of Isomeric—N:C(OR) *and* NR:CO—*Compounds in the Quinazoline Group:* M. T. Bogert and C. E. May.

4, 6-Diamino Isophthalic Acid and Some of its Derivatives: M. T. Bogert and Alfred H. Kropff.

3-Amino Phthalic Acid and Some of its Derivatives: M. T. Bogert and F. L. Jouard.

The Colored Salts of Schiff's Bases: F. J. Moore.

The Oxidation and the Reduction of b-g-Diphenyl-g-Cyanbutyric Acid: S. Avery.

An Insoluble Congo Red; a White Derivative of Congo Red: Irving W. Fay.

On an Oxidation Product of Tetrabromorthoquinone: C. Loring Jackson and H. A. Flint.

INDUSTRIAL CHEMISTRY

W. D. Richardson, *Chairman*

The Cleaning of Blast Furnace Gas: G. D. Chamberlain.

A review of methods of cleaning and present tendencies and practise. The cleaning divided into two phases. (1) A preliminary scrubbing either dry or wet, or a combination of the two, for fuel purposes—hot blast stoves and boilers. (2) Fine washing for gas-engine use. The raw gas carrying from 1 to 5 grams of dust per cubic foot is cleaned down to .1 to .5 for fuel and to .005 gram per cubic foot or less in fine gas for engine use. The magnitude of the problem is suggested in the fact that approximately six tons of gas are incidentally produced for each ton of pig-iron made.

Determination of Nickel and Chromium in Steel: E. D. Cambell.

The object of this research was to modify the cyanide-iodide method for the determination of nickel, in such a way that a satisfactory titration could be made in the presence of iron. The titration of nickel with potassium cyanide, using silver iodide as indicator, was proposed by the author in 1895, but in the original method the nickel was separated from the iron before titrating. In the new method the iron is kept in solution as double pyrophosphate by means of sodium pyrophosphate, copper when present is avoided by dissolving in dilute sulphuric acid. Chromium is determined in the same sample as that used for the nickel by a slight modification of the Galbraith method.

Application of Ericsson's Lead Method to the Analysis of Spelter, Zinc and Lead Ores: Eric John Ericsson.

The method was described in the September issue, 1904, of the *Journal of the American Chemical Society*. The lead is brought into solution as nitrate, ammonia and ammonium persulphate added in excess and boiled. The resulting lead peroxide is filtered off, washed. Filter with precipitate are thrown back into beaker in which precipitation was made, excess of acidulated hydrogen peroxide added and stirred until the lead peroxide is dissolved, the excess of hydrogen peroxide is measured by standard potassium permanganate of such strength that each tenth of a cubic centimeter = 0.01 per cent. lead when 1.92 grams are taken as in low-grade ores and the determination of lead in zinc ores. In the case of spelter 19.2 gram sample are taken when each tenth of the potassium permanganate solution = 0.001 per cent. lead. It is believed the new method will fill a long-felt want, since we have not heretofore had a reliable method for low-grade ores. It will be found on investigation to be a marvel of accuracy.

The Crystallization of Soap: W. D. Richardson.

When crystals form in transparent soap they usually first appear as bundles of two or three long slender needles pointed in opposite directions from a central nucleus. Later more needles appear until the crystal looks something like two whisk-brooms with the handles together. The nucleus does not appear to grow larger with age, but more needles form from the center until a circular disk of radiating needles is formed and this may increase in size indefinitely. Sometimes only one or two crystals will form in a bar of soap, at other times they will form in such numbers that the whole bar of soap becomes opaque and at a little distance can not be distinguished from a piece of opaque cold-made soap. In cold-made soap the same crystal-form is observed, with radiating needles starting from nuclei of fibrous structure which occupy the spaces originally occupied by fat globules in the emulsion of fat and alkali solution. It is suggested that in old bars of ordinary curd soap the same structure may be found, although it is difficult to observe microscopically. The composition of the nuclei has not been determined.

Glue Standards and Methods for Determining their Viscosity and Jelly Strength: Jerome Alexander.

Although the viscosity and jelly strength of glues and gelatines are the most important test figures, no standard methods have been agreed upon for their determination. It is proposed to establish as standards the methods described by the author in *J. S. C. I.*, Vol. 25, p. 158, which in brief are as follows: To determine—*Viscosity.* A glass pipette of convenient size and construction, which delivers 45 c.c. of water at 80° C. in fifteen seconds. Exact measurements and instructions for making the pipette are given. *Jelly Strength.* The jelly tester described, by which is determined the weight required to effect a certain compression of an unsupported block of jelly of definite size, composition and temperature (see also U. S. Patent No. 882,731). Sixteen uniformly graduated grades of glue were selected as standards, which include not only the so-called "Cooper grades," but also all other grades of glues and gelatines. The standards vary *per grade* under the conditions given, about one second in viscosity, and about 622 grams (22 oz.) in jelly strength.

Abstracts have not been received for the following papers:

Gas Producer Practise: George C. Stone.

The Influence of Fine Grinding on the Ferrous-Iron and Water Content of Minerals: W. F. Hillebrand.

The Stability of Rosin at Slightly Elevated Temperatures: C. H. Herty and W. S. Dickson.

A Rapid Method for the Determination of Oil in Cottonseed Products: C. H. Herty and M. Orr.

The Effect of Leaching Alcoholic Distillates through Wood Charcoal: Wm. L. Dudley.

The Mercerizing Process: J. M. Matthews.

Coal Modifications, Natural and Artificial: S. W. Parr.

Modifications of Illinois Coal by Low Temperature Distillation: S. W. Parr and C. K. Francis.

An Initial Coal Substance having a Constant Thermal Value: S. W. Parr and W. F. Wheeler.

Reactions in Water Softening: Edward Bartow.

The Relation between Teachers of Chemistry and the Chemical Industries: B. B. Freud.

Note on the Determination of Unsaponifiable Matter in Oils and Fats: A. G. Stillwell.

A Method for Preparing a Standard Alkaline Solution: David Wilbur Horn.

The Nature of the Volatile Matter of Coal as Evolved under Different Conditions: Horace C. Porter and F. K. Ovitz.

Refining and Testing Wood Turpentine: F. P. Veitch and M. G. Donk.

The Determination of Vanadium, Molybdenum, Chromium and Nickel in Steel: Andrew A. Blair.

Selective Economy in Raw Materials: H. F. Mork.

The Basis of Quality in Paper: A. D. Little.

The Calorific Power of Petroleum Oils and the Relation of Density to Calorific Power: H. C. Sherman and A. H. Kropff.

A Comparison of the Calculated and Determined Viscosity, Flash and Fire Tests in Oil Mixtures: H. C. Sherman, T. T. Gray and H. A. Hammerschlag.

Paint Analysis: Percy H. Walker.

A Microscopic Investigation of Broken Steel Rails: Henry Fay.

Industrial Chemistry as Taught at Pratt Institute: Allen Rogers.

B. E. Curry,
Secretary

(*To be continued*)

SCIENCE

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FRIDAY, AUGUST 14, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

THE CALL TO PUBLIC HEALTH[1]

ONE of the most fruitful sequels of the scientific age has been the new and higher valuation which it places upon ordinary human life.

As long as this present every-day world and this ordinary human life were held, whether by ancients or by medievals, to be merely the prelude to another and a better, any serious struggle for longevity, any earnest plea for health for health's sake, fell upon deaf ears. As long as a sick man or his friends could honestly exclaim in the face of sickness or death, "I know that if my earthly house of this tabernacle be dissolved I have an house not made with hands, eternal, in the heavens," disease and death lost their terrors, and even became almost attractive.

Ideals of this kind, full of hope and rich in encouragement for weary mortals, ought never, and need never, to have been divorced from perfect joy and satisfaction in this present life. It was the refusal to consent to any such separation that brought on the warm springtime of the Renaissance after the winter of the Middle Ages. And it must be reckoned the colossal blunder of theology and ecclesiasticism that in their reaction to the Renaissance they blindly turned their backs upon this world and fixed their gaze upon a distant and an unknown world of which they dreamed much but knew little. It was well that theology should urge man on to the ultimate and the ideal, but it need not, in doing this,

[1] The annual address in medicine, Yale University.

have neglected the near-by and the real. Is it any wonder that under such guidance mankind, while running regardless through the mazes of this world, its eyes glued to the heavens, should have stumbled and fallen over the commonest obstacles; or that some, bruised in falling, should have turned to rend those who had misled them?

The philosopher of the future will surely count as pathological those periods of history in which ordinary life, for whatever reason, was cheaply held; whether by the morbid ambition of kings and generals, or the morbid mentality of theologians and ecclesiastics. Then will it become the glory of the medical profession that nearer than either warriors or churchmen to the sublime teachings of Jesus of Nazareth have been, all through the ages, the theory and practise of physicians, who have always held the life to be more than meat, the body than raiment; who have emphasized that portion of the liturgy which prays, "as well for the body as the soul"; and who have believed that Christ meant what he said when he asserted that he came that mankind might have life, and might have it more abundantly.

The call to life, and to life in this world, is thus the first and fundamental call of the scientific age. And the next is the call to health, *i. e.*, to wholeness or fulness of normal life. It is not merely that we may have life, but that we may have it more abundantly. The first and chief characteristic of science is that it seeks always after nature, after the normal, *i. e.*, the natural, and looks askance upon the abnormal and the super- or the sub-natural. Hence the call of a scientific age for normal, natural life and healthy living; hence its disapproval of disease, hence its disgust with dirt as a cause of disease, and its belief in public health as well as private welfare.

The call to health is also the primal call to individual duty, for the call to life rests not upon us, but upon our forbears. Endowed by our ancestors with living bodies full of a machinery more wonderful and intricate than the works of any other known mechanism, we ought first to realize our responsibility for the care and operation of this precious apparatus. And here again we have to deplore that blind, if not insane, leadership which for so many weary centuries led mankind, not only to an ignorant contempt for the flesh, but to ingenious and hideous forms of mortification of the body, such as fastings, flagellations and various grotesque forms of worship or penance. Happily, we have now a more reasonable regard for the human mechanism, a more general recognition that it is worthy of respect and care. And yet, even to-day our children are taught but little in their schools and less in their colleges about the human body and its proper care and conservation. Physiology, hygiene and sanitation, as elements in the curriculum, are despised by many principals and superintendents of elementary and secondary schools; and, being only rarely subjects required for admission to the higher schools and universities, education is sacrificed to examination, and physiology is pushed aside in the struggle for examination records that will count. The call for public health to be effective must begin not with a clamor for a secretary of public health in the cabinet at Washington, but with a general insistence upon sound and accurate teaching in the public schools of the essentials of physiology and hygiene and the basic principles of sanitation. Out of such teaching would soon grow an interest in the public health, a call for efficient service, and an expenditure for sanitation, which, rightly directed, would become irresistible and lead up logically to federal supervision and assistance.

But the call to public health is not merely a call to individual welfare; it is also one of the primal social duties. Next after himself, man owes it to his neighbor to be well, and to avoid disease in order that he may impose no burden upon that neighbor. A normal community can only be made up of normal members, and we are but just beginning adequately to recognize that the tuberculous person or the typhoid patient is a menace to the public health. The Germans have given us that excellent phrase *Bacillenträger;* and this, for one disease, we have recently translated as typhoid-carriers. It would be well if we went further, and, instead of speaking as we usually do, merely of "consumptives," if we referred sometimes to these as tuberculosis-carriers. If we could go further yet and refer to syphilis-carriers and other sex-disease carriers, we should do useful service by educating the public to one of the gravest social aspects of public health reform.

The call of the scientific age to public health is nothing less than a summons to mankind to carefully consider and wisely control the whole physical sphere of human life and activity. And this great sphere falls naturally into two hemispheres: namely, that of the human organism on the one hand, and that of the environment of that organism on the other. The general public perceives most easily the environment and its significance to health. Plague and pestilence proceeding from without have long been known and dreaded. The cold of winter, the heat of summer, the lightning stroke, a scarcity of food or drink—all these have long since taught man his dependence on his nearer surroundings. Sunshine and rainfall, dew and frost, seem more remote and mysterious; while planets and fixed stars, the moon and the milky way, have influences so uncertain as to connect them with the unknown and the supernatural—inexplicable human qualities, such as insanity, being easily regarded as moon madness or "lunacy." Of any appreciation of the physical give and take, the chemical and electrical action and reaction, between man and his environment, our predecessors had little or no idea. The story of Newton and the apple still seems to most unscientific minds absurd and impossible. Even to-day it is not in any broad and accurate form that the public conceives of the environmental aspect of public health problems. The idea has gone forth that water should be pure, but most persons still suppose that whatever water flows from city pipes is safe to drink—especially if it is bright and cool. Others, more intelligent, refuse all city water in places known to have impure supplies; yet thoughtlessly drink that very water on cars or steamers departing from such a city, where these have taken on supplies of the impure water. That milk, most ancient and most trusted of all human foods, may carry sickness and death concealed beneath its white and innocent-looking mantle, is an idea which spreads but slowly. That contagion may come, not merely on the wings of the wind, but in a cup of cold water or of milk, in the caress of affection, on the hand of pity stretched out to save, upon the penitential garment, or even upon the sacramental communion cup or the broken bread—these ideas, dimly dreamed of in the past, are among the very corner-stones of sanitary knowledge to-day.

Turning to the other hemisphere of human concern, the organism itself, we enter that province which the medical profession has long made peculiarly its own. The medieval philosophers recognized dimly the true relations of organism and environment, but they fell into the picturesque error of regarding the human body as a kind of miniature copy of the remainder of the universe, and especially of the heavens. Hence they spoke of man as the microcosm, standing over against, yet reproducing, as it were, the rest of the universe or the macrocosm. It is the glory of the medical profession that it has always had scientific curiosity, that it has insisted upon actually dissecting the human body, mapping out laboriously its real anatomy, puzzling out slowly and painfully its true physiology. It has often been mistaken, but it has seldom refused to observe or to reason. Hippocrates is still admired as the father of medicine, not for his theories, which are now merely historical curiosities; nor for his practise, which was doubtless poor enough; but for his method, which was sound and scientific as well as new; for his insistence on observation and study, especially of the patient; but above all, for his conception of disease as a natural rather than a supernatural phenomenon. Sydenham is still called the English Hippocrates, because he, too, looked upon disease as a natural disturbance of a material mechanism. And that this mechanism possesses—must possess, in order to exist at all—some power of resistance to external conditions is obvious. That some human bodies possess more and some less of this power of resistance is perfectly plain. That the same body may, and actually does, vary in its powers of coping with its surroundings, is also a fact of common human experience. That this "vital resistance" or "vitality" can, within narrow limits, be increased or diminished, is also commonly understood, though seldom popularly formulated—for every one knows the refreshment and reinvigoration of rest, of sleep and of food; the depression and danger of overwork, loss of sleep, starvation, debauchery or poisonings. But the idea that we can artificially and at will secure immunity from virulent diseases, from which there was formerly no escape, dates back less than two centuries: namely, to 1717, and to the letters of Lady Mary Wortley Montagu from Constantinople, telling about inoculation against the smallpox as practised there.

Both conceptions—control of environment and control of the bodies of the people—are indispensable to scientific efforts for public health. The terms "environment," "organism," "vital resistance," "immunity" and the like, are easy to pronounce, easy to repeat. But to the biologist each has had a history and each is full of deep significance. He who would really master the philosophy of life and disease and health must first become a biologist, for the great fact which biology teaches, that man has arisen from the lower animals, helps us to comprehend many human habits and proclivities which would otherwise be hard to understand. Anthropology, especially, and archeology, by showing how man probably first hunted, then tamed, and finally domesticated and dwelt with lower animals, helps us to realize, as our ancestors never dreamed, our lowly origin and our filthy habits. If we are careless of excrements, neglectful of parasites, heedless of food and drink, guided by appetites rather than reason, we do not to-day lay all the blame upon an hypothetical Adam for a natural if not praiseworthy curiosity. We look rather to those long ages of essentially animal behavior, under animal conditions and with animal associations, and marvel not so much at our present carelessness as that we have ever climbed so high. If our dietary of to-day is too rich in protein, and especially in meat, we have perhaps to thank for it those long ages before agriculture had arisen, when meat was the staple food; when the kid or the fatted calf was killed for the guest bidden to meat, as well as for the returning prodigal; when meat and drink went together, and when grace before meat began to be said as it often is to-day—

although the "meat" of to-day may be largely cereals, vegetables and fruit.

We need thus to broaden and deepen our knowledge of the human organism and its evolution before we seek to modify it or its behavior towards the environment. And so, too, in our studies of the environment for health's sake, or for preventive medicine, we must begin with the broadest ideas. For we are here dealing with that other and vastly greater hemisphere of human interest, which, taken together with the human organism, makes up nothing less than the whole known universe. We may even define the environment as that part of the universe not ourselves—a conception which, made dynamic by the interaction of the two reciprocal factors, organism and environment, becomes almost sublime. How delicately the human organism is attuned to its environment we realize when we consider that wonderful rhythm which we call our sleep and our awaking, and that other rhythm of hibernating plants and animals which is the response to seasonal rather than nocturnal darkness. The more intimate relations of climatology and public health have yet to be worked out, but no one can doubt their fundamental importance, and Major Woodruff's main contention, in his interesting book on the effects of tropical light on white men, is certainly correct, as any one knows who has ever felt the tropical sun, or even suffered severely in middle life from sunburn.

The increasing call for health which, as I have shown, has its origin in the conviction that life is worth living, especially if it be normal, healthy life, finds strong support on every hand, but especially in the conservation of human energy; in greater humanitarianism; and in economic and moral efficiency. There is a kind of conservation of human matter and energy as truly as there is of physical matter and force. I hold no brief for vitalism; but our physical human energy is subject to laws of dissipation as surely as is that of the sun, and that man who expends his thought and energy upon himself and his ills, dissipates and loses his stock of energy available for other and better purposes. On the other hand, we must not forget that many invalids and persons in poor health have been heavy contributors to the happiness and welfare of the world. As examples I need only mention the names of Charles Darwin and Robert Louis Stevenson.

The call to health has humanitarian aspects. Is it a light or a small affair to postpone premature death, or to avoid sickness, and thereby postpone or avoid the pain, the sorrow and the weeping of those who would mourn? Is it not a kind of cruelty to allow infected water or milk to carry into happy homes the germs of typhoid or scarlet fever? If a thief in the night should wound and kill, as milk-borne typhoid often does in a family of children, should we not call him cruel? Sickness and deaths from carelessness are not, perhaps, as repugnant or as cruel as those from malice or robbery, but the actual effects upon the family and the social organism are much the same.

As for moral considerations involved in the present-day call to public health, we need only to think of the peevishness or the querulousness of invalidism, which often rises, or falls, into selfishness so gross as to be pathological; of the dyspepsia, with its moral as well as physical torments to patients and their friends; or of those degenerated and perverted human specimens which disease sometimes produces, to show that here also we can no longer attribute to devils what often proceeds from disease, and that the call to health and prevention for morals' sake is loud and urgent.

On the economic side, the call for health is barely beginning to be appreciated. Sickness and death mean everywhere heavy financial burdens upon the family and the community, and it is now being realized as never before that Emerson's dictum, "the first wealth is health," is strictly true, not only for the individual but for the social individual or community. New light is just now being shed, for example, upon the economic value of one public health measure, viz., a pure water supply, by a verification which one of my students and I have made of a theorem suggested independently, as it seems, by Mr. Mills, the distinguished engineer member of the Massachusetts State Board of Health, and Dr. Reincke, the health officer of Hamburg, Germany, but first publicly formulated and published by the eminent American sanitary engineer, Mr. Allen Hazen. Hazen's theorem asserts that for every death from typhoid fever avoided by the purification of a polluted public water supply, two or three deaths are avoided from other causes. Working under my direction, Mr. Scott MacNutt has recently been able to confirm this surprising theorem, and even to establish it as conservative. We have also gone further than Hazen and discovered what the other causes are from which deaths are thus avoided; and, although our results are not yet all published I may say that conspicuous among these "other causes" are pneumonia, pulmonary tuberculosis, bronchitis and infant mortality. Mr. MacNutt and I have also raised the question, To what is this unexpected result due? But this question we have not yet been able to answer. It may be that the germs of other diseases than typhoid fever are more often waterborne than has hitherto been suspected, so that purification of a polluted water supply causes a cessation of infection; or it may be that polluted water somehow depresses the vital resistance and so permits micro-organisms which might otherwise have been successfully resisted, to gain a fatal foothold; or it may be that both these factors are at work, and that each is partly responsible for the fortunate result. On this problem we are still at work.

The city of Pittsburg is just installing a great municipal filter plant for the purification of its principal water supply, at an expense of upwards of $7,000,000. It is reasonable to estimate that in a year or two this should effect a saving of 100 deaths a year from typhoid fever; for the number of typhoid fever deaths of late years has been 400 or more yearly. Valuing these lives at $5,000 each, as is customary, the saving effected by the purification works should be half a million of dollars worth of human life annually, making the building of the filter a sound and profitable economic as well as a humanitarian measure. But if, as Mr. MacNutt and I have shown, Hazen's theorem is true, then for every 100 deaths saved from typhoid fever, at least 200 will be saved from other causes; which means at least $1,000,000 more saved to the city of Pittsburg annually, of its present waste of human life.

The call to leadership in the public health service is a call to the educated everywhere, but especially to educated physicians. And I would, if I could, impress upon the young men about to claim that title from this ancient university, that it is their duty as well as their privilege to lead a willing public on to higher achievements of public as well as private health. It has long been the glory of the medical profession that its members were primarily naturalists rather than supernaturalists, as the word "physician" itself testifies, for it means "a naturalist." That other cognomen of the profession, "doctor," points the way to another duty, another high and noble function, namely, that of the "teacher." Physicians and doctors, naturalists and teachers of physic, *i. e.*, of nature—need any one ask for a nobler vocation! But if teachers and students of nature, you must be learners, also, and that not merely of the healing art, but of that other equally important sister art, the art of prevention. The call to public health is a call to preventive as well as to healing medicine; and here under our definitions, you may to-day join hands with such members of the laity as aid in the promotion of health, the prevention of disease; for example, with the sanitary engineer, the sanitary chemist, the sanitary biologist, the physiologist, the statistical expert, and the expert in physical education—for these, too, are naturalists and hence physicists, *i. e.*, in the strict sense, physicians.

Fortunately, the call of the age to public health comes to us with the new knowledge in pathology. We now know as never before that in that portion of the universe not ourselves lie many, perhaps most, of the sources of our sickness. The call to health is thus largely a call to beware of our environment, *i. e.*, of the things about us, and here at last we can agree with the monastics. But again the unwisdom of a philosophy which bids us turn our eyes heavenward and neglect things close at hand becomes painfully manifest.

Nor is the newer doctrine merely an enlightened selfishness; it is practical altruism, also, for it recognizes the solidarity of mankind and the fact that whoever purifies drinking water or dirty milk from the germs of disease; whoever promotes temperance or avoids sickness in himself or his household, lifts a burden from other men's shoulders and increases the potential efficiency of some other of those units of which the whole body politic is made up. The call of the age to health is a call to sacrifice and to service, both personal and public; and the call to service has been the deepening undertone of the call to humanism, all along the ages. Sophocles, in his day, urged it upon the Athenians, and Œdipus seizes upon public service for his final passionate appeal to the prophet Teiresias for aid against the plague with which the land was cursed: "For in thee is our hope; and a man's noblest task is to help others, by his best means and powers." Our modern cynics may smile at the inconsistency of an age like our own which is constantly preaching the gospel of service and efficiency, and yet suffers grievously from bad domestic service and bad municipal service; but physicians, at least, do not need to be told that it is one thing to prescribe for a patient and quite another to persuade that patient to follow good advice.

Let us next inquire what responses these various calls of the scientific age for life and health have hitherto awakened or are now awakening, and what should be the attitude of the young men just graduating in medicine toward the new movement. The first, though perhaps in part unconscious, responses were those of the eighteenth century reformers, Voltaire, Beccaria, Turgot and others, in France, and Lady Montagu, John Howard, Captain Cook the navigator, and above all Edward Jenner, in England. The eighteenth century, and especially that portion of it in which Mr. John Morley has happily located the scientific renascence, consciously or unconsciously felt the beginnings of the new movement; and in Voltaire's "Man of Calas," in Captain Cook's famous second voyage, in John Howard's travels and revelations, in Lady Montagu's introduction of inoculation and Jenner's work on vaccination for smallpox, began to shake off medieval ideas of life, death, health, dirt and disease, and to prepare for Virchow and Darwin, and Pasteur and Koch and von Behring in the nineteenth century. As one of the foremost responses of the nineteenth century we must put that perhaps unconscious one which began, we are told, exactly a century ago, and which is known as the temperance movement. Under whatever form, and however fanatical or foolish, or at times even harmful, he may have been, the temperance or prohibitionist agitator has always urged the salvation of the body as well as the soul; the conservation of family life threatened with ruin by drunkenness; the social significance and the economic importance of temperance, and even abstinence, as regards alcohol.

I make this acknowledgment with special pleasure, because on another occasion, and because of the fanatical and harmful subjection of public school education in physiology to the so-called "scientific temperance" propaganda, I have publicly and severely criticized and even castigated that form of the movement. Of that criticism I have absolutely nothing to retract; but I here gladly give high honor to the authors and promoters of the temperance movement in its broader features, for having done the age a great service by urging its attention to the welfare of the body, and insisting that the salvation of the body from drunkenness and the horrible sequelæ of alcoholism is not only possible, but also worth while. The use of alcoholic liquors, oddly enough, had already served sanitary science well, much earlier, since lead poisoning appears to have been first detected by a physician, Sir George Baker, among drinkers of Devonshire cider—the cider mills of Devonshire in the eighteenth century having had lead connections, easily soluble in the acids of apple juice.

Of contemporary response nothing has equalled, or even approached in breadth and significance, the anti-tuberculosis movement. Begun by laymen—as were also the earliest boards of health—this movement has become especially important because of the cooperation in the campaign, on an equal footing, of medical men and laymen. In this anti-tuberculosis movement the medical profession has for the first time, as far as I know, thrown off the ancient mantle of professional exclusiveness in dealing with a medical problem, and invited the public to share with themselves all of their professional knowledge—and ignorance. This step seems to me of extreme importance and sure to prove of lasting honor to the profession. The clergy long since led the way and shared their knowledge and their aspirations with the people; the medical profession has now taken the same democratic and inevitable step, and it only remains for teachers and practitioners of the law to follow suit. Perhaps when they have done this our legislatures will be improved and our cities better governed. For better or worse, America has embraced democracy, and in a democracy any professionalism that smacks of aristocracy or unnecessary secrecy, is out of place.

Official recognition of the call to public health began in the nineteenth century with the factory acts, the health of towns' commission, and the organization of state and local boards of health. State medicine has powerfully responded to the call in England and of late in Germany, but in our own land more slowly. The national board of health of the United States had an honorable if brief existence about a quarter of a century ago. The state board of health of Massachusetts, reorganized upon a thoroughly modern plan in 1886, has won great and deserved distinction, and still maintains its leadership among all our state boards. Michigan and Connecticut, and especially Ohio, New York and Pennsylvania, and very lately Virginia, have followed after. In Massachusetts, and to some extent in the other states, investigation has been added to administration as a state function, and with the happiest results.

Here and there municipal boards of health have responded heartily to the call to public health, but as a rule these boards are poorly made up, poorly officered and little respected. Here, then, is a place where the young physician can often take hold and help to forward the cause. He can urge and work for the establishment and support of a good chemical, bacteriological and diagnostic laboratory; he can report his cases of infectious disease promptly; he can appear before the local medical society, or the local academy of arts and sciences, or the local natural history society, and urge upon its members the importance of clean streets, pure water, fresh and clean milk, tenement house inspection, and the like. He can even write to the newspapers, without fear of any breach of professional ethics, advocating these reforms. The medical man who advertises himself is more obnoxious to-day than ever before; but the man who writes to the papers and has something vital to say, even if he makes himself known and talked about thereby, is rightly held to be doing good. In this connection a word should be added of hearty appreciation of the splendid work done by the Harvard Medical School in its free courses of popular lectures on medical subjects, given during the last two winters before large and appreciative audiences in Boston.

The call to health and preventive medicine has met with no quicker or heartier response anywhere than from workers in applied science and technology—engineers, chemists, biologists, bacteriologists and statisticians. The appointment by the governor of Massachusetts of Mr. Hiram F. Mills, a distinguished hydraulic engineer, to a position on the state board of health in 1886, and his election by his colleagues to the chairmanship of the committee on water supply and sewerage, marked a new epoch in public health science, and was a direct response to the call for expert leadership in the hygiene and sanitation of the environment. The establishment of an engineering division of the work of the board naturally followed; and this example has been imitated with success by other boards, notably those of Connecticut, Ohio, Pennsylvania and New York. The fact is, as I have shown on another occasion, that full knowledge of all the numerous aspects of public health science and preventive medicine has become impossible for any one man, or any one kind of man, so that various kinds of experts must to-day cooperate. The great municipal filtration works, which to-day purify our rivers, are not built or operated or even thoroughly understood by medical men. They are built and operated by engineers, tested and proved by bacteriologists, and paid for by the people.

The medical departments of the army and the navy are making their own responses to the call to public health. The magnificent work of those self-sacrificing officers of the army medical corps which gave us our present ideas of yellow fever control, has shed renown upon the whole American medical profession. And the brilliant achievements of the United States Public Health and Marine Hospital Service, in applying these ideas and discoveries to the actual suppression of the great yellow fever epidemic of 1905, have added honorably and materially to that renown. The more recent and remarkably efficient work of this same branch of the federal service in controlling the alarming outbreak of bubonic plague on the Pacific coast deserves the highest praise. Both achievements, especially when added to the orderly, extensive and fruitful investigations constantly going forward in the Hygienic Laboratory of the Public Health and Marine Hospital Service, ought to make the fact better known than it yet is, that we already possess the very large and active nucleus of a national board of health, prepared at all times to respond to the call of states or cities in sanitary distress or in need of sound advice on public health matters. When to all these responses and successes we add that greatest of all modern sanitary achievements, the making habitable of the Isthmian Canal Zone, largely through the genius of one man, we need not be surprised that the American Medical Association has chosen that man for its next president, namely, Colonel William C. Gorgas, medical member of the Isthmian Canal Commission, but a sanitarian rather than an ordinary medical man.

Enough has been said to show the marvelous responses made or making on every hand to the call with which we are dealing. And yet much more might be said. The establishment of the Rockefeller Institute for Medical Research, of the McCormick Institute for Infectious Diseases, of sanitary and engineering research laboratories, of a permanent and well-equipped federal census bureau, the recent proposal of Dr. Ditman, of Columbia University, for the establishment of a school of sanitary science and preventive medicine—all these testify that the call to health is being heard and answered.

The relation of the physician to the public is rapidly changing. He will soon be expected to be as proficient in the art of prevention as in that of healing. He will not be expected to build water works or sewerage systems, or to install systems of street cleaning, or garbage disposal, or heating and ventilation. These will be left, where they belong, with the sanitary engineer. He will not be expected to be an analyst of foods and drugs, or a judge of their purity. Public health work of this kind belongs to the sanitary chemist. He will not usually, though he will occasionally, be a bacteriologist to boards of health, or sanitary testing stations, or municipal water works, or sewage filters. Such work will be done more and more by sanitary biologists. What he will do, will be, first and foremost, to fulfill that most ancient and most honorable function of the medical man and remain the trusted and intimate medical adviser of individuals and of families in sickness and in health. He will not, however, be content with this alone. He will seek, in season and out of season, not merely to cure but still more to prevent disease among individuals, families and communities, by urging higher standards of living; by teaching temperance in all things; by advocating pure water, pure milk, pure food, pure living. If it is in him to be an investigator or a teacher, he will be one or both of these things. If not, he will be a frank and honest, but not a captious, critic; he will mold and reform, if he can not lead, public opinion. And by so doing he will give to his day and his generation noble and useful service; he will respond to the call of the age; he will do his part for the public health; he will uphold greatly the traditions of a great profession.

William T. Sedgwick
Massachusetts Institute of Technology

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE[1]

The aggregate of the appropriations carried in the act is $11,672,106. This does not include an appropriation of $460,000 for the printing and binding of the department, which appears in the appropriation act for sundry civil expenses. There are also permanent appropriations of $3,000,000 for the federal meat inspection and of $528,000 for the Adams fund, both of which are administered by the department, but not included in the act, making a grand total of $15,660,106 for the coming year, and an apparent increase over the previous year of $2,320,814, or about 15 per cent. A large part of this increase, however, is only nominal, as for the present year over

[1] From *The Experiment Station Record.*

$1,000,000 derived from receipts from forest reserves is available, whereas under the terms of the act for 1907–8 subsequent receipts must be turned into the treasury. The real increase carried by the act is distributed through the work of the entire department, but notably larger sums are available for what may be termed its administrative duties, such as the management of the national forests, the pure food and drug inspection, and the campaign against the gipsy moth and cattle tick, as well as for additional buildings and equipment on the forest reserves and for the Weather Bureau.

In the matter of general legislation the act perhaps contains no measures of the large importance of the meat-inspection law or the Nelson amendment, which have been such notable features in previous years, although a number of new lines are provided, and some are of considerable importance. Among these may be mentioned the inauguration of evaporation investigations and of studies of the prevalence and extent of tuberculosis among dairy cattle, the establishment of a standard of cotton grading, the inspection of foods intended for export under certain conditions, and the making of denatured alcohol in small amounts under farm conditions. The sum of $10,000 is appropriated for the testing of plants as to their suitability for paper making, and a like sum is available for an inquiry into the destruction of forests by the production of turpentine and resin and the sources and methods of the industry, and for a report, in cooperation with the Bureau of the Census, upon the production of the naval stores industry.

The president was directed to reserve not to exceed 12,800 acres of the Flathead Indian Reservation in Montana for a permanent national bison range, for a herd of bison to be presented by the American Bison Society, $30,000 being appropriated for payment of these lands and $40,000 for fencing and the erection of buildings. An amendment diverting $5,000 annually from the Morrill and Nelson funds of Cornell University to the Mount Tabor Industrial and Manual Training School was adopted by the senate, but eliminated in conference.

Under the new appropriation act the Weather Bureau receives $1,662,260, an increase of $248,720, the latter chiefly for the erection of additional buildings and the repair and improvement of those now completed. Of this amount $60,000 was appropriated for the erection of a main observatory building at Mount Weather, Va., to replace that destroyed by fire October 23, 1907, and for the erection of a central heating and lighting plant, together with $15,000 for the completion of a physical laboratory and other buildings. The establishment of new stations was authorized and $110,000 was appropriated for sites and buildings, of which $5,000 is to be used for the reestablishment of the station at Pikes Peak. The work of the bureau was increased in scope by the addition of investigations on evaporation. The limit of the cost of maintenance of the bureau printing office was raised from $18,000 to $30,000.

The appropriation of the Bureau of Animal Industry was increased $48,300, making a total of $1,080,860, exclusive of the meat inspection which, as previously stated, is now provided for by permanent law, and also of the emergency appropriation for the eradication of the cattle tick in the south. The latter appropriation was increased from $150,000 to $250,000, of which $25,000 was made immediately available. Specific authority was conferred for the enforcement of the laws of March 3, 1891, relative to the humane treatment of cattle exported to foreign countries, and of June 29, 1906, for the prevention of cruelty to animals during interstate transportation. The investigation of the prevalence and extent of tuberculosis among dairy cattle in the United States was included in the lines of work to be undertaken; while a clause authorizing the expenditure of $5,000 for an investigation of hemorrhagic septicemia, infectious cerebro-spinal meningitis, and malignant catarrh and for the working out, in cooperation with the Minnesota station, of the problem of prevention by means of antitoxin or preventive vaccines was eliminated.

The Bureau of Plant Industry received an apparent net increase of $289,446, but this includes the boll-weevil work of the bureau, which last year was carried as an emergency appropriation of $150,000. The general work of the bureau was extended to include the establishment of an official standard of cotton classification. A clause making the grain standards fixed by the department the official standards for grading was reported by the house committee, but stricken out on a point of order. The provision for grain inspection was continued on the present basis, except that it was included in the general work of the bureau instead of from a specific appropriation. The work on the prevention of algal and other contaminations of water supplies was restricted to farm water supplies. The appropriation for the introduction of rare seeds and plants from foreign countries was increased $20,000, making $56,000 for this purpose, iu addition to the congressional seed distribution, which was continued on the usual basis.

The general policy of the forest service was again the subject of extended discussion. An increase of $1,496,200 was granted, making its total appropriation $3,896,200, by far the largest carried in the act. As has been explained, however, the greater part of this increase is in lieu of the forest receipts. The sum of $600,000, an increase of $100,000, was appropriated for the construction and maintenance of roads, bridges, telephone lines, cabins, fences, and other permanent improvements. A number of additional limitations were imposed restricting the entire appropriation to territory under the jurisdiction of the United States, reducing the limit of cost of buildings on the forest reserves from $1,000 to $500, and limiting traveling expenses to "business directly connected with the forest service and in furtherance of the works, aims, and objects specified and authorized in and by this appropriation."

The provisions of the previous year authorizing the extension of the national forests and the giving of advice to owners of woodlands as to their care were eliminated, but authority to aid other federal bureaus in the performance of their duties in respect to the national forests was granted, and advances of money may hereafter be made to chiefs of field parties for fighting forest fires.

The Bureau of Chemistry received an increase of $128,800, chiefly for additional expenses incident to the enforcement of the National Food and Drug Act. Authority was granted to demonstrate and illustrate the methods for the making of denatured alcohol on a scale suited to the farmer or associations of farmers, and also to investigate the character of the chemical and physical tests which are applied to American food products in foreign countries, and, on request, to inspect such products when intended for export to countries requiring such tests.

The appropriation for the Bureau of Soils was increased to $234,700, a net increase of $27,800. Its work was provided for as at present except for some changes as to the scope of the tobacco investigations.

In the Bureau of Entomology the salary of the entomologist was increased from $3,250 to $4,000. The total appropriation was increased $48,950, making $184,960, of which $10,000 is immediately available. This appropriation, however, includes the boll-weevil investigations which have been carried in an emergency appropriation. In addition, the bureau has charge of the gipsy and brown-tail moth campaign, for which an emergency appropriation of $250,000, an increase of $100,000, was made, the entire appropriation being immediately available. The silk investigations in progress for several years are to be brought to a close.

In connection with the Bureau of Biological Survey it will be recalled that while the customary appropriation of $52,000 was granted last year, the secretary was directed to report to what extent, if any, the work done by the survey was duplicated by any other department of the government, and the practical value of the work to the agricultural interests of the country. This report, according to Chairman Scott of the house committee on agriculture, "demonstrates clearly that the work of the bureau is not a duplication of any being done elsewhere, and that it is of direct and very great value to agriculture"; and the work of the bureau was accordingly continued with an increase of $10,000 for biological investigations.

The total appropriation for the Office of Experiment Stations, including $720,000 for the stations under the Hatch Act, is $1,034,620, an increase of $21,400. This increase includes $3,400 for statutory salaries and $5,000 for agricultural education through farmers' institutes and agricultural schools, making $10,000 for the latter purpose. For the general maintenance of the Office and the irrigation and drainage investigations the appropriations of this year, $30,000 and $150,000, respectively, were continued. The appropriations for the stations in Alaska, Hawaii and Porto Rico were increased $2,000 in each case to correspond with the increase to the state stations under the Adams Act, and $5,000 was granted for the establishment and maintenance of a station in the island of Guam. This island, embracing about 210 square miles, has a population of about 9,000, chiefly engaged in agriculture of a primitive sort, and it is planned to extend assistance to its inhabitants who are now experiencing great losses from a cocoanut disease recently introduced, which threatens the complete extinction of the industry.

An appropriation of $7,000 was also made to the office for setting up and completing the apparatus formerly used in the nutrition investigations and the preparation for publication of results already obtained. In accordance with the current appropriation act, the respiration calorimeter and accessory apparatus belonging to the government have been brought from Middletown, Conn., to Washington, and it is planned to install them in completed form in the basement of one of the new laboratories of the department.

The Bureau of Statistics received an increase in its general fund for the collection of agricultural statistics of $7,000. Reductions on the statutory roll, chiefly through transfer, made a net gain of $1,700.

To provide for the increase in the general business of the department consequent on that of the several bureaus, additional appropriations were granted of $13,700 for the office of the secretary, $4,900 for the division of accounts, $18,160 for the division of publications, and $5,200 for the library. The chief of the division of accounts was made administrative officer of the fiscal affairs of the department. An increase of $39,200 was also allowed for contingent expenses, of which $25,000 is for the construction of shops, stables, and storage buildings to replace the present structures and $8,000 for rent.

The work of the Office of Public Roads was broadened to permit the furnishing of expert advice on road maintenance and administration, as well as on road building, and the appropriation was increased $17,340. A provision was inserted forbidding the rent or purchase of road-making machinery.

Large as is the aggregate appropriation for the department, it represents only about 1.5 per cent. of the entire federal appropriation and a per capita expenditure of less than 20 cents; and, as has been indicated, much of this sum is in the nature of permanent improvements upon an investment.

COMMANDER PEARY'S EXPEDITION

Commander Peary, from the steamship *Roosevelt*, at Sydney, N. S., on July 16, addressed to Dr. H. F. Osborn, president of the American Museum of Natural History, the following letter:

We are leaving Sydney to-day for the North. I shall go north across the Gulf of St. Lawrence through the Strait of Belle Isle; along the southern portion of the Labrador coast; to the west coast of Greenland in the vicinity of Godhab; then follow the west coast through Davis Strait and Baffin Bay, and across Melville Bay to Cape York, which, if everything goes well, should be reached about the first of August.

For some ten days I shall be occupied in the region from Cape York (76 degrees north latitude) to Etah (about 79 degrees north latitude), taking on board my Eskimos with their dogs, and hunting walrus for my meat supply.

About the middle of August, after replenishing the coal supply of the *Roosevelt* from the auxiliary steamer *Erik*, and putting down a coal depot at Etah, the *Roosevelt* will part company with the *Erik*, turning south for home.

I shall then endeavor to force the *Roosevelt* through Kane Basin, Kennedy Channel and Robeson Channel, to winter quarters at Cape Sheridan on the north coast of Grant Land. I hope to get my ship to Cape Sheridan not later than September 15.

Early in February, 1909, I shall leave the ship with dogs and sledges, in the effort to reach the Pole across the ice of the central Polar Sea.

Returning I shall probably come down upon the northern coast of Greenland, and follow that coast back to the *Roosevelt*, which should be reached about the end of June, 1909.

If the sledging journey has been successful the *Roosevelt* will then force her way south the latter part of July, and I shall hope to get in touch with the world again in September or October of 1909.

Should the effort of the spring of 1909 prove unsuccessful, I have supplies and equipment with which to remain another year, and make a second attempt in February, 1910.

Details of the movements of the expedition (as far as the imperfect communication of the North will permit) can be obtained from my friend, Mr. H. L. Bridgman, secretary and treasurer of the Peary Arctic Club.

SCIENTIFIC NOTES AND NEWS

The Oklahoma constitution contains a provision making it obligatory upon the legislature to establish a Geological Survey. In pursuance of this provision the first state legislature passed a law placing the survey under the control of a commission consisting of the governor, the state superintendent of public instruction and the president of the State University. The sum of $15,000 was appropriated for the work. The commission met on July 25, and elected as director Dr. Chas. N. Gould, head of the department of geology at the State University of Oklahoma. He was instructed to report as soon as possible on the building stone, road material, and oil and gas of the state. Parties are now in the field investigating these problems.

Among the recently elected senators in Italy are G. B. Grassi, professor of comparative anatomy at Rome; A. Carle, professor of surgery at Turin; P. Foa, professor of pathologic anatomy at Turin; G. D. Novara, professor of surgery at Genoa, and G. Paladino, professor of physiology at Naples.

The president and vice-presidents of the Royal College of Surgeons of England, on behalf of the council, addressed to Mr. Thomas Bryant, F.R.C.S., a past-president of the college, on July 16, a letter congratulating him on attaining the age of 80 years and still retaining perfect health of mind and body.

Sums have now been received amounting to a total of $225,000 for the Koch endowment, to be applied in the crusade against tuberculosis as Dr. Koch may direct.

The Cornplanter medal for Iroquois Research administered by the Cayuga County Historical Society, of Auburn, New York, has been awarded to Dr. David Boyle, of Toronto.

Dr. Alexander Tschirch, professor of pharmacology at Berlin, has been elected rector of the university.

Dr. W. R. Whitney has been appointed non-resident professor of chemical research in the Massachusetts Institute of Technology.

Professor Salvin-Moore has resigned the directorship of the Liverpool Cancer Research Committee, and the professorship of experimental cytology in the university.

President George T. Winston, of the North Carolina Agricultural College and Station, has retired with a pension from the Carnegie foundation.

Mr. F. G. Clapp, for a number of years with the United States Geological Survey in the investigation and reports of coal, oil, gas and artesian waters, has resigned in order to take up professional work in geology and allied branches of engineering.

Dr. Julius Hahn, professor of physics at Vienna, will shortly reach the age of seventy years and will retire from the active duties of his chair.

Dr. W. Dönitz, head of the scientific department of the Royal Institute for Infectious Diseases in Berlin, has celebrated his seventieth birthday.

Dr. Edmund Otis Hovey has returned to the American Museum of Natural History after an absence of three months in the West Indies. The principal points visited by him were the islands of Martinique, St. Vincent, Guadeloupe, Grenada and Barbados, in all of which he made collections for the museum supplementary to those previously obtained by him. He was particularly fortunate in securing photographs showing the changes which have taken place during the last five years in both of the active volcanoes, having camped out on Mt. Pelé for ten days and on La Soufrière for five days. Temperature observations on the fumaroles were made, including pyrometer observations on the high-temperature vents of the summit of the new cone of Pelé, where a heat of 959° F. was found. No dust or débris is being discharged at Pelé, although there is abundant and vigorous steam action. The Soufrière of St. Vincent is absolutely quiet. The bottom of the crater is now occupied by a beautiful lake, which is apparently as large as that for which the volcano was famous before the eruptions of 1902–3. Dr. Hovey also obtained many interesting data regarding the extent of erosion and the advance of vegetation and cultivation in both devastated areas. Mrs. Hovey accompanied him on the expedition, including even the camping out on the volcanoes.

A recent letter from Mr. V. Stefánsson, who, with Dr. R. M. Anderson and party, left New York City in April on an expedition to the mouth of the Mackenzie River under the auspices of the American Museum of Natural History and the Geological Survey of Canada, reports the successful arrival of the party at Smith's Landing on the Slave River, from which point they were planning to push on to Macpherson in time to make connections with the mail leaving there about the middle of July.

Word has been received from Mr. Roy C. Andrews, who is now on the Pacific coast near Victoria, B. C., for the purpose of collecting Cetacean specimens for the American Museum of Natural History, that he has secured a fine skeleton of a humpback whale, together with a complete set of baleen. At the time of writing he had measured, photographed and described twenty-four whales of this species, having at the same time made a careful study of their external and osteological characters with a special view to showing individual variation. There being a scarcity of sulphur-bottom whales at this point, Mr. Andrews was planning to go to Kynquot, on the other side of Vancouver Island, in the hope of obtaining one of these animals, terminating his expedition with a trip to Murderer's Cove, Alaska, where dolphins are reported to be very plentiful.

We learn from the *Journal of the American Medical Association* that a life-size statue of S. P. Botkin, 1832–1889, was unveiled in the grounds of the Military Medical Academy at St. Petersburg on the eighteenth anniversary of his death, May 25. In the memorial address Sirotinin stated that of the seventy pupils who worked under Botkin's direction more than half have become professors at various universities. Botkin founded in 1869 and maintained the Russian *Archives for Internal Medicine,* and in 1880 founded the *Weekly Clinical Gazette,* better known as *Botkin's Gazette,* which became very popular.

James Duncan Hague, a well-known consulting engineer and mining expert of New York City, at one time connected with the U. S. Geological Survey, fellow of the American Association for the Advancement of Science and of the American Geological Society, died at his country home at Stockbridge, Mass., on August 3, at the age of seventy-two years.

Mr. Arthur Lister, F.R.S., of Leytonstone, the son of J. J. Lister, F.R.S., and the younger brother of Lord Lister, eminent for his work on the Mycetozoa, died on July 19, at the age of seventy-eight years.

Mylius Erichsen, the Danish explorer, and two companions have perished in a snowstorm, while carrying on explorations on the north-eastern coast of Greenland.

Sir John Banks, an Irish physician, known for his work on nervous diseases, died on July 16, at the age of ninety-seven years.

The Forest Service has arranged for six sub-offices, to be situated in six cities which are centers of interest in forestry. Two of these are at San Francisco and Denver, and one will probably be Portland. It is also expected that offices will be opened in the states of Montana and Utah.

Foreign journals announce that a Society of the Observatories of Mont Blanc has been regularly constituted, with a board of directors largely chosen from the Academy of Sciences, for the more systematic continuation of the work begun by the late M. Janssen and M. Vallot. The society has decided to place the Vallot and Janssen observatories under the direction of M. Vallot. With this object the latter has given his establishment to the society just formed—a purely scientific association—which appeals for members and funds. The secretary is Comte de La Baume-Pluvinel, 9 Rue de La Baume, Paris.

UNIVERSITY AND EDUCATIONAL NEWS

Professor James Douglas has given to the University of Arizona ten thousand dollars as an endowment, the income of which is to be used for the purchase of "instruments of precision and research" in the School of Mines and the Department of Mineralogy.

The Peabody College for Teachers at Nashville, Tennessee, which is at present a department of the University of Nashville, but is soon to be established on a separate foundation by the trustees of the Peabody Education Fund, has, by recent action of its authorities, raised its entrance requirements to the full fourteen units as defined by the Carnegie Foundation. The entrance subjects are arranged in three groups, the first requiring Latin and Greek, the second Latin and modern language, the third Latin or modern languages. In the second and third groups there are many alternatives in language, history and science. Following these entrance groups are three four-year courses, all leading to the degree of bachelor of arts. The work in the freshman and sophomore years is mainly prescribed while that in the junior and senior years is nearly all elective. During the last two years the student must select forty per cent. of his work from the professional courses given in the Department of Education, Psychology and Philosophy. The year is divided into quarters, and the classes meet five times a week, and each student is expected to take three courses. The minimum requirement for graduation is thirty-six courses of five hours each, or a total of one hundred and eighty hours.

We learn from the London *Times* that at a meeting of the governing body of the Imperial College of Science and Technology, held on July 24, a letter from the Royal Commissioners of the Exhibition of 1851 was read, intimating that the commissioners had appropriated the whole of the remaining site of their estate at South Kensington for the purposes of the Imperial College of Science and Technology. The question of the provision of additional buildings and laboratories on the sites granted by the commissioners was under consideration, and it was decided, in the first instance, to proceed at once with the provision of new mining and metallurgical buildings for the Royal School of Mines, and to invite Sir Aston Webb, R.A., to serve as architect to these buildings and of such other buildings as the governing body may determine to erect. The Hon. R. J. Strutt, F.R.S., was appointed additional professor of physics and Mr. S. Herbert Cox, professor of mining. Further, an additional professor of zoology, a professor of metallurgy, and an assistant professor of botany are to be appointed in the near future.

Dr. Charles Oliver Merica has been elected president of the University of Wyoming.

Dr. H. A. Christian has been appointed Hersey professor of the theory and practise of physic at the Harvard Medical School.

At Yale University Louis Doremus Huntoon, M.E., at present assistant professor of mining and metallurgy in the Scientific School, has been promoted to a full professorship; George Surface, Ph.D., of the University of Pennsylvania, has been appointed instructor in geography, and George M. Collwell, Ph.D., instructor in mathematics.

MR. B. E. PORTER, instructor in animal husbandry of the Maryland Agricultural College, has been elected professor of agricultural animal husbandry in the Hawaii Agricultural College.

DR. J. M. READE, formerly fellow in botany in Cornell University and during the past year instructor in botany in the University of Georgia, has been made professor of botany in the latter institution.

DR. HERBERT G. KEPPEL, of Northwestern University, has been elected head of the department of mathematics of the University of Florida.

DR. RUDOLF TOMBO, JR., while continuing in his professional duties, has accepted the secretaryship of the alumni council of Columbia University.

T. SLATER JACKSON, B.A., M.D., C.M., has been reappointed demonstrator in the biological department of McGill University, after an absence of three years, during which he visited the tropical seas of Africa and Asia.

THE following appointments have been made at University College, London: Mr. H. M. Hobart, B.Sc., to the newly created lectureship in electrical design; Mr. R. E. Middleton, to the lectureship in municipal engineering for the session 1908–9; Dr. A. W. Stewart, to the lectureship in stereo-chemistry, for the session 1908–9; Mr. G. C. Mathison, M.B., B.S., to the Sharpey research scholarship in physiology; Mr. W. F. Stanton, to be demonstrator in the department of applied mathematics, and Mr. H. S. Bion, to be demonstrator in the department of geology.

PROFESSOR ADOLF KNESER, of Breslau, has declined a call to a chair of mathematics at Leipzig.

DISCUSSION AND CORRESPONDENCE

THE ANNUAL APPROPRIATION FOR SALARIES OF THE INSTRUCTING STAFF AT BRYN MAWR COLLEGE

TO THE EDITOR OF SCIENCE: The reader of the article on "The Salaries of Professors in American Colleges and Universities" that appeared in SCIENCE, July 24, is led to conclusions that are clearly impossible when considering the data concerning Bryn Mawr College given in Table II. along with the data on "Academic Appointments" that are to be found in the Bryn Mawr College programs. The following calculations for the academic year 1905–6 illustrate this fact:

Grade of Academic Appointment	Number of Appointees in each Grade	Average Salary in each Grade	Annual Expenditure in Salaries in each Grade
Professor	8	$2,500	$20,000
Assoc. Prof.	8	2,000	16,000
Associate	15	1,500	22,500
Therefore	31	received	$58,500
at an average salary of $1,887.09			
President	1	$8,000	8,000
Therefore	32	salaries use	$66,500
Total appropriated for 47 salaries			106,687
Balance for 15 salaries			$40,187
at an average salary of $2,679.13			

According to the program, these 15 remaining members of the staff consisted of 3 lecturers, 9 readers and 3 demonstrators. It follows that in this academic year members of the staff in the higher ranks of professor, associate professor and associate averaged only seven tenths as much salary as members of the staff in the lower ranks of lecturer, reader and demonstrator.

When the data for the academic years 1904–5 and 1906–7 are treated in the same way, it is found that average salaries in the higher ranks mentioned were $1,879.31 and $1,983.33, respectively, while the average salaries in the lower ranks were $2,454.83 and $2,177.05. In the first of these years the staff numbered 48, and in the second, 49. The other years to which the figures in your table might have referred are 1902–3, 1903–4 and 1907–8, but these years are excluded because the instructing staffs, according to the college programs, numbered 50, 51 and 54, respectively, while the number in your table is 47.

Only two assumptions have been used in making the calculations given above. The first is that the president receives $8,000. It will be clear to you that if this assumption involves an error of $2,000, more or less, this does not have any very great effect on the conclusions. The other assumption is that the $106,687 given as "The Annual Appropriation for Salaries of Instructing Staff" is actually spent for the salaries of the instructing staff.

The absurdity of the conclusions raises the question of what is meant by "The Annual Appropriation for Salaries of Instructing Staff," which has been used as the basis of classification of the American colleges and universities. One would naturally think that it means the money spent on the salaries mentioned. If it does mean this, it is clear that Bryn Mawr College has received too advanced a position in the classification.

With great latitude allowed, the phrase might perhaps be interpreted as meaning money available for salaries though not necessarily so spent. This interpretation is particularly improbable in the case of Bryn Mawr College. Its alumnæ have been trying during the last few years to obtain gifts of money from the friends of the college for an endowment fund, the interest on which is to be used to increase the salaries of the professors. In order to retain the older and better known members of the faculty in spite of offers from other institutions, the alumnæ wish to have the salary of a professor raised from $2,500, which has been the salary attaching to that grade, to $3,000. They have already accumulated nearly $100,000 toward this fund. If in the foregoing calculation we insert $3,000 in the place of $2,500 as the salary of a professor, it appears that an annual appropriation of $106,687, if available, would not only have met this increased demand but would also have sufficed to have given the instructors of lower ranks, namely, lecturers, readers and demonstrators, an average salary of $2,412.46. Making similar changes in the two other academic years considered, this average salary could have been $2,260.38 and $1,871.50. The calculation leaves no doubt that Bryn Mawr College if it had $106,687 actually available annually for the salaries of the instructing staff would be able, unaided, to raise the salaries as the alumnæ desire.

David Wilbur Horn,
Associate and Associate Professor of Chemistry in Bryn Mawr College, 1901–7

AIR-SHIPS, PAST AND PRESENT

To the Editor of Science: In a review of "Air-ships, Past and Present" presented in Science, July 3, 1908, pp. 20–21, I notice that O. Chanute, the reviewer, gives 21,100 feet as the greatest altitude above the earth's surface heretofore attained by kites.

I do not know whether this statement was made in ignorance of the Weather Bureau kite flight of October 3 last, or not; but in any case you may wish to note in your journal, if not already there recorded, the following facts:

On October 3, 1907, one of the international dates for scientific kite flights, the Weather Bureau observers at Mt. Weather, Va., succeeded in raising a meteorograph to an altitude of 23,110 feet above mean sea level by means of kites. At that altitude the wind was WNW, the temperature — 5.4° F. For the flight 37,300 feet of piano wire was used and the number of kites required to lift were eight having a total lifting surface of 505 square feet.

Cleveland Abbe, Jr.

SCIENTIFIC BOOKS

Heredity. By J. Arthur Thomson, Regius Professor of Natural History in the University of Aberdeen. New York, G. P. Putnam's Sons. 1908.

So much interest is now concentrating on the problems of heredity as a result of the abundant and important observations that have been carried on in recent years, following the leads of Mendel, DeVries and Galton, that a critical estimate of our present knowledge of the phenomena of inheritance can not fail to be of interest. Such an estimate Professor Thomson endeavors to give in the volume before us, which the author speaks of as an "introduction to the study of heredity," and which, it may be said at once, is a book well worth careful reading, bringing together as it does in a concise form the results of observations widely scattered in scientific periodicals, not always readily accessible and all more or less deterrent to the layman.

The author has endeavored to approach his subject *sine irâ et studio* and to a large extent he has been successful. He avowedly sails, however, under the flag of Weismannism and nails this flag firmly to the mast, refusing to believe, for example, that any explanation of the regeneration of a *Stentor* or a *Hydra* is possible "apart from the postulate of diffusely distributed 'specific units.'" True, he admits that determinants are "scientific fictions," that they are elements of a "symbolic notation" to be discarded so soon as it is shown to be inconsistent with demonstrable facts, but nevertheless he believes that heredity can be discussed and understood at present only on the assumption of the existence of such material bases of inheritance. But that such a concept is merely carrying the difficulty a step farther back is not considered. The determinants are living entities which grow and reproduce, vary and inherit, even as the cell, and, admitting their existence, we are still far from understanding the ultimate causes of the phenomena of heredity. Indeed, it would seem that the problem of heredity and the problem of life are fundamentally the same, or, at all events, that the solution of the one is dependent on that of the other, for, as Professor Thomson puts it, "the organism and its inheritance are, to begin with, one and the same." But a complete comprehension of the ultimate causes of life, of organization and of inheritance is yet of the future, and it must be admitted that the concept of determinants or specific material units furnishes a convenient "notation" for the discussion of certain phenomena of inheritance; it is not, however, the only concept possible, and it is to be regretted that its dominance in Professor Thomson has rendered him somewhat intolerant of epigenetic possibilities.

The book starts with definitions of heredity and inheritance, and proceeds to discuss the physical basis of inheritance, the germ cells, their maturation and fertilization. Then follows a discussion of variation, which is classified as fluctuating and discontinuous, a consideration of the latter leading to a criticism of the mutation theory of DeVries; and, similarly, a chapter is devoted to modes of inheritance, which are classified as blended, exclusive (preponderant, although discarded by the author, seems preferable) and particulate. A remarkably sane discussion of reversion follows, the phenomenon being regarded as of rare occurrence, and many of the cases usually referred to it, such, for instance, as the classic one of supernumerary mammæ, are properly excluded. Reversion is defined as including "all cases where, *through inheritance*, there appears in an individual some character or combination of characters which was not expressed in his immediate lineage, but which had occurred in a remoter but not hypothetical ancestor." With a discussion of telegony and maternal impressions, in which again a thoroughly judicious position is taken, and of the inheritance of acquired characters, concerning which the author's Weismannian convictions determine his position, the exposition of what may be termed the illustrative side of the question is concluded, this having occupied approximately one half of the volume.

A most interesting chapter on heredity and disease precedes one on the statistical study of inheritance, and this is followed by a consideration of the results of experimental studies, in which the Mendelian phenomena are discussed. Then follows an account of the theories of heredity, a relatively brief historical review preceding an exposition of Weismann's theories, and after a consideration of heredity and sex and of sex determination, the book concludes with a most suggestive and admirably expressed discussion of the social aspects of the question.

This summary of the contents of the book will indicate the breadth of its scope and the thoroughness with which its subject is discussed. Criticism is, of course, possible, but the errors against which it must be directed are rather of omission than of commission. One would have wished, for instance, a fuller statement of the method and results of the statistical study of heredity, the chapter upon that topic being principally a discussion of Galton's views of inheritance, and space for the enlargement of the chapter could have been obtained by a curtailment of that devoted to Weismann's theories, which have already been made familiar to English readers. A consideration of the results of Morgan and Seeliger, and especially of those of Godlewski, would probably have modified the deduction drawn from Boveri's experiments on the fertilization of non-nucleated fragments of echinoderm eggs, as to the all-importance of the chromosomes in inheritance; and, similarly, no notice is taken of the work of Herbst and Doncaster, whose results antagonize those of Vernon on the influence of overripeness of the germ cells in the determination of the two parents in inheritance. But these and the few other imperfections that might be noticed do not interfere materially with the value of the book. It fulfils its purpose as an "introduction to the study of heredity" excellently well, it is rich in illustrative facts and judicious criticism, and is written in a style which is clear, consecutive, forcible and, at times, even picturesque.

It should be added that there is a good index, a bibliography of representative papers on heredity occupying forty-eight pages, and a very useful subject-index to the bibliography.

J. P. McM.

Mind in the Making. By Edgar James Swift, Professor of Psychology and Pedagogy in Washington University, St. Louis. New York, Charles Scribner's Sons. 1908. Pp. viii + 329.

Professor Swift's book is of real value to both investigators in educational psychology and students of college grade. The former class will find in it data of importance on the youthful delinquencies of people whose adult lives were decidedly above the average in conventional and probably in real morality, on the variability of intellectual achievement and on the influence of the knowledge of one or more foreign languages upon the learning of another. This last set of facts is especially important because it represents the cooperation of a teacher in service (Mr. William W. Hall, of the Yeatman High School in St. Louis) with a psychologist in an experiment conducted under class-room conditions. Such school-room experiments, comparable to the scientific work now being done in hospitals or on experimental farms, are a most hopeful sign that education is to be rationalized by science.

The data reported by Professor Swift support the conclusions: (1) that youthful irregularities in the way of theft, intemperance and the like are distributed amongst individuals continuously from a condition of complete lawlessness to that of complete "goody-goodyness," (2) that their presence then is consistent with a higher than average restraint from crime in adult life; (3) that individual differences in intellectual capacities are so great as to be of great practical importance, and (4) that the influence of training with one foreign language upon efficiency in learning another does not consist, to any considerable extent, in a subtle discipline of general mental functions. These conclusions, though doubtless acceptable to observant and matter-of-fact thinkers, have all been contradicted by theorists concerning education and by the practises recommended by leaders in educational administration.

Competent students of education in college classes and amongst teachers in service will profit by the study of these data and those repeated from Professor Swift's more familiar researches in the psychology of learning. For such the book contains also a descriptive account, with illustrative cases, of the influence of defects in vision, chorea, hysteria and the like upon education, a review of certain aspects of brain anatomy and physiology, a critique of the rigidity and narrowness of present curricula and methods of teaching, and a chapter on the nature of the educative process. All of these should be very useful.

The influence of the report of cases of eminent men and women who did not succeed in schools is more doubtful. It tends, probably without the author's desire, to give the impression that failure to achieve in school is a sign of success out of school and even that failure in early life is a sign of success later. The discussion of the criminal tendencies of boys may also, if taken too naïvely, lead to the expectation that juvenile delinquency is *per se* a healthy stage in a desirable mental growth. Professor Swift, if I understand him, accepts neither of these conclusions, but he does not clearly deny them. Nor does he make clear the very complicated states of affairs of which the data given are but one aspect.

Concerning some of the conclusions which Professor Swift does definitely accept (such as: "*Every young child must be regarded as a potential genius,*" "*It is doubtful whether in three fourths of the cases criminal tendencies are anything else than a convenient name with which to cover our social sins and failures in education,*" "*Progress* [in the course of practise] *is never steady, but always by leaps*"), it must be noted that other intelligent investigators possessed of the same facts as the author would still not proceed to his conclusions. The ambiguities of units of mental measurement and the complexities of selective influences play too large a rôle in almost all our studies of human nature to leave any one's work exempt from revision and amendment.

The book is interesting throughout, partly because of the selection of topics and partly because the author possesses the admirable quality of writing to produce reactions in others rather than to express his own thoughts. The lack of an index should be remedied, especially since the book is a collection of essays whose separate titles can not at all adequately describe their contents.

Edward L. Thorndike
Teachers College,
Columbia University

BOTANICAL NOTES

RECENT SYSTEMATIC PUBLICATIONS

The fourth part of Dr. A. J. Grout's "Mosses with Hand-lens and Microscope" appeared late in April of the present year. It covers pages 247 to 318, and includes the completion of the family *Leskeaceae* and about half of the *Hypnaceae.* Twenty full-page plates, mostly from the Bryologia Europaea and Sullivant's Icones Muscorum, and thirty-two cuts serve to illustrate the text. The announcement is made that the closing part (V.) will be issued some time next year (1909). This closing part will complete the family *Hypnaceae,* and include analytical keys to sterile mosses, a list of errata, and a complete index. When the whole work is finished it will be a most useful addition to American bryological literature, and an indispensable aid to the beginner in the study of mosses. The fine quality of paper and the clear type and good presswork add much to the pleasure one experiences in using the book.

The problem of introducing the student to the work of identifying the plants about him is one which has puzzled botanical teachers not a little, especially since the introduction of laboratory studies has left little time for the old-fashioned preparation by the study of some such text-book as the old Gray's "Lessons" of our boyhood days. When this was used the pupil had nothing to do but to get ready for field work and the "classification" of flowering plants. That was all there was in botany. We had to run over the book in order to know how to "classify" the spring flowers when they appeared. We had to know the meaning of such words as cordate, ovate, spatulate, serrate, dentate, crenate, sepal, petal, introrse, extrorse, hypogynous, epigynous, dehiscent, indehiscent, orthotropous, anatropous, albuminous, exalbuminous, etc., for these were in constant use in the keys to the families and genera, and the descriptions of all botanical groups from divisions and classes to species and varieties. Thus long ago; but now-a-days after a longer or shorter course in laboratory botany where he has learned something of the evolution of the higher plants from the lower, he is sent to the fields with no previous instruction in the terminology of plant structures. He is told to "dig out" the identifications of the plants he finds by the aid of some manual of systematic botany. And it must be confessed, it is often pretty hard digging. The keys and descriptions are so technical as to be difficult of understanding, while the number of species described in the manual is so great as to bewilder and confuse the would-be botanist. Hence has arisen the demand for simple, local floras. By the use of non-technical descriptions it has been found possible to designate the plants of a limited region so that all of the species may be recognized. This is what has been done by Professor Dr. Clements and his colleagues in the University of Minnesota—Dr. C. O. Rosendahl and Dr. F. K. Butters—in their "Guide to the Spring Flowers of Minnesota." Here by the time limitation, added to the areal limitation, the authors make it possible to readily distinguish practically all of the higher plants their students will find. Keys are very freely used, in fact the booklet is little more than a collection of keys, first to the families, then to the genera, and last to the species. Etymologies are freely given, and every name has its accent correctly indicated. It must prove to be of the greatest use to the pupils in botany classes in all grades of Minnesota schools.

About a year and a half ago Roland M. Harper published an instructive paper in the Annals of the New York Academy of Sciences (Vol. XVII., part 1) entitled "A Phytogeographical Sketch of the Altamaha Grit Region of the Coastal Plain of Georgia." With the index which has now been added it constitutes a stout pamphlet of 436 pages, and 28 full-page plates of reproductions of photographs. A geological map of Georgia showing especially the coastal plain region, including the Altamaha Grit, and seventeen diagrams in the text serve to further illustrate the paper. From map and text we learn that the Altamaha Grit covers about 11,000 square miles in southern Georgia, stretching in a belt of irregular width from the Savannah River southwestwardly to the southwestern corner of the state. Originally the region was covered with open forests in which there was little shade, a condition favoring the growth of shrubby and herbaceous vegetation. The number of species of flowering plants and ferns is given as 739, of which 53 are trees and 107 shrubs and woody vines. The larger trees (with trunks one to three feet in diameter) are *Nyssa uniflora, Persea pubescens, Gordonia lasianthus, Liquidamber styraciflua, Liriodendron tulipifera, Magnolia grandiflora, M. glauca, Quercus alba, Q. michauxii, Q. lyrata, Q. phellos, Hicoria aquatica, Taxodium distichum, T. imbricarium, Pinus palustris, P. elliottii, P. taeda, P. serotina, P. glabra.* Among the genera of arborescent species that are notably absent from the region are *Tilia, Celtis, Populus, Catalpa, Sassafras, Negundo, Platanus* and *Fagus.* Other notable absentees are *Monarda, Rosa, Ranunculus, Polygonum, Trillium, Adiantum* and *Phegopteris.* The paper will repay careful reading and study.

THE DEVELOPMENT OF A GREAT JOURNAL

The few living botanists who saw the beginnings of the *Botanical Gazette* in 1875 have watched its later development with increasing interest and gratification. Appearing as a thin four-page, rather badly printed sheet, of poor paper, and bearing the name of *The Botanical Bulletin,* its beginnings were anything but promising. Yet there was something in it that won it friends from the beginning, in spite of the fact that it was issued by a practically unknown young man, in a little town in the Mississippi Valley, nearly a thousand miles from any considerable botanical library or collection of plants. It was not profound, and no important discoveries were announced in its pages. It was, however, an honest effort to tell truthfully and simply some things that the editor and his friends had seen in the vegetation about them. It made no pretense to being anything more than a little journal of little notes. And it fulfilled this mission so well that it made a distinct place for itself, and as the years went on it enlarged its field, grew in size, and finally came to be the one indispensable journal for every American botanist. It is not necessary to relate the varying fortunes of this journal, nor to tell of its repeated enlargements; most of these are more or less familiar to the present generation of botanists. Within the last few months the *Gazette* has had to take another step in its evolution. In its growth year by year it has added more pages of matter, more text figures and more full-page plates, each of which has added not only to its value to the reader, but very materially to the expense of its publication. On comparing it with the average of five of the leading foreign botanical journals it appears that during the past two years the *Gazette* has been giving 945 pages to their 648, 45 plates to their 12; and 182 text figures to their 122, while the average subscription price of the foreign journals is thirty per cent. higher. Accordingly after consulting with many botanists as to what changes should be made to equalize the *Gazette* with other journals of its rank, the editors announce that since "the pressure for publication is increasing rather than diminishing" they will maintain the 80-page size for each number, however gaining additional space by "a more rigid selection of original papers, a greater compression of these papers in text and illustrations, a franker expression of opinion in reviews, and the abandonment of the department of 'News.'" With these changes the publishers advance the subscription price to seven dollars per year, a step which is amply justified by the fact that the *Gazette* will still cost far less per page and plate than any of the foreign journals of its rank. Botanists everywhere will be glad to know of the growth and development of this American journal, and will wish it the continued success which it has earned so well.

Charles E. Bessey
The University of Nebraska

SPECIAL ARTICLES

AN EXAMINATION OF THE THEOREM OF ALLEN HAZEN THAT FOR EVERY DEATH FROM TYPHOID FEVER AVOIDED BY THE PURIFICATION OF PUBLIC WATER SUPPLIES TWO OR THREE DEATHS ARE AVOIDED FROM OTHER CAUSES[1]

If Hazen's theorem is true, the purification of polluted water supplies has sanitary and economic consequences much more far reaching than has hitherto been supposed. If, for example, in the city of Pittsburg, purification of the public water supplies by the new municipal filters should, as may reasonably be expected, effect a saving of at least one hundred deaths a year from typhoid fever and, according to the theorem, in addition two or three hundred deaths from other causes, such saving of human life means also the avoidance of a present economic waste of two millions of dollars annually instead of half a million from typhoid fever alone.

[1] Preliminary communication.

Hazen's theorem rests upon the discovery by Hiram F. Mills and others that in several cities purification of the public water supply has been immediately followed by a marked decline in the total death rate, such decline being far greater than that which would have been effected by the decline in typhoid fever mortality alone. It appears to have been first definitely formulated and published by Mr. Hazen in a paper on "The Purification of Water in America," presented to the International Engineering Congress at St. Louis, in 1904. The theorem has not hitherto attracted the attention or consideration which it deserves, and we have therefore critically examined the evidence upon which it rests and, having found the theorem not only correct but conservative, have gone further and undertaken to discover precisely what are those "other causes" of death in which the extraordinary decline referred to takes place.

For these purposes we have made an elaborate statistical study of the influence of the purification of polluted public water supplies in Lowell and Lawrence, Mass., upon the total death rates of those cities, and also upon their death rates from various diseases; comparing the data for each city with those of the other, and of both with similar data for Manchester, N. H., a city of the same class which from various points of view, such as location and population, is remarkably well adapted to serve as a norm. As a result of our studies we have found that the theorem is true not only for the cities mentioned, but also for certain other cities, including Hamburg, Germany, when this city substituted a pure for a polluted water supply in 1893. We find, furthermore, that the decline in total mortality is accounted for to a large extent by the diminished number of typhoid fever deaths, but to a much greater extent by a decline in deaths from other causes; that about eighty per cent. of the decline in general mortality can be readily accounted for; and that among the "other causes" from which the death rates are diminished *pulmonary tuberculosis, pneumonia* and *infant mortality* are prominent.

Finally, we have raised the questions, To what is this remarkable result of the substitution of pure for polluted water due? Is the marked decline in the total death-rate attributable simply to cessation of infection; or is it due to some enhancement of vital resistance; or is it due to the cooperation of these factors? In other words, must pulmonary tuberculosis, pneumonia, infant mortality, etc., be added to the list of water-borne diseases, or does the use of impure water depress the vital resistance of the human organism?

The complete paper, containing a discussion of these and similar questions, numerous statistical tables, diagrams, etc., will be published in the near future.

W. T. Sedgwick
Scott MacNutt
Biological Department,
Massachusetts Institute of Technology

THE THIRTY-EIGHTH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY—II.

BIOLOGICAL AND SANITARY CHEMISTRY

Thomas B. Osborne, *Chairman*

The Effect of Pasteurization upon the Development of Ammonia in Milk: W. G. Whitman and H. C. Sherman.

The purpose of this investigation was to follow by accurate quantitative determination the development of ammonia in raw and pasteurized milk as a possible measure of protein decomposition. The ammonia content of raw milk kept at 15° to 20° C. usually increased rather rapidly for two days, more slowly during the third and fourth days, and then decreased somewhat for a few days following, increasing again later if the observations were sufficiently prolonged. A similar slight decrease of ammonia toward the end of the first week was sometimes, but not usually, observed in milk pasteurized at 65°; never in milk pasteurized at 85°, which always showed a continuous increase in ammonia content. In milk obtained under ordinary market conditions in New York City and thereafter kept at 15–20°, pasteurization was usually less efficient in checking the development of ammonia than in checking the production of acid, and this was especially true of the milk pasteurized at the higher temperature (85°) which often developed a relatively large amount of ammonia before becoming sour.

Chemical Evidence of Peptonization in Raw and Pasteurized Milk: Rachel H. Colwell and H. C. Sherman.

An attempt was made to judge roughly of the extent of peptonization from the intensity of the biuret reaction after the removal of coagulable proteins and proteoses. The results indicate that pasteurization at 60° for twenty minutes restrained peptonization to about the same extent that it restrained souring, and had no marked influence upon the development of offensive odors. Pasteurization at higher temperatures (75° and 90°) delayed souring to a much greater extent, had less restraining effect upon peptonization and resulted in the subsequent development of much more offensive odors.

Investigations of Wheat Oil: Joseph S. Chamberlain and Geo. L. Bidwell.

The authors determined the physical properties, the iodine absorption, saponification value and refractive index of the crude fats extracted by ether from wheat germ and from wheat flour. The crude fats were then purified by treatment with acetone. The soluble portions consisting in each case of pure liquid oil were studied in the same way. The results show that the purified oils obtained from wheat germ and wheat flour are much more alike than the crude fats. They think it possible that the usual statement, that these two oils are distinctly different, may not be true and expect to study the question further.

Plant Food removed from Growing Plants by Rain or Dew: J. A. Le Clerc and J. F. Breazeale.

Wheat, barley and other plants were grown in pots in a greenhouse and not subjected to weathering conditions. It was demonstrated that the gradual decrease in the total salt content of these crops from the milk stage until final harvest is not due to a physiological process, as was formerly supposed by many investigators, but to a purely mechanical one. The salts do not recede from the plants to the soil through the stems, but are dissolved and leached out by rain or dew.

Analytical data were also cited to show that the same process takes place in potato, rice and oat plants and also in the leaves of trees.

On the Behavior of Lecithin with Bile Salts and the Occurrence of Lecithin in Bile: J. H. Long and Frank Gephart.

The occurrence of lecithin in bile is still a disputed question. From work on the bile of the polar bear Hammarsten concluded some years ago that lecithin is a normal constituent of the bile of this animal. The evidence was indirect, as the presence of the lecithin was inferred from the recognition of certain decomposition products. Failing to effect a separation ourselves, we have attempted to show the presence of lecithin in ox bile in other ways. In preparing pure bile salts, in this case a mixture of taurocholate and glycocholate of sodium, it was found that they contained about 0.3 per cent. of phosphorus. This observation has been frequently made and is one of the grounds on which the lecithin content is assumed. We have determined the sulphur, the nitrogen, the phosphorus and the optical rotation of these salts, and the results may be best explained by assuming the presence of about 7.5 per cent. of the lecithin body. For various reasons, however, the calculation can not be exact. We have determined the extent of the solvent action of bile salts on lecithin and find that 100 parts of the former will dissolve almost exactly 80 parts of the latter to yield a clear solution. This solvent action is much hastened by the presence of many inorganic salts, but the weight dissolved is not increased. We have found the optical rotation of a mixture made in the above proportions, the results of which justify the figures given some years ago by Ulpiana for the rotation of egg lecithin, assuming that in our mixture the one active body does not interfere with the other. We believe this assumption to be correct, or, in other words, that the solution of the lecithin in the bile salt solution is a physical rather than a chemical phenomenon. We have carried out some experiments to show the extent to which these artificial mixtures of lecithin and bile salts may be separated from each other, and conclude from the results found that there is but little prospect that the very small amount of the lecithin which may occur in bile may be actually separated and identified as such.

Some Experimental Studies on Indigestible Carbohydrates: Victor C. Myers. (From the Sheffield Laboratory of Physiological Chemistry, Yale University.)

The purpose of this investigation was to determine quantitatively the digestibility of Iceland moss, *Cetraria islandica*, in man. In three experiments on two different individuals, the raw *cetraria* carbohydrate was almost completely recovered in the stools. In one experiment in which the material was thoroughly boiled there seemed to be a slight utilization. Two experiments recently made by Mr. MacArthur, in this laboratory, with one of the isolated carbohydrates, lichenin, indicate the possibility of its complete utilization. This is certainly different from what beaker digestions would lead us to expect. It is hoped by further investigation the coming year to finally solve this problem.

The Effect of Phytic Acid and its Salts on Plants: Oswald Schreiner and M. X. Sullivan.

Wheat seedlings growing in soil were found to affect the fertility of this soil in such a way that the seedling crop of wheat was retarded in growth. Among the products of germination there was found by Patten and Hart's method a small amount of phytic acid or anhydro-oxymethylene diphosphoric acid. Accordingly, this acid and its salt were tested as to their effect on wheat. Phytic acid was found to be toxic to wheat in solutions as weak as five parts per million. Its sodium and potassium salts, on the contrary, were decidedly beneficial. The toxicity of the free acid is greater than the toxicity of phosphoric acid containing the same amount of P_2O_5. The increase in transpiration and green weight in solutions of the potassium and sodium phytinate is about the same as the increase given by di-potassium and di-sodium phosphate containing the same amount of P_2O_5. Phytic acid and its salts appear to play an important rôle in plant synthesis.

A Study of the Forms of Nitrogen in the Urine of Herbivora receiving Nutrients from a Single Plant Source: E. V. McCollum and E. B. Hart.

Three lots of calves have been fed for more than a year with rations derived from a single plant source. These rations were respectively corn, wheat and oats, and their products. A standard lot received a mixture of the above grains and their products. The object of the experiment is to study biologically the value of proteids from different plants for the nutrition of animals. An extended study is being made of the metabolism of these animals, but most of the data are as yet too incomplete to be reported. Of the total nitrogen digested, the following per cent. was eliminated in the urine:

Corn-fed animal	31.98
Wheat-fed animal	54.86
Oat-fed animal	41.51
Mixture-fed animal	55.97

These figures are the averages for seven days' record for each animal. The form in which the nitrogen appeared in the urine of each of these calves was determined for a period of two days during which the urine and feces were collected quantitatively. The forms estimated were ammonia, urea, uric acid, purin bases, hippuric acid, kreatinin, kreatin and allantoin. The following are the more conspicuous results. (1) The high percentage of urea compared to that of hippuric acid. The urea ranged between 62.05 and 82.41 per cent. and the hippuric acid between 1.26 and 9.05 per cent. of the total nitrogen. Urea was uniformly higher and hippuric acid lower in wheat-fed calves than in the other lots. Corn-fed calves excreted less nitrogen as urea and more as hippuric acid than the other lots. (2) The kreatinin output calculated in terms of the total nitrogen excreted was very much higher in corn-fed calves than in other lots. Averages: for oat lot, 3.69; wheat lot, 3.01; corn lot, 9.08; mixture lot, 4.57; per cent. of the total nitrogen. (3) The total absence of allantoin from the urines of all wheat-fed calves. Allantoin was present in the urine of the other lots in amounts varying from 3.99 to 11.76 per cent. of the total nitrogen.

The Behavior of Alanin in Metabolism: Graham Lusk.

On giving twenty grams of i-alanin to a dog made diabetic by phlorhizin injections, sugar increased in the urine in an amount to indicate an almost complete (93 per cent.) conversion of alanin into dextrose. This coincides with previous experiments by Mandel and Lusk which showed a complete conversion of lactic acid into dextrose within the organism.

On a Globulin from the Egg Yolk of the Spiny Dog-fish: C. A. Alsberg and E. D. Clark.

The yolk does not contain a typical vitelline: but in its stead a globulin free from phosphorus and perhaps iron. This may be due to the fact that the animal is viviparous.

On the Utilization of Inorganic Phosphorus by Animals: E. B. Hart and E. V. McCollum.

This work embraces experiments extending over a period of two years with growing pigs. The results clearly indicate that inorganic phosphates, such as bone ash, finely ground rock phosphate, or precipitated calcium phosphate—a mixture of di- and tri-calcium phosphates—can be used by these animals where rations containing insufficient phosphorus are being fed. Young animals of forty pounds weight, receiving inorganic phosphate, together with other salts as supplementary on a ration very low in mineral constituents, grew to be animals of 280 pounds weight, bore litters of fairly vigorous pigs, which on the same ration completed the cycle back to 80 pounds, while animals on the same ration, less the inorganic phosphate, collapsed in three months with loss of weight and use of limbs. Some of the more important observations made are as follows: (1) Animals on a ration extremely low in phosphorus made as large gains up to 75 to 100 pounds as did animals receiving an abundance of this element. After reaching this point loss of weight began, followed by collapse. (2) When such low phosphorus rations as induced the above symptoms were supplemented with inorganic phosphates, no untoward results appeared. Animals fed a low phosphorus ration, supplemented with inorganic phosphates, made as vigorous a development as others receiving wholly organic phosphorus. (3) Determinations of calcium and phosphorus in the principal organs and tissues of the animals on the low phosphorus ration showed that they maintained their composition normal. The per cent. of ash in the skeletons of pigs on a depleted phosphorus ration was reduced to nearly one half that of pigs which received a normal ration, or the phosphorus-poor ration plus inorganic phosphates. When the animals were starving for phosphorus they drew it from the skeleton, but always removed calcium and phosphorus in the proportions found in tri-calcium phosphate.

The Importance of Digestion in the Utilization of Cane Sugar: Israel S. Kleiner.

The average output of saccharose after intraperitoneal or subcutaneous introduction into dogs under various experimental conditions was found to be 65 per cent. to 75 per cent. in a large number of experiments. The extremes were 37 per cent. and 99 per cent. There is some evidence that the portion not recovered is not all excreted into the intestine, but is metabolized within the body.

Effect of the Ratio of Magnesium to Calcium on the Roots of Seedlings: Burd L. Hartwell and F. R. Pember.

Magnesium nitrate has been found to be toxic to wheat seedlings; the addition of calcium and potassium has been found to lessen the toxic effect of magnesium salts. The leafy portion of the seedlings appeared normal. The toxicity of the magnesium salts was shown by comparing growths in these solutions with those in distilled water. The toxic effect of magnesium is greater when there is a deficiency in potassium. Lime added to such solutions is beneficial, but is not believed to be a substitute for potassium.

Abstracts have not been received for the following papers:

The Spontaneous Oxidation of Cystein and Cystin: Albert P. Mathews.

Investigations on Wheat Oil: Joseph S. Chamberlain and George L. Bidwell.

Phosphorus Metabolism Experiments: F. C. Cook.

Artificial Digestion with Organic Acids and with Essential Oils: Edward Gudeman.

Hydrolyses of Carbohydrates with Blood Serums: Edward Gudeman.

Composition of Cold-stored Poultry: M. E. Pennington.

On Nucleic Acids: P. A. Levene.

The Digestibility of Corn Meal: L. H. Merrill.

INORGANIC CHEMISTRY

Philip E. Browning, *Chairman*

The Estimation of Potassium in Soils as the Cobalti-Nitrite: W. A. Drushel.

It was first shown by Karl Gilbert, of Tubingen, ten years ago that potassium is quantitatively precipitated by sodium cobalti-nitrite as the double cobalti-nitrite of sodium and potassium, if the mixture is allowed to stand from 10 to 20 hours. Two years later Adie and Wood used the same reagent for the quantitative estimation of potassium, decomposing the precipitate by boiling with dilute sodium hydroxide, and titrating the nitrites with standard potassium permanganate. Their method has been shortened by evaporating the mixture nearly to dryness after adding an excess of sodium cobalti-nitrite, instead of allowing it to stand 10 to 20 hours, and by oxidizing the precipitate after washing well with a sodium chloride solution, directly with dilute, hot, standard permanganate instead of decomposing the precipitate and removing the cobalt. The oxidation is completed by acidulating with dilute H_2SO_4, the excess of permanganate bleached with standard oxalic acid and the solution titrated to color with permanganate. One cubic centimeter of decinormal permanganate is equivalent to .000857 gram K_2O, since the cobalt is reduced from the trivalent to the bivalent condition. For potassium in soils a weighed amount of soil is digested with 20 per cent. HCl; the extract is evaporated to dryness and gently ignited to remove any ammonium chloride and organic matter present. This residue is then extracted with water acidulated with acetic acid. The extract thus obtained is treated with concentrated sodium cobalti-nitrate and the process carried out as previously indicated.

Potassium in Animal Fluids as the Cobalti-nitrite: W. A. Drushel.

For potassium in urine the dried residue from a measured quantity is treated with a 9:1 nitric-sulphuric acid mixture in a covered platinum dish over the steam bath. After the violent oxidation is over the cover is removed, and the solution evaporated to dryness. The residue is then ignited, gently at first and finally at the full heat of the bunsen burner. In the case of protein-containing fluids, as the blood, lymph, serum and milk, it is preferable to oxidize the dried residue with concentrated nitric acid alone over the steam bath. The solution is then evaporated to dryness, gently ignited, moistened with concentrated H_2SO_4, and ignited as in the case of urine. The residue thus obtained contains nothing which might interfere with the cobalti-nitrate method; it is, therefore, dissolved as may be over the steam bath with a little water acidulated with acetic acid, and, without filtering, the solution is treated with an excess of sodium cobalti-nitrite. From this point the process is carried out as described for soils. The cobalti-nitrite method is applicable in the absence of mineral acids and the salts of ammonium, cesium, rubidium and thallium. The method is rapid and for small amounts of potassium compares favorably with the chlorplatinate method if proper care be taken in washing and oxidizing the precipitated potassium sodium cobalti-nitrite, the chief sources of error being the slight solubility of the precipitate (1 part in 25,000 to 30,000 of water) and in its tendency to include traces of sodium cobalti-nitrite. In this work the chlor-platinate method was used as a control.

Electrolytic Determination of Nitric Acid: Owen S. Shinn.

It was found that by keeping copper in solution, either by the addition of copper sulphate during reduction, or by retarding the speed at which the anode rotates, the nitric acid is completely reduced to ammonia. This may be determined either by distilling or by titrating excess of acid. Results are almost theoretical.

Observations of Columbium: C. W. Balke and E. F. Smith.

This investigation forms an additional chapter in the study of columbium which has for some time been receiving attention in the laboratory of the University of Pennsylvania. It shows that by crystallization of columbium potassium from 35 per cent. hydrofluoric acid titanium may be completely eliminated. A new method for the preparation of columbium pentachloride passing $SnCl_2$ vapors over columbic oxide is described in great detail. The vapor density of the columbid, $CbCl_5$, is also determined. Numerous analyses of it are also given. The atomic weight of columbium, by decomposition of $CbCl_5$ with water, was determined. The value after all corrections was found to be 93.5. A series of columbates of the ratio 1:1—R_2O, Cb_2O_5 was prepared and minutely studied. Columbates of the ratio 4:3 were also investigated chemically and crystallographically. A third series in which the ratio is 7:6, $7K_2O.6Cb_2O_5$, was also investigated. The following percolumbates were obtained: Na_3ClO_8, Pb_3ClO_8, $MgNaClO_8.8H_2O$, $CaKClO_8.4H_2O$, K_3ClO_8, CO_3ClO_8. The double fluorides of columbium received an exhaustive and thorough review. Pertantalates, analogous to percolumbates, were prepared and analyzed.

The Separation of the Alkali Metal in the Electrolytic Way: J. S. Goldbaum and E. F. Smith.

By means of a mercury cathode and rotating silver anode not only have chloride of the alkaline earth and alkali metals (sodium and potassium) been analyzed, but ammonium halides have been successfully and quantitatively determined. The decomposition values of rubidium and cesium halides have been ascertained and sodium has been separated from ammonium potassium rubidium and cesium. Potassium has been separated from cesium and rubidium. Rubidium and cesium have been separated in this way. The time for this has been greatly reduced. The results have been exceedingly accurate. At present lithium halides are receiving attention.

Specific Gravity and Valence: Arthur J. Hopkins.

Meyer's curve of atomic volumes calls for a symmetrical arrangement of the periodic system, a form of which is suggested. The periodicity of the curve is then shown to be due to the item specific gravity alone. The curve for specific volume is shown to have the same character as Meyer's, the characteristics of which entirely disappear when the figures for specific volume are multiplied by volume or, more exactly, by position number on the periodic system suggested. It is shown that the position number is more important than atomic weights in calculations of certain physical properties.

A System of Qualitative Analysis for the Common Elements. V. Detection of the Acidic Constituents: Arthur A. Noyes and Roger D. Gale.

In the process described by the authors all the volatile acids are separated from the basic constituents by distilling the substance with a mixture of 10 c.cm. of 85 per cent. phosphoric acid and 20 c.cm. of water. The distillate is divided into two equal portions, the former being collected in barium hydroxide solution, and the latter in water. The first portion contains the weaker and more volatile acids, H_2CO_3, H_2SO_3, H_2S, HCN, HNO_2, as well as free halogens; the second portion contains the stronger or less volatile acids, HCl, HBr, HI, HSCN, HF and HNO_3. General and special tests for these constituents are applied separately to the two distillates. By adding copper and continuing the distillation of the substance with the concentrated phosphoric acid, sulphates are reduced to sulphurous acid, and this is collected in water as a third distillate and tested for with barium chloride and bromine water. Boric acid is also distilled over by boiling a separate portion of the substance with methyl-alcohol and sulphuric acid, the alcoholic distillate being tested by the addition of hydrochloric acid and turmeric solution.

Certain Organic Acids and Anhydrides as Standards in Alkalimetry, Acidimetry and Iodimetry: Isaac K. Phelps.

The paper is a continuation and extension of my paper with Hubbard on succinic acid as a standard; in that paper ammonium hydroxide with cochineal as an indicator was used; now I show that succinic acid, or anhydride, malonic acid, benzoic acid, phthalic acid or its anhydride may be used with exactness with sodium hydroxide and phenolphthalein as an indicator and that these same acids and anhydrides may be used also as standards in iodimetry.

Abstracts of the following articles have not been received:

The Estimation of Chromic and Vanadic Acids in the Presence of one Another: Graham Edgar.

In how far are we justified in assuming the Homogeneity of the Chemical Elements? B. B. Boltwood.

The Action of Light on Water of Crystallization: Ralph H. McKee and Elvin J. Berkheiser.

The Estimation of Cerium in the Presence of the Other Rare Earths by Potassium Ferricyanide: Philip E. Browning and H. E. Palmer.

The Perchlorates of Hydrazine: A. W. Browne and J. W. Turrentine.

The Electrolysis of Anhydrous Hydronitic Acid: A. W. Browne and G. E. F. Lundell.

On the Question of the Existence of Lead Suboxide: David Wilbur Horn.

A System of Qualitative Analysis for the Common Elements. IV. Analysis of the Alkaline-Earth and Alkali Groups: Wm. C. Bray.

The Estimation of Vanadium by Permanganate after Reduction by Titanous Sulfate: H. A. Newton.

The Action of Bismuth Oxide on Reduced Salts of Vanadium: H. A. Newton.

Processes of Differential Oxidation and Reduction Applied to the Estimation of Vanadium, Molybdenum and Iron: Graham Edgar.

Determination of Arsenic in Insecticides: D. L. Randall and F. W. Woodman.

The Perchlorates of Hydrazine: A. W. Browne and J. W. Turrentine.

PHYSICAL CHEMISTRY

Frank K. Cameron, *Chairman*

Liquid above the Critical Temperature: W. P. Bradley, A. W. Browne and C. F. Hale.

The authors, who adhere to the view that liquid does exist above the critical temperature, describe a way in which that liquid can be "seen" in a Cailletet apparatus while temporarily localized by virtue of its greater specific gravity. It forms ripples which flow down the walls of the container, adhering thereto, and accumulating under the unliquefied vapor. Its top may be sharply bounded, though not, of course, by a meniscus. The location of the boundary is marked by the conduct of the ripples as they flow down upon it, and also by that of similar ascending ripples which may be caused by slight evaporation of the liquid, brought about by appropriate increase of volume. These and other phenomena are continuous above and below the critical temperature.

The Relation between the Temperature of Kerosene and the Explosion Pressure of the Supernatant Mixture of Vapor and Air: W. P. Bradley and C. F. Hale.

The explosion pressure of the vapor air mixture of two typical samples of kerosene, confined at atmospheric pressure, were measured from the temperature at which explosion first occurred to that at which the mixture was too rich in vapor to explode. Explosion was induced by the electric spark. At the temperature of the Elliot (closed) cup flash point the explosion pressure is already one half the maximum pressure. At that of the Tagliabul (open) cup flash point it is almost equal to the maximum, while in that of the Tagliabul fire point the mixture is rich, so that the explosion pressure is greatly reduced and the danger therefrom is practically over.

Note on the Hydrolytic Dissociation of Nitrobenzene: R. R. Renshaw.

Attempts have been made to determine the decomposition of nitrobenzene by water at different temperatures and concentrations by the colorimetric estimation of the nitrite formed. A hundredth molar solution is dissociated between 0.003 and 0.004 per cent. at 37°. Equilibrium is only reached after a number of days. The results at higher temperatures in sealed tubes are of no value on account of the alkali dissolved from the glass. This and similar reactions will be studied by the conductivity method.

The Specific Heats of the Elements: J. E. Mills.

The paper gives a critical summary of the data upon the specific heats of the elements and points out the following conclusions: (1) The specific heats of the elements change rapidly with the temperature, the change being greatest at low temperature and for elements with low atomic weight. (2) It is absolutely hopeless to claim any sort of constancy for the product of the atomic weight of an element and its specific heat at varying temperatures. (3) The value of the atomic heat at the absolute zero is not the same for all substances, but the substances with the larger atomic weight have at that temperature the largest atomic heat. (4) The total energy of a molecule in the liquid condition at its melting point, if its energy at 0° absolute be considered zero, is approximately three times the kinetic energy of the same molecule were it a gas at that temperature. (5) It is suggested that the law of Dulong and Petit is only a special case of an equation similar to the equation for gases, in which the molecular heat at constant volume, multiplied by the ratio of the specific heats less than one, is equal to 2K where K is the gas constant.

Some Relations at the Critical Temperature: J. E. Mills.

It was shown that if the density of a liquid be plotted against the temperature the line drawn through the density where it varies linearly with the temperature will, if prolonged, cut off on the ordinate line at the absolute zero just twice the distance that it cut off on the ordinate line at the critical temperature, and this line intersects the temperature axis at a point equal to twice the critical temperature. Moreover, the line of mean density of liquid and saturated vapor discovered by Cailletet and Mathias likewise meets the temperature axis at the same point (twice the critical temperature). The critical density is therefore one fourth of the density of the liquid at absolute zero.

The Relation of the Rate of Settling to the Size of Particles in Suspension: E. E. Free.

Most investigators of sedimentation phenomena have worked with very fine powders where the factors effecting the rate of fall are exceedingly complex. This paper describes an attempt to study the much simpler case of the fall of relatively coarse particles. Quartz sand of various sizes was dropped through distilled water in a long tube and the velocity of fall measured between points a meter apart. It is shown on theoretical grounds that for spherical particles the relation of velocity and size of particle is given by the equation $V^2 = Kr$ where K is a constant. Taking the value of K as found for the coarsest particles (which are least likely to be subject to disturbing influences), the theoretical parabola is plotted and it is shown that the points for powders less than .25 mm. in diameter lie far above the curve. That is, the finer powders fall more slowly than would theoretically be expected. This is probably due in part to the action of secondary forces and in part to the fact that finer grains are more angular and do not approach the spherical form so nearly as do the coarser. With the finest powders flocculation comes into play and again increases the rate of fall.

The Aluminum Cell for preventing Underground Electrolysis: F. E. Gallagher.

After a brief discussion on prevention of underground electrolysis, experiments with a cell containing electrodes of aluminum and lead in a sodium acid phosphate solution were described. The length of time a "formed" aluminum electrode is held cathode determines the extent to which a film decays, and therefore the time required to build up a high resistance when such an electrode is again made anode. The effectiveness of an aluminum anode in checking current is less at low impressed voltage. Under continued direct current action both the lead anode and aluminum cathode are attacked in sodium acid phosphate solution. Carbon instead of lead in phosphoric acid solution would prove more serviceable.

The Specific Heat and the Latent Heat of Vaporization of Silicon Tetrabromide: L. Kahlenberg and E. H. Zobel.

The silicon tetrabromide was prepared by passing bromine over heated metallic silicon. The product was freed from excess of bromine by fractional distillation, treatment with metallic mercury, and finally redistilling. The boiling point of the purified product was 148°.7 at 736 mm. pressure. The specific heat between the temperatures of 24° and 144° was found to be 0.10055, and the latent heat of vaporization was found to be 28.86. The method for determining the specific heat was that employed by Berthelot, and the method of Kahlenberg was used in making the determinations of the latent heat of vaporization. The figures obtained are the mean of several determinations that gave closely agreeing results.

Equilibrium in the System Silver Chloride and Pyridine: Louis Kahlenberg and Walter J. Wittich.

There are two distinct crystalline compounds of silver chloride and pyridine, namely, $AgCl.2C_5H_5N$ and $AgCl.C_5H_5N$; these have hitherto been unknown. The former compound is stable between —56° and —22° C. It was obtained in minute crystals that are very unstable at temperatures above —22° C. $AgCl.C_5H_5N$ is stable between —20° and —1° C. The salt forms small needlelike crystals which are more stable than $AgCl.C_5H_5N$. From —1° to 110° C. the solubility of AgCl in pyridine decreases rapidly as the temperature rises. The entire equilibrium curve of the system silver nitrate and pyridine has been established from the freezing-point of pyridine up to 110° C.

The Validity of Faraday's Law at Low Temperatures: Wendell G. Wilcox.

The experiments were made on silver nitrate solutions in pyridine. The conclusions reached are that the electrochemical equivalent of silver is independent of the temperature and that Faraday's law holds for temperatures as low as — 55° C. provided secondary changes taking place at the electrodes are taken into consideration.

Replacement of Heavy Metals in Non-aqueous Solutions by Metallic Calcium: J. H. Walton, Jr. (Preliminary Report.)

A series of experiments have been carried out for the purpose of determining whether or not a strongly metallic substance, such as calcium, is able to replace the heavy metals of salts which are dissolved in non-aqueous solvents. As a typical heavy metal copper was selected, the oleate being the salt used because of its solubility in a large number of solvents. The experiments were carried out by heating the solution at 100° in a sealed tube with a strip of metallic calcium, the surface of which had been scraped until bright. The following solvents were used for the copper oleate: Toluene, xylene, pyridine, carbon tetrachloride, ethylene bromide, turpentine, paraffine oil, lard oil, carbon bisulphide, aniline, nitrobenzene, amyl acetate. The calcium was tarnished, but in no case was it coated with copper. Calcium heated with fused copper oleate at 150° for two hours also did not precipitate copper. A number of similar experiments were carried out in which the following alloys of calcium were heated with solutions of copper oleate in the above solvents: Ca-Zn, Ca-Cd, Ca-Pb, Ca-Sn, Ca-Bi, Ca-Sb, Ca-Al, Ca-Hg. In the case of the alloys containing Pb, Zn and Cd, respectively, replacement of the copper was observed in pyridine solution; with the other alloys this did not happen. This is in accordance with the observations of Sammis, who found that these metals when heated with certain copper oleate solutions precipitate the copper. In the case of the Ca-Pb alloy it was observed that whereas metallic lead causes the precipitation of Cu only on heating at 100°—the Ca-Pb alloy is coated with copper after standing a few minutes at room temperature. The action of the alloys of Ca is being made the subject of further investigation.

The Absorption of Carbon Dioxid by Certain Bases: F. K. Cameron and W. O. Robinson.

The pressure curves of CO_2 over various metal hydroxids at 0° C. up to 5 atmospheres pressure were determined. It is shown that solid bicarbonates of lime, magnesia and ferrous oxide and carbonates of aluminia, ferric oxide and beryllia do not exist under the forenamed conditions.

The Dry Grading of Powders: E. E. Free.

It is often necessary to grade a powder without wetting it. Bolting cloths are useful for coarser powders, but not for finer. Air elutriation has been used technically to meet this problem and has been used for scientific purposes by Cushman and Hubbard.[1] This paper suggests an improvement of their apparatus, in that the stream of air carrying the suspended powder is introduced into the smallest of a series of percolation jars and passes through them successively in order of increasing size (instead of the reverse). The velocity of the air stream thus decreases from jar to jar and finer and finer powders are deposited in each. The main trouble with this apparatus is due to flocculation of the powder. The finer grains stick to the larger and to the sides of the apparatus and the only fraction which is entirely of the size desired is the last, or finest fraction. The intermediate grades all contain a small amount of finer material. This flocculation is mainly due to water films on the particles and to electrical charges. That due to water is decreased by drying, but this increases the electrical flocculation. The minimum of flocculation is found when air and powder are almost, but not quite, dry.

The Solubility of Basic Copper Carbonate in Solutions of Carbon Dioxide: E. E. Free.

The investigations detailed in this paper form part of the studies on the effect of copper salts in irrigating waters, which have been in progress for several years at the Arizona Agricultural Experiment Station. It is shown that the compound precipitated from solutions of carbonates and copper salts is of variable composition, but that under the action of carbon dioxide and water for several days it changes to a compound of definite solubility and probably definite composition. The $CuO:CO:H_2O$ ratio (molecular) of this compound is 1.000:.515:.603. Its solubility in water is greatly increased by the presence of carbon dioxide. With 1,200 parts of carbon dioxide per million about 35 parts of copper per million dissolve. The solubility in solutions of carbon dioxide is increased by the presence of sodium chloride, sodium sulphate and probably calcium sulphate, and is depressed by the presence of sodium or calcium bicarbonate.

The Constitution of Alum Molecules in Solution: Chas. L. Parsons and W. W. Evans.

Diffusion experiments with iron, aluminum and chromium alums, both with membranes and agar

[1] *J. Amer. Chem. Soc.*, **29**, 589–597 (1907).

agar, showed that the constituents of the molecules of the alums separate from each other readily by diffusion at both 0° and 25°.

The Constitution of Solutions of Iodine in Aqueous Potassium Iodide: Chas. L. Parsons and Geo. A. Perley.

Diffusion experiments with solutions of iodine in aqueous potassium iodide, using membranes or agar agar, show that the potassium iodide and the iodine diffuse independently of each other in both dilute and concentrated solutions.

The Inversion of Cane Sugar by Invertase: C. S. Hudson.

It is shown that in dilute solutions the inversion is a unimolecular reaction, following accurately the logarithmic formula. The real rate can not, however, be measured in a polarimeter unless the solution is made alkaline before each reading, as otherwise the apparent rate of inversion is observed which differs from the real rate by as much as 50 per cent. Henri, Armstrong and others who claim that the actions of invertase and of other enzymes differ from the usual types of catalysis, have measured the apparent rate rather than the real rate. The investigation is being continued and a preliminary notice of it may be found in the July number of the *Journal of the American Chemical Society.*

Abstracts for the following papers have not been received:

Precipitation of Copper from Chloride Solutions by Means of Ferrous Chloride: Gustave Fernekes.

Precipitation of Copper from Chloride Solutions by Means of Ferrous Chloride and its Relation to the Genesis of the Michigan Copper Deposits: Gustave Fernekes.

Equilibrium in the System—Potassium Iodide, Iodine and Ethyl Alcohol: Chas. L. Parsons and Geo. A. Perley.

The Velocity of Reactions in Gases moving through Heated Tubes and the Effect of Catalysis: Irving Langmuir.

An Automatic Regulator for Electric Currents: Irving Langmuir.

On the Mechanism of the Formation of Esters from Alkyl Halides and Salts of Organic Acids: S. F. Acree and F. M. Rogers.

The Dissociation Pressures of Certain Oxides at High Temperature: P. T. Walden.

A Physico-chemical Study of the Phosphoric Acids: G. A. Abbott.

The Use of the Conductivity Method in Testing Nicotin Solutions and Tobacco Extracts: Harris E. Sawyer.

Studies in Electromotive Force: G. N. Lewis.

The Reduction of Cadmium by Mercury and the E.M.F. of Cadmium Amalgams: G. A. Hulett and R. E. DeLury.

Cadmium, Cadmium Sulfate and its Solutions: G. A. Hulett.

Types of Electrolytes: J. Johnston.

The Hydration of Ions: E. W. Washburn.

Negative Viscosity: Frederick H. Getman.

Latent and Specific Heats of Some Fused Salts: H. T. Kalmus.

The Behavior of Colloidal Metals with Immiscible Solvents: W. Lash Miller.

Solutions of Metals in Liquid Ammonia: C. A. Kraus.

Electrolytic Reduction of Permanganate Solutions: J. W. Turrentine.

Mercury Cathodes in Nitric Acid Solutions: J. A. Wilkinson.

On Vapor Pressures: O. F. Tower.

On the Electrolytic Oxidation of Hydrazine Sulfate: J. W. Turrentine.

Action of Ferric Sulfate on Copper: C. G. Schluederberg.

Experiments with Halogen Carriers: C. G. Schluederberg.

The Source of the Thorium Disintegration Products Present in the Atmosphere: Bertram B. Boltwood.

The Presence of Lead in Autunite and Other Secondary Uranium Minerals: Bertram B. Boltwood.

The Capillarity of Mercury in the Presence of Vapors: Morris Loeb and Stephen R. Morey.

Determination of the Vapor Tension of Solutions by Means of the Morley-Brush Gauge: O. F. Tower.

B. E. Curry,
Press Secretary

Transmitted by Professor Chas. L. Parsons, *Secretary.*

New Hampshire College

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 21, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

CHEMICAL PUBLICATIONS IN AMERICA IN RELATION TO CHEMICAL INDUSTRY[1]

THE American Chemical Society holds a unique place among the chemical societies of the world. It combines functions and activities which could, heretofore, be found only in separate organizations. It is the only large chemical society in the world which includes both those who are engaged in the application of chemistry to the industries and to chemical engineering and those who are engaged in teaching and in researches with no immediate practical bearing and which provides adequately for the interests of all classes of chemists. There are two reasons which justify this policy. In these days of intense specialization one of the greatest dangers to a professional man is that he will become so intensely absorbed in the field in which he is working that he loses all interest in other lines of work and falls out of touch with the rapid advances which his science is making in every direction. This tendency is almost as marked and fully as dangerous for those who are engaged in pure research as for those working in applied chemistry. Both classes of our members find that contact with chemists having a radically different point of view is exceedingly stimulating and useful. The advantages of an Abstract Journal which covers both fields are so self-evident as scarcely to require remark.

The second reason which justifies the

[1] An address delivered at the New Haven meeting of the American Chemical Society, July 2, 1908.

union of all classes of chemists in a single society is that only in this way is it possible to provide at moderate expense those publications which are needed by every chemist. The chemists of the world seem to have realized only very dimly the advantages in economy which result from combination for purposes of publication. The fundamental principle is that for a small circulation the original cost of gathering the material and setting the type forms a large proportion of the total cost of publication. After the matter has once been accumulated and printed the cost of printing and distributing additional copies is relatively small.

The German Chemical Society, when it began to publish, officially, the *Chemisches Zentralblatt,* adopted the plan that the journal was to be sent only to those who will pay for it. The result is that those who take the *Zentralblatt* must pay nine dollars a year for it in addition to the dues of the society and the journal goes to about one half of the members. The total circulation of the *Zentralblatt* is only about 2,000. The American Chemical Society in establishing *Chemical Abstracts* has adopted a different plan. While it was recognized that a few of our members might not care for the journal, it was seen that by increasing the dues of all the members it could be sent to all at a comparatively moderate expense. Accordingly, the dues were increased by three dollars for all members. While *Chemical Abstracts* costs, at present, between five and six dollars per member, it is securing such support among the chemists of America and of the world that the permanent success of the enterprise seems to be assured. In adopting the budget for 1907 the council considered that if enough new members were gained during the first year to make up for those who fell out on account of the increase of dues we should do well. Instead of that the society had a net gain of 310 members. When *Chemical Abstracts* was started in January, 1907, we had a membership of 3,079. We now have 3,800 members.

In establishing *Chemical Abstracts* it was recognized that the funds available would not permit of the publication of as large a journal as the *Chemisches Zentralblatt.* It has, however, approached much more nearly to the size of that journal than was anticipated and, while the abstracts in some divisions are relatively brief, it may be fairly said that *Chemical Abstracts* covers the whole field of chemistry better than any other similar publication. To illustrate, *Chemical Abstracts* gives abstracts of American, English, German and French patents, while the *Zentralblatt* gives abstracts of German patents only. The number of abstracts in biological, mineralogical and geological chemistry greatly exceeds the number in the same lines in the *Zentralblatt* and the same is true of all lines of technical chemistry. The total number of abstracts, even in the first year of publication, is also greater in *Chemical Abstracts,* although the total number of pages is less.

The fields covered by *Chemical Abstracts* are so varied that at the low subscription price of six dollars a year it should secure many subscribers among persons whose primary interest is in other sciences than chemistry. Physicians and biologists will find much that is of value to them under biological and pharmaceutical chemistry, physicists will be interested in physical chemistry, radioactivity and electrochemistry and geologists in mineralogical and geological chemistry.

As an almost necessary result of what has been stated about publication, the American Chemical Society has accepted the principle that it can afford to extend the benefits of its membership to any one who is willing to pay the dues. The statement has recently been made that this has resulted in a membership which is largely non-professional. Such a statement is wholly misleading. While the fact that a man is a member of the society is no guarantee that he is a trained chemist, there are very few members who are not engaged in chemical work and I think I am safe in saying that ninety per cent. of the members have had a good chemical training.

The American Chemical Society is about to establish a *Journal of Industrial and Engineering Chemistry.* This journal, too, is to be sent to all members of the society. The objection has been raised that it should be sent only to those members who are especially interested in it. Such a course does not seem wise for two reasons. First, in accordance with the ideal of the society, which is to care adequately for the needs of all classes of chemists, we wish to continue to furnish all of our members with original papers as well as with abstracts in all fields of chemistry. Second, if we were to adopt the other plan, we could afford to give as a rebate to any one who does not care for the journal only the amount which would be saved by printing a smaller number of copies. This amount is so small as to be scarcely an object. We seem to be justified, therefore, in adopting for the *Industrial Journal* the same plan which has met with so much success in the case of *Chemical Abstracts.*

We already have some members in nearly every civilized country in the world—in England, Germany, South Africa, Australia, New Zealand, China, Japan, Chili, Brazil, Argentina and many others.

The broad policies which have been adopted by our society can succeed only on the basis of a very large membership. We need the loyal support of every American chemist.

W. A. Noyes

THE THEORY OF THE PARASITIC CONTROL OF INSECT PESTS

All who have recently discussed the question of the possibility of controlling insect pests by the use of parasitic or predaceous insects or by fungous or bacterial diseases, have failed to consider the subject from a very important point of view.

The conditions determining the life or death of insects are much more complicated than is usually appreciated, and the individual factors in the problem are far from independent. The correct estimation of this interdependence of the causes of death in insects is of vital importance in this connection. The efficiency of each factor is so influenced by the efficiency of the others that the elimination of one cause of death or the addition of an entirely new natural enemy will usually have but a slight effect upon the rate of survival or none at all.

The reproductive powers of most organic beings are very great. Were not all creatures liable to die prematurely, that is, before they reproduced themselves, reproduction would of necessity have been limited to two offspring from each pair. Whenever reproduction is at a more rapid rate it is a *prima facie* evidence that the chance of premature destruction requires it and the greater the reproductive power the higher this normal death rate. Were conditions otherwise, rapid extinction or enormous increase would result. The fact that species maintain themselves for ages with the ratio between the birth rate and that of premature death not varying an appreciated fraction of a per cent. is very evident.

This balance between birth- and death-rates is much greater than the numerical stability. For instance, in the case of a species increasing a hundred fold in a generation, an average disturbance of only a hundredth part of a per cent. in this ratio —*i. e.,* if on the average one more individual in ten thousand should come to maturity—this would result in nearly tripling the numbers of individuals within a hundred generations, and one tenth of one per cent. augmentation—*i. e.,* if one more in a thousand should survive—would be an increase in numbers amounting in the same period to nearly fourteen thousand fold.

DISTURBING, CONTRIBUTING AND EFFECTIVE FACTORS

The various causes of death may be classed into two groups; first, those that destroy all insects in a certain condition or position, irrespective of the numbers present (for instance, frost, which might kill the same proportion whether there was but one to the acre or a hundred thousand); and second, those that are more and more efficient as the numbers increase. This is true in general of predaceous and parasitic insects and of diseases. Causes of death of the first class will aid in maintaining the balance in an insect to the extent they are uniform in their action, the regularly recurring winter, for instance; but are usually erratic and disturbing rather than balancing. Those of the second category, however, all tend towards balance and their efficiency is attested by the approximate balance maintained in nature. Probably in all cases numerous parasites and predators and other factors of this same class contribute to form the controlling environment of an injurious species, and each factor has a different potentiality. Those of the second category can be further subdivided into two classes, the contributory and the effective. In the former class, the efficiency increases with the increase of the host, but not in a sufficient ratio to ever overtake it. Thus with the host at one hundred per acre it may destroy one third, at two hundred four ninths, at four hundred thirteen twenty-sevenths, etc., never reaching fifty per cent. Any series that does not ultimately pass the percentage of normal death rate is incapable of itself diminishing the numbers of its host. Its only effect is in slowing down the rate of increase until some effective factor becomes operative or until a disturbing factor like frost produces a general destruction.

The effective class of factors is that in which the ratio finally reaches one hundred per cent. Thus with the host at one hundred per acre it may destroy say one half, at two hundred three quarters, at four hundred, seven eighths, etc.; finally reaching a fraction so large that only those survive that are necessary to maintain the species.

Every factor of this class has its particular point of balance. One may overtake the host at two hundred per acre and another only at two million per acre, but both be finally efficient. To a member of this class of checking factors, Mr. Elwood Cooper, the former Horticultural Commissioner of California, would apply the term "the true parasite," and those alone he would consider worthy of importation.

To determine at any time the status of an insect we should have to know the percentage of efficiency of each factor under the existing numerical prominence of the host and in order to prognosticate the future we should need to know the ratio of increased or decreased efficiency of each under the changed numbers of the host.

None of these factors can ever be determined with any great degree of accuracy because they are each involved in as complicated a system of interrelations and in many cases the efficiency of a check against any one insect is profoundly influenced by the ups and downs of numerous other insects that serve as alternate hosts.

The complication of the subject indeed is so great that accuracy even of observation will be impossible, but the failure to reckon with all the factors of the problem will make conclusions of little significance.

The interrelation of factors may be of the most complicated nature; for instance, a parasite which of itself might be wholly inefficient due to its slow rate of reproduction as compared with that of its host, might be rendered very efficient by the cooperation of a contributing factor which could only delay the rate of increase.

It will be thus readily seen that the efficiency of all these factors working together is neither the sum nor the average of the potential efficiency of each, though much nearer the latter than the former. Many writers have assumed that by adding a new parasite, its efficiency was simply added to that of others previously existing. This supposition is certainly far from the theoretical conception of the interrelations of species as presented above, and has not been borne out in actual experience.

RELATION OF LIFE CYCLE OF HOST

Thus far the insect whose control is sought is conceived of as existing in but one condition. The growth and transformation of insects add still further complications to the subject. The checks are not simultaneous in their action, but at each stage in the progress of its development the insect lives in a different environment. The parasites, for instance, that affect the egg will find the next generation of eggs perhaps more profoundly influenced by the checks that have operated during the remainder of the life of the insect than anything they have accomplished, and so perhaps with the checks operating at any stage. A serious attack of one parasite during early larval life might result in protecting the insect from still more efficient destroyers in the late larval stage and really cause more to come to maturity.

SUGGESTIONS FOR LABORATORY STUDY

We can eliminate most causes of death under artificial breeding conditions and often produce one hundred per cent. of survival. When this can be done we are in a position to begin the experiment of testing first one at a time each cause of death, then to study their interrelations or the simultaneous or alternating effects of two of these factors, in the case of parasites studying as thoroughly in detail also their environment. Until considerable work of this kind is done the basis for our theories will not have been well enough established to deserve a place as science.

ECONOMIC RELATIONS

The power of an insect to do damage is due as a rule to the number present during their chief feeding period, and may be quite independent of the numbers that finally come to maturity, and is absolutely independent of the ratio between birth and death rates. A temporary disturbance of this rate produces increase or decrease and may place an insect suddenly in the destructive class or remove it, but while an insect maintains itself in injurious numbers the ratio is as low as though the insect were rare.

In the case of most of our injurious insects the natural increase is more than a hundred fold, so that less than one per cent. is in these cases the established average rate of survival. This is true even of such recently introduced pests as the gypsy and brown tail moths, and the boll weevil, everywhere, except when the conditions are temporarily disturbed by efforts at control and along the border of the infested area where the insects are invading new territory.[1]

[1] This invasion of new territory probably involves but a narrow strip. In the case of the

This being the case it will be evident that the effective portion of the work of any introduced parasite lies within the fraction of one per cent. that would otherwise survive. It therefore follows that should an insect be introduced that would destroy fifty per cent. of the pest, more than forty-nine per cent. of this fifty per cent. is simply the destruction of individuals that would have died from other causes. The real question to be settled therefore becomes whether the new insect replaces a more or a less efficient cause of death. The apparent per cent. of efficiency is really no criterion whatever of the value of the introduction. That which we are desiring to secure is the reduction of the numbers especially during the period of injury, and therefore the only significant datum is the determination of the relative abundance maintained by the injurious species. The numbers of any particular parasite is not even a safe index of its rôle in the maintenance of this status, unless one were able to accurately weigh its efficiency as contrasted with that which it replaced.

All entomologists appreciate that natural enemies are largely if not the only controlling factors that maintain the present status of insect abundance, but do not so uniformly appreciate that the change of status though related is nevertheless essentially a different problem.

C. W. Woodworth
University of California

AN ASTRONOMICAL EXPEDITION TO ARGENTINA

The Department of Meridian Astrometry of the Carnegie Institution, in charge of Professor Lewis Boss of the Dudley Observatory at Albany, N. Y., where the work of the department is carried on, is dispatching an expedition to the Argentine Republic to establish a branch observatory there. This observatory will be established at San Luis about 500 miles west from Buenos Aires. This town of about 10,000 inhabitants is located near the eastern edge of the Andean plateau at an elevation of about 2,500 feet. It is reported to have a fine climate with remarkably clear skies.

The new observing station consists of the necessary observing structures, and temporary barracks for office rooms and quarters for the staff. The principal instrument will be the Olcott Meridian Circle of the Dudley Observatory. This instrument will be set up in its new location for the purpose of making reciprocal observations upon stars already observed at Albany, together with observations upon all stars from south declination to the south pole that are brighter than the seventh magnitude, or which are included in Lacaille's extensive survey of the southern stars made at the Cape of Good Hope in 1750. It is thought that this new scheme of making reciprocal observations on the same stars, with the same instrument, alternately used in the two hemispheres will present peculiar advantages in point of accuracy in the systematic sense. To reach this accuracy has long been the problem of fundamental work in astronomy. It is estimated that the work of observation in Argentina will last three or four years.

The object of these observations is to gather material for facilitating the construction of a general catalogue of about 25,000 stars, in which will be contained accurately computed positions and motions of all the stars included in it.

The department has already completed for publication a general catalogue of 6,188 stars, including all the most accurately ob-

boll weevil the extreme annual migration is about the width of two counties. The total extension of this insect into new territory only requires an average survival of about two per cent. in the outer two tiers of counties.

served stars and all from the North to the South pole of the heavens that are visible to the naked eye. This work has already resulted in interesting conclusions in reference to star-streams, the solar motion in space, and other stellar problems.

The preliminary expedition to establish the new observing station sailed from Brooklyn for Buenos Aires, August 20, on the steamship Velasquez. Accompanying Professor Boss, is Professor Richard H. Tucker, of the Lick Observatory, well known for his work in observation with the Meridian Circle of the Lick Observatory. He will superintend the construction of piers and buildings for the new observatory, and he will be placed in charge of the observations after the station shall be ready for operation. Mr. Varnum, for many years an assistant at the Dudley Observatory, is also a member of the party. Later on the remainder of the staff, which in all will consist of eight persons, will be sent to the new observatory when it shall be ready for work.

This undertaking has met with cordial recognition from Mr. Epifanio Protela, Argentine minister to the United States, and from other representatives of the Argentine Government, which in the most liberal and enlightened spirit has extended every assistance and courtesy.

SCIENTIFIC NOTES AND NEWS

Professor C. O. Whitman, head of the Department of Zoology in the University of Chicago, has resigned the directorship of the Marine Biological Laboratory, Wood's Hole, Mass., which he has held for the past twenty years. Professor Frank R. Lillie, of the University of Chicago, the assistant director, has been elected to the directorship.

At the meeting of the French Association for the Advancement of Science at Clermont Ferrand, the gold medal of the association was presented to Sir William Ramsay.

In connection with the Sheffield meeting of the British Medical Association, the faculty of science of the University of Sheffield has conferred honorary degrees as follows: President-elect, Professor Simeon Snell; Dr. Henry Davy, of Exeter, the outgoing president; Professor Bouchard, of the University of Paris; Professor John Chiene, professor of surgery at Edinburgh; Dr. Kingston Fowler, dean of the medical faculty of the University of London; Professor Fuchs, the Viennese ophthalmologist; Professor Lucas-Championnière; Dr. C. J. Martin, director of the Lister Institute; Professor John Murphy, of Chicago; Dr. Thomas Oliver, known for his work on dangerous trades; Mr. Edmund Owen; Sir Henry Swanzy, of Dublin; Professor Tillmanns, of Leipzig; and Dr. Dawson Williams, editor of *The British Medical Journal.*

The Journal of the American Medical Association states that a banquet in honor of the seventieth birthday anniversary of Gen. George M. Sternberg was given on June 8, when nearly 200 men celebrated in the annals of government, science and literature met to honor the former surgeon-general. The Hon. John W. Foster, formerly secretary of state, presided as toastmaster. A silver loving cup was presented to General Sternberg by those who attended the banquet, and a large American flag was given him by the attachés and patients of the Sternberg Sanitarium in Maryland.

M. Gaillot has been elected a corresponding member of the Paris Academy of Sciences in the section of astronomy, in the room of M. Trepiéd.

The president of the Republic of France has conferred upon Professor Wm. B. Alwood, of Charlottesville, Va., the Cross of Officier du Mèrite Agricole, and the Société Nationale d'Agriculture de France, has awarded him the silver medal and diploma of the society.

Dr. James A. Nelson, formerly honorary fellow in entomology and invertebrate zoology at Cornell University, has accepted an appointment with the Bureau of Entomology at Washington, D. C. Dr. Nelson who is a graduate of Kenyon College and received his

Ph.D. at the University of Pennsylvania, will be occupied with certain problems in insect embryology.

Dr. Gustav Melander succeeds Dr. Ernst Biese as director of the Finnish Central Meteorological Station.

Dr. F. Ristenpart, of Berlin, has been appointed director of the Observatory of Santiago de Chile, as successor to Dr. A. Obrecht.

We learn from *The Auk* that Mr. Robert Ridgway has returned from his trip to Costa Rica. Although his visit was not as prolonged as originally intended, Mr. Ridgway succeeded, with the cooperation of his friends, in collecting over 900 birds, besides other material. His collecting stations were chiefly Escasú, at the base of the Cerro de la Candelaria; Guayabo, at the eastern base of the Volcan Turrialba; also at an altitude of over 9,000 feet on the volcano itself; and at Bonilla, east of Guayabo.

The assistants of Professor Novarro, of Genoa, have decided to endow a prize to be called by his name and awarded for work in general pathology. Professor Novarro's election to the Italian senate was the occasion of the movement.

At the recent meeting of the British Medical Association the Stewart prize was awarded to Colonel Sir David Bruce, F.R.S., for his researches as to the origin and prevention of Mediterranean fever and the Middlemore prize to Profesor Simeon Snell for his contributions to the science of ophthalmology.

The death is announced of Edward Augustus Samuels, the author of an "Ornithology and Zoology of New England."

Sir Thomas Stevenson, senior scientific analyst to the home office of the British government, died on August 7, at the age of seventy years.

Prince Yamashima, who made valuable contributions to Japanese meteorology and seismology, has died at the age of thirty-one years.

The deaths are also announced of Professor J. V. Barbosa du Bocage, director of the Zoological Institute, at Lisbon, at the age of eighty-four years; of Dr. Hermann Karston, the botanist, at Berlin, at the age of ninety-two years, and of Professor Daguillon, assistant professor of botany at the Sorbonne.

The New York Academy of Medicine announces that the sum of $1,000 will be awarded to the best essay in competition on "The Etiology, Pathology and Treatment of the Diseases of the Kidney." Essays must be presented on or before October 1, 1909.

By the will of Mrs. A. L. R. Waldo-Sibthorp, bequests are made to the Royal Hospital for Incurables and the Charing Cross Hospital, respectively, of £20,000 and £10,000, and the residue of the estate, estimated at some £75,000, is bequeathed to the West End Hospital for Diseases of the Nervous System.

According to the *Journal of the American Medical Association*, the Swedish Medical Association is to celebrate its centennial next October, at Stockholm. A special committee is making great efforts to have a notable collection of historical medical portraits, medals, printed and manuscript works and an antique apothecary shop as features of the celebration. The committee includes some of the editors of *Hygiea*, the official organ of the Swedish Medical Association, which issues an appeal for all to bring forth their historical relics, etc.

The meeting of Imperial and Colonial Meteorologists has been postponed until next year at the time of the British Association for the Advancement of Science meeting in Winnipeg. The postponement is due to the fact that many English meteorologists whom it is desirable should attend, wish to be present at the Winnipeg meeting and do not care to visit Canada this year.

We learn from *The Observatory* that the commonwealth government of Australasia has taken over the meteorological services of all the Australian States.

The same journal states that efforts are being made to establish a solar observatory in Australia, and in particular at Adelaide. The Melbourne, Sydney and Perth Observatories are busy with the Astrographic Catalogue, so that three of the Australian colonies are scarcely in a position to undertake this new work; but South Australia is freer, and if it can establish a solar observatory, either at Adelaide or elswhere, a gap in longitude will be satisfactorily filled. The scheme is receiving substantial private support. In addition to the promise of a telescope (a 6-in. Grubb equatorial refractor) from the trustees of the estate of the late Lord Farnham, Dr. W. Geoffrey Duffield, of the Physical Laboratories, Manchester University, has received from Mr. Frank K. McClean the offer of £500 towards the purchase of a large spectroheliograph, on condition that an additional sum of £1000 be privately subscribed towards the same piece of apparatus.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Toronto is conducting a course in hygiene of twenty lectures. Dean Reeve of the medical faculty will take up the eye and ear; Dr. George R. McDonagh, the nose and throat; Dr. Charles Sheard, contagious and infectious diseases; Dr. Abbott, color blindness, and Dr. William Oldright, general sanitation.

Dr. Chas. C. Adams, of the University of Chicago, has been appointed associate in animal ecology at the University of Illinois.

In the faculty of engineering at University College, London, a new lectureship in electrical design has been instituted, to which Mr. Henry Metcalf Hobart has been appointed.

Mr. W. Jackson Pope, F.R.S., professor of chemistry in the University of Manchester, has been elected into the professorship of chemistry, at Cambridge, rendered vacant by the resignation of Professor G. D. Liveing, who has held the chair since 1861. Mr. Pope, who was born in London in 1870, was educated at Finsbury Technical College and the Central Technical College, London. Before going to Manchester he was head of the chemistry department of the Goldsmiths' Institute, London.

Dr. Hans Speman, of the University of Würzburg, has been appointed professor of zoology at the University of Rostock.

DISCUSSION AND CORRESPONDENCE

THE CHEMICAL FORMULA OF THE MINERAL BENITOITE

In a recent issue of Science (May 1, 1908) Mr. Edward H. Kraus discusses the recently described mineral benitoite, and suggests a formula which differs somewhat from the one proposed by Professor Louderback in his original paper. The two analyses already reported, and a third which will be published shortly, all show that the empirical formula of the mineral is $BaTiSi_3O_9$ and the most reasonable assumption is that it is made up of the three oxides BaO, TiO_2 and SiO_2. Mr. Louderback's proposal is that the mineral is a very acid titano-silicate of barium, whereas Mr. Kraus suggests that the titanium here plays the part of a base and that therefore the mineral is a double metasilicate of barium and titanium. Though it must be admitted that absolute proof of the correctness of either of these two suggestions is at present scarcely possible it seems to me that the arguments advanced by Mr. Kraus are entirely unsatisfactory and I submit the following objections.

The main argument upon which Mr. Kraus bases his formula is the alleged isomorphism of benitoite with beryl, which mineral is usually regarded as a salt of metasilicic acid. If the most favorable values are chosen the ratios of the *a* axis to the *c* axis for the two minerals are 1.4989 and 1.4230, respectively. These figures show an actual difference of more than sixteen per cent. of the magnitude concerned, and even interpreting the law of isomorphism with that degree of looseness which is not uncommon among mineralogists, furnish no evidence upon which to base conclusions as to the molecular structure of the two compounds. The two minerals also differ widely as to form and habit; one is trigonal and the other holohedral. Further, many of the illustrations which Mr. Kraus cites as examples of isomorphism are open to serious question; galena and argentite most certainly can not be called isomorphous merely because they both crystallize in cubes.

The occurrence of benitoite in rock formations which are of a basic character, upon which Mr. Kraus bases a second argument, is to my mind of no significance. The benitoite and the natrolite matrix in which it occurs are clearly secondary and must have been formed from percolating solutions. Even if it be assumed that these solutions were also basic it by no means follows that the titanium which they contained would take the part of a base, on the contrary it is more probable that it would take the part of an acid. Associated with the benitoite are two other titanium-containing minerals, namely, titanite and a mineral to which the name carlosite was given, but which we have since shown to be identical with neptunite. All three minerals are found in the natrolite matrix and appear to have been formed contemporaneously. There is good reason for supposing that titanium takes the part of a base in both titanite and neptunite and it is not probable that a third mineral formed under similar conditions would differ in this respect.

There is on the contrary much to be said in favor of the formula suggested by Mr. Louderback. The properties of the element titanium, when in this degree of oxidation, are clearly those of a very weak acid. The entire lack of a definite compound of titanium and silicon, in view of the frequent occurrence of both oxides in the same formation, is striking. If benitoite is a double metasilicate of barium and titanium it is most remarkable that the proper conditions for the formation of both its constituent single salts have nowhere prevailed.

A cursory examination of the literature shows that many of the compounds in which titanium is supposed to take the part of a base have not been isolated in pure form, nor has their structural formula been satisfactorily determined. They are in all probability analogous to certain complex acids, such as those which phosphoric acid forms with the acids of the chromium group of elements rather than to simple salts.

Titanium is more closely related to silicon than to the more basic zirconium. Like the former element it shows a decided tendency to combine with itself and form complex molecules, and the substitution of one element for the other in such a chain would not seem unreasonable. Further, there is nothing unreasonable in the formation of compounds containing such a relatively large percentage of acidic elements if the acidic elements represented are very weak in their properties and the basic elements are very strong in theirs; the compound borax furnishes a good illustration.

W. C. Blasdale
Department of Chemistry,
University of California

APPOINTMENTS IN AMERICAN UNIVERSITIES

To the Editor of Science: As a Scot, called some years ago to teach in an American university, I am much interested in Dr. S. J. Meltzer's communication, printed in Science of August 7, especially as two of the gentlemen to whom he refers are countrymen of my own. However, my purpose is not to traverse his protest, which seems to me well taken. Dr. Meltzer's letter involves a much larger question. I think that those of us who have to make recommendations for vacancies must have felt often that here, at least, we stand badly in need of a clearing-house. Why should not each great department of inquiry have its own bureau of information, to bring men and places together? Our present methods are largely haphazard, especially with reference to the less important appointments, whence the more important must be filled some day. One hears of vacancies after they have been settled; and one's knowledge of available appointees, especially of the younger men, is far from complete. Here is an opportunity for Science and similar publications to ventilate a need, with a view to common action.

R. M. Wenley
University of Michigan

SCIENTIFIC BOOKS

Musée Ostéologique. Étude de la Faune Quaternaire. Ostéométrie des Mammifères. Par Edmond Hue Médecin Vétérinaire, Membre de la Société Préhistorique de France. Album de 186 planches contenant 2,187 figures. Premier Fascicule, pp. vi + 50, pl. 93. Deuxième Fascicule, pl.

94–186. Royal 8vo. Schleicher Frères, Éditeurs. Paris. 1907.

The existence in Europe of hundreds of Quaternary and prehistoric stations yielding copious remains of men and animals occasions the desire on the part of the archeologist to study for himself the bones which he may have exhumed from grotto or lake dwelling. Hitherto, in order to identify these remains he has had to take them to some museum having a large osteological collection, or to search through the literature for illustrations of particular groups, or to have recourse to the general works of Cuvier and of DeBlainville, which are not always accessible and which were designed rather for the morphologist than for the archeologist.

To facilitate the identification of such collections M. Hue has placed in the hands of the student this veritable "Musée Ostéologique" containing no less than 2,187 original figures of mammalian bones. The drawings have been very skillfully and accurately made from nature by the author himself, the mechanical form and the arrangement of the book are excellent, and the price (24 fr.) is moderate. Forty-one recent mammals are represented, including the principal types whose ancestors are found in the Quaternary of Europe. The work is divided into three parts. Part I. treats of osteometrical methods, Part II. figures the cranium and dentition, Part III. the limb bones.

In Part I. the author endeavors to put the osteometry of the mammalia upon a practical basis. Hitherto, he thinks, the measurements given in different works upon Quaternary mammals are too frequently unsatisfactory because each author has followed his own system of measurements. Owing to the fragmentary character of most Quaternary crania and limb bones, the important longitudinal and transverse diameters are often unattainable, and the effective comparison of any two similar fragments is limited by the number of exactly corresponding measurements given. Hence the justification for multiplying measurements and for the present effort to standardize the mensuration of the mammalian skeleton in general.

For this purpose the well-established measurements and ratios of physical anthropology are not sufficient. Measurements and ratios applicable to all mammals are needed, and, by reason of the divergence in type, additional standard measurements for each order.

Selecting the skull and lower jaws of the dog as a representative mammal, the author establishes, defines and illustrates (Pl. 1–7) a long series of paired points, between which measurements may be taken in normal mammalian skulls.

The author then takes up the different orders in turn and establishes similar paired points, which are especially characteristic in the Carnivora, Rodents, Ruminants, Equidæ and Suidæ. Standard measurements for the dental system are then established and the subject of cranial indices is discussed and illustrated. The mensuration of the limb bones and vertebræ is similarly treated (pp. 28–50, pl. 8–21).

In the third part (pl. 79–186) the limb bones are figured in the same systematic manner, the Ruminants again being very fully represented. As all the drawings of each part, *e. g.*, the humerus, are brought together, one can very quickly identify a specimen by glancing over a few plates. On the other hand, one can readily follow up the osteology of a single form by consulting the alphabetical table of species. The smaller crania and practically all the teeth are represented as of the natural size, the larger objects are always given in some convenient scale and centimeter scales are given in many of the plates.

The reviewer has gone over the plates with some care, but has not noticed any material errors, though it can scarcely be hoped that none are there. On the contrary, the many admirable features of the work become very apparent. For instance, the roots as well as the crowns of the teeth are represented, a feature more or less neglected even in the best odontographies. The grouping of the same part in different animals, and the representation of each object in orthogonal projection, bring out the underlying family resemblances and differences, accentuating diagnostic characters which would not be noticed ordinarily except through long familiarity with the bones themselves.

M. Hue's drawings serve to emphasize the fact that the text-books of osteology and mammalogy have failed to make the most of the characters offered by the scapula, humerus, femur and other limb bones, although such characters are very important to the fossil bone hunter in the field, and also sometimes give indications of affinity between two forms whose skulls and dentition have become widely divergent. In this connection, in view of the sharp ordinal and family differences in the tarsus and especially the astragalus, it is rather curious that the author devotes so many plates to the tibia and fibula, which are usually less clearly distinctive, and yet only figures the tarsus of two forms, the dog and the reindeer.

In conclusion, M. Hue may be assured that his work will be of use not only to the archeologist, but also, and to a considerable degree, to the student of mammalian osteology. The work, of course, covers only a rather limited fauna, but its method and example are alike valuable. It would greatly widen the general intelligibility of osteology if the skeletal parts of all the more important genera of mammals, both living and fossil, could be represented in plates similar to those of M. Hue, but arranged historically, *i. e.,* according to the best views of their evolutional sequence. This would naturally be a large undertaking, but no bigger for the twentieth century than DeBlainville's Osteographie was for the first half of the nineteenth century.

William K. Gregory

Essai sur la Valeur Antitoxique de l'Aliment Complet et Incomplet. By A. LeRenard. Paris, J. Mersch. 1907. 8vo; pp. 211.

It is seldom that a work appears which has more interest for general physiology than the present one. Starting with a study of the toxic action of copper salts upon *Penicillium glaucum,* the author has incepted a series of illuminating experiments upon the ability of the different essential nutrient elements to function as antitoxic agents. The action of the various salts and ions was tested in all combinations possible, always in the presence of a suitable source of carbon.

While the idea of an antidoting action between elements is not new, it has never before been so extensively investigated as an antagonistic relation between foods and poisons.

The author presents a lengthy review of literature upon the general subject of toxicity and antidoting action, but unfortunately devotes little attention to the work which has been done since 1900. It is to be especially regretted that the discussion does not include the investigations upon the antidoting action of physiologically balanced solutions by Loew, Loeb, Osterhout, Duggar, Benecke and others.

The chapter on the general biology and physiology of *Penicillium glaucum* gathers up and coordinates much of the modern and early work upon this classical and oft-investigated fungus. The chapter upon the physiological rôle of the essential nutrients seems conspicuously brief in comparison with the treatment accorded other subjects of like importance. Nitrogen, potassium and phosphorus receive a brief elementary treatment; the other mineral elements are very briefly dismissed.

The author's extended discussion of the nature of toxicity contains numerous points of special interest for the student of physiology, a few of which deserve mention in passing. He emphasizes the necessity for distinguishing between injurious effects due to the osmotic strength of the solution and those actually due to poisons, especially since the former may be brought about by non-toxic substances.

Following the classification of Chassevant and Richet, which distinguishes between antigenetic and antibiotic concentrations of the toxic agent, LeRenard distinguishes the antiauxic and antibiotic concentrations of copper for *Penicillium glaucum.* The antiauxic concentration is defined as the one which allows the fungus spore to germinate and produce some sort of a germ tube, but does not allow the development of the same into a thallus. It is admitted that antiauxic effects may also be produced by a paucity of nutrients. By diminishing the amount of poison, a sufficiently weak concentration is finally reached which will allow the fungus thallus to make a good growth, but prevent it from forming organs of fructification; this is the antigenetic concentration. The antibiotic concentration is one sufficient to kill an adolescent thallus; however, two sorts of antibiotic effects are exhibited by thallophytes when acted upon by poisons. (1) Before reaching the fatal concentration, a point is found at which the plant ceases to grow. This point is designated the partial antibiotic concentration, and may be represented by an action analogous to that of ether or chloroform, which deadens or suppresses some of the functions. (2) The total antibiotic concentration causes a sudden and complete termination of the vital functions.

In estimating the effect of toxic solutions in his investigation, LeRenard made use of a new standard. On account of the very dilute solutions sometimes used, the fungus could make but little growth and the usual criterion of dry weight was inapplicable. He, therefore, determined what was practically the antiauxic concentration in each case. This was determined by ascertaining the point at which the majority of spores became vacuolate, transparent, and with some swelling assumed a spherical or elliptical form, *i. e., utricular germination.* Such a spore, if transferred to a nutrient solution, will germinate and develop a normal thallus; but left in the antiauxic solution, it develops no further than the germ-tube stage.

The complete nutrient solution used contained $C_6H_{12}O_6+NH_4NO_3+MgSO_4+KH_2PO_4+H_2O$. The experiments consisted in determining the maximum concentrations of four salts of copper (the acetate, chloride, nitrate and sulphate) which would allow the utricular germination in the presence of a complete or incomplete nutrient. The results obtained may be briefly summarized as follows:

Neither single mineral salts in solution weaker than the normal, nor organic compounds containing no acid or metal radicals, have any antitoxic value against copper salts for *Penicillium glaucum;* but the salts of K, Mg, NH_4, or organic acids which contain in their structure the groups CH_3, CH_2, or CH singly joined to a functional acid group possess an antitoxic value.

The bases combined with active organic acids determine the relative antitoxic value of the salts of these acids.

The amine group NH_2 destroys the antitoxic value of CH_2. The imide function, OCN, is more or less indifferent. The nitrile group, CN, is distinctly toxic. The organic combinations of C and of N taken singly are therefore inactive.

Carbohydrates, when added to an appropriate mineral salt, exhibit an antitoxic value, which for a constant quantity of appropriate salt vanishes at about the centinormal concentration with aldoses; but goes somewhat higher for ketoses and complex hexoses. The aldehyde and ketone functions play, therefore, a very important function in the antitoxic action of these bodies. The position of the hydroxyl groups in the carbohydrates has very little influence upon the antitoxic value.

The appearance of antitoxic action is dependent upon the simultaneous presence of a combined carbon compound, and of a suitable mineral salt forming an organo-metallic compound, which recalls by its formation and modifications the side-chain of Ehrlich.

The antitoxic value of the carbon group in a mixture varies with the quantity of metal or of mineral salt united to this carbon group.

The dissociation of the mineral salts induces a sudden decrease in their antitoxic value, and the molecules of the useful salts (organic or inorganic combined with carbon compounds) generally appear more active than the ions for the K and Mg salts and also for certain salts of NH_4. The effect of the ions is generally independent of their quantity. Sometimes their effect diminishes proportionally to their quantity, but generally there must be a material diminution in quantity before any effect can be noticed.

Certain salts exhibit specific properties. The antitoxic value of the NO_3 ions becomes zero when the total quantity of NO_3 in solution becomes equal to or less than 0.000352 per cent. SO_4 shows the same phenomenon when the quantity becomes 0.000096 per cent. In the presence of an excess of K, the ions

NO_3 and SO_4 are only active when the former occurs in the ratio of 10:1 of K, and when the latter is present as 200:1 of K. The influence of molecules and ions is zero when phosphates are used.

Magnesium salts possess a greater antitoxic value than the corresponding potassium or ammonium salts. Mixing a small quantity of $(CHOO)_2Mg$ with twice the quantity of CHOOK does not modify the antitoxic value of the former in the presence of copper acetate, but with the other salts of copper its value is increased. The addition of ammonium or potassium salts to a solution of the corresponding magnesium salt decreases but does not increase the antitoxic value of the latter. The mixture of corresponding salts of potassium and ammonium, however, increases slightly their antitoxic value in the presence of some copper salts, but not for others.

A part of the antitoxic activity of mineral salts is due to the acid radicals, the NO_3 radical being the one which is most active. Therefore the inorganic salt possessing the most antitoxic activity is $Mg(NO_3)_2$.

By mixing a small quantity of $(NH_4)_2SO_4$ with twice the amount of CHOOK, the antitoxic value of the former is not modified, except in presence of copper acetate, where the antitoxic value is slightly increased. The K ions appear to decrease the antitoxic value of the $(NH_4)_2SO_4$ molecules. When $(CHOO)_2Mg$ molecules are added to $(NH_4)_2SO_4$ the antitoxic value of the Mg molecules decreases. The mixing of a small quantity of NH_4NO_3 molecules with an equal quantity of CHOOK increases their antitoxic value. The K ions are depressing when they are present in large amounts, but have the same action as CHOOK when they are present in small numbers. When NH_4NO_3 is added to less than half the same amount of $(CHOO)_2Mg$, the first salt exerts a depressing action upon the second.

The addition of a small amount of CHOOK to less than half the same quantity of $Mg(NO_3)_2$ diminishes the antitoxic value of the latter except with the copper acetate, where it is increased. The addition of CHOOK to $S+NH_4+Mg$ or to $P+NH_4+Mg$ raises the antitoxic value of these combinations.

When a small quantity of $MgSO_4$ is added to twice as much NH_4NO_3 the antitoxic value of the mixture is greater than that of the NH_4NO_3 alone, but is greater, equal or less than that of the $MgSO_4$ with different salts of copper. The addition of CHOOK to the mixture is without action upon the antitoxic value, except with $CuCl_2$, where it is lower.

The mixture of a small amount of $NH_4H_2PO_4$ with a smaller amount of $Mg(NO_3)_2$ diminishes considerably the value of the latter. The addition of CHOOK to the two salts raises their antitoxic value.

Mixing a small amount of $Mg(NO_3)_2$ with twice the amount of $NH_4H_2PO_4$ and an equal amount of K_2SO_4 represents a complete mineral nutrient and the maximum of resistance to poison.

The author's conclusions are sustained by a large mass of experimental data which will repay careful reading and constitute an important addition to our knowledge of the relations between poisons and foods.

Howard S. Reed
Department of Agriculture,
Washington, D. C.

Kurzes Lehrbuch der Organischen Chemie. By Dr. W. A. Noyes. Translation into the German by W. Ostwald. Pp. 722. Akademische Verlagsgesellschaft, 1907.

It has seldom happened that an English text in organic chemistry has been translated into the German, inasmuch as organic chemistry is essentially a German science, and practically all of our texts have come from that country. That W. A. Noyes's book has been translated into the German augurs well for organic chemistry in our own country. Especially does this seem true when it is noted that the translator is no other than Walter Ostwald, of Leipzig. The translation is remarkable. The translator has given a faithful representation of the original text, at the same time he has completely eliminated that stiffness so characteristic in translations of this kind.

Geo. B. Frankforter

SCIENTIFIC JOURNALS AND ARTICLES

The American Journal of Science, for August, contains the following articles:

E. T. Allen and J. K. Clement: "Rôle of Water in Tremolite and Other Minerals."

G. C. Ashman: "Quantitative Determination of the Radium Emanation in the Atmosphere."

R. W. Langley: "Determination of Small Amounts of Barium in Rocks."

W. G. Mixter: "Heat of Combination of Acidic Oxides with Sodium Oxide and Heat of Oxidation of Chromium."

I. K. Phelps and L. H. Weed: "Concerning Certain Organic Acids and Acid Anhydrides as Standards in Alkalimetry and Acidimetry."

I. K. Phelps and L. H. Weed: "Comparison between Succinic Acid, Arsenious Oxide and Silver Chloride as Standards in Iodimetry, Acidimetry and Alkalimetry."

W. E. Ford and E. W. Tillotson, Jr.: "Orthoclase Twins of Unusual Habit."

J. V. Lewis: "Palisade Diabase of New Jersey."

F. B. Loomis: "New Horse from the Lower Miocene."

The contents of *The Auk,* for July, are as follows:

E. S. Cameron: "Observations on the Golden Eagle in Montana."

J. H. Riley: "Notes on the Broad-winged Hawks of the West Indies, with Description of a New Form."

Richard C. Harlow: "Recent Notes on Birds of Eastern Pennsylvania."

C. J. Pennock: "Birds of Delaware—Additional Notes."

J. A. Allen: "The Case of *STRIX* vs. *ALUCO*."

Edward J. Court: "Treganza Blue Heron."

Francis H. Allen: "Larus kumlieni and other Northern Gulls in the Neighborhood of Boston."

J. A. Allen: "*Columbina* versus *Chæmepelia*."

James H. Fleming: "The Destruction of Whistling Swans (*Olor columbianus*) at Niagara Falls."

Austin Hobart Clark: "The Macaw of Dominica."

TYPES OF AMERICAN GRASSES

Under this title, Mr. A. S. Hitchcock has recently published in "Contributions from the U. S. National Herbarium," Vol. 12, Pt. 3, the results of his studies of the types of American grasses described by Linnæus, Gronovius, Sloane, Swartz and Michaux. These studies were made by Mr. Hitchcock in the spring of 1907, at which time he made a detailed examination of American grasses preserved in the larger herbaria of Europe.

The contribution is a noteworthy one and will go far toward fixing names for the American grasses discussed, not alone specifically, but probably in some cases generically as well. The preservation of grass specimens is in most cases satisfactory as they are little subject to insect depredation. In a large majority of instances, Mr. Hitchcock found the type specimen readily and certainly identifiable; in some instances where the author had confused two or more species under one, he was obliged to consider each case upon its merits, and he has presented the evidence on which the type specimen was selected by him. In a few of these cases there is opportunity for difference of opinion, but it seems to the writer that Mr. Hitchcock's decision in such cases should be accepted without further question in all instances in which he has first designated the type.

There are a few species which require transposition of names, as for example, *Cenchrus tribuloides* L., the type of which proves to be the same as *C. macrocephalus* (Doell) Scribn.; the plant which has mostly been known under the name *tribuloides* should bear the name *C. carolinianus* Walter; the study brings out a number of cases in which priority requires the acceptance of earlier published names than those in current use.

It has been perhaps widely assumed that most of the species of the older authors were more comprehensive in including slightly different races than those of recent writers. In some instances this is doubtless true, but in many others the species conception was apparently broad only because the describer had but a single specimen, or at best but few to base an opinion upon. Linnæus proposed some species on specimens which have been regarded by some modern authors as belonging to the same species, the differences being so slight, while on the other hand he sometimes included widely different species in a single one; as a matter of fact, the lines of demarkation between species have usually been matters of opinion and judgment, and we have had and presumably always shall have, authors who will take broad or narrow views. This being the case, the necessity of determining in some way the absolute types of species is becoming more and more apparent, and such a work as the one now reviewed is a valuable contribution to taxonomic literature.

The type specimens of some species could not be found by Mr. Hitchcock, and presumably some of these have been lost; in such instances he has been obliged to base his conclusions upon the original descriptions; three of the species described by Swartz are those apparently preserved without types. If, in such cases we could be sure that the types do not exist, it seems to the writer that it would be advantageous to designate some other specimen as an artificial type, taking all possible care to select such a specimen from the characters assigned in the original description, and from as near the type locality as possible.

A list of new names and those replacing names in current use is appended.

N. L. Britton

DR. JOHN B. TRASK, A PIONEER OF SCIENCE ON THE WEST COAST

Dr. John Boardman Trask, who came to California in 1850, was born in Roxbury, Mass., in 1824. He died in San Francisco, July 3, 1879. His death was a public loss and was so regarded by all who were familiar with his career and varied services to the commonwealth and the community in which he lived.

Following the close of his connection with the United States and Mexican Boundary Survey, he became the first state geologist of California and was one of the illustrious eight who founded the California Academy of Sciences.

Two years and more have passed since the fine building, the home of the academy, the gift of James Lick, was destroyed by fire and earthquake. In considering that memorable event with its various tragic incidents and the loss of the library and collections, there arise from the ruins remembrances of other and earlier days, recollections of that little coterie of eight men who came together on the sixteenth of May, 1853, and organized the first society of natural history west of the Mississippi River—an event in its way equally noteworthy, though lacking the spectacular elements of the April disaster.

Soon after my arrival in California in June, 1858, I became acquainted with most of these pioneers in science, and with some of the earlier recruits who joined the little squad of charter members. Of these latter and their associates[1] it may be said, without injustice to any, that Dr. Trask, by virtue of his genial qualities, untiring energy and all-around ability, was the leader, closely followed by Dr. Albert Kellogg, of precious memory, who in the new environment of his adopted state reveled amid the multifold glories of field and forest and lived, as it were, in a botanical paradise.[2]

That these men and their fellows were regarded in those strenuous hurly-burly days of the "gold fever," as akin to cranks, pottering with their shells, and bugs, and posies, was not an unnatural thought to the average man, hustling for the "almighty dollar" or rather for the "golden nugget." However

[1] Dr. William P. Gibbons, one of the founders, described several species of fishes. Among the very earliest members were Dr. H. H. Behr, entomologist and writer on the Lepidoptera, etc.; Dr. W. O. Ayres, ichthyologist; Hiram G. Bloomer, botanist, and Col. Leander Ransom and Dr. Arthur B. Stout.

[2] Whoever has read Dr. Kellogg's "Forest Trees of California," published in the Second Annual Report of the State Mineralogist of California, 1880–2, will readily admit the propriety of these words. The plants described by him number over 300. A complete list carefully sought from all sources was published by the Academy in 1885 in the form of a Bulletin. Dr. Kellogg died on the 31st of March, 1887, and was buried in Mountain View cemetery near Oakland.

eccentric, time and place considered, they kept "the noiseless tenor of their way," led by the spirit that inspired and possessed them, and builded better than they knew, doubtless, not better than at times they hoped. As Dr. Kellogg was the first resident Californian to describe the botanical forms of the state, so Dr. Trask was the first to describe the recent and fossil shells, as may be seen by reference to the first volume of the *Academy's Proceedings* in 1855–6, which includes the following: *Anodonta Randalli* = *A. angulata* Lea, *Anodonta*[3] *triangularis* = *A. Nuttalliana* Lea, *Anodonta rotundovata* = *A. Wahlametensis* Lea, from the Sacramento River and lagoons, and *Alasmodon Yubaensis* = *Margaritana margaritifera* Linnæus, *var. falcata* Gould, from the Yuba River.

In the same volume certain fossil mollusks are described as follows: *Ammonites Batesii* from Arbuckles Diggings, Shasta County; *Chemnitzia papillosa, Tornatella elliptica, Murex fragilis* and *Fusus Barbarensis,* all from Santa Barbara; *Fusus robustus* and *F. rugosus* from San Pedro, *Ammonites Chicoensis* and *Baculites Chicoensis,* both from Chico Creek, and subsequently the following: *Plagiostoma*[4] *Pedroana, P. annulatus* and *P. truncata* from San Pedro, Calif.

His last paper, "On Nine New Species of Zoophytes from the Bay of San Francisco and adjoining localities," was published in the Academy's Proceedings, March 30, 1857. It described the following: *Sertularia anguina, S. furcata, S. turgida, Plumularia Franciscana, Crisidia gracilis, Crisea occidentalis, Menipea occidentalis, Scrupocellaria Californica,* and *Hippothea amabilis.*

By resolution of the State Senate of California, passed March 26, 1853, Dr. Trask was called upon "for such information as he may possess relative to the Geology[5] of California and productive resources of the state." This report, of which only 2,000 copies were printed, is entitled:

1. "Report of 1853, Geology of the Sierra Nevada or California Range," by John B. Trask, Sacramento, 1853, 31 pp. It contains a sketch of the geology and mineral resources of the eastern valleys of the Sacramento and San Joaquin, and to the coast line within 41st and 42d degrees of north latitude, from personal observations made during the years 1850–52. Reviewed *Mining Mag.,* 1853, vol. 1, pp. 6–23.

2. "Report on the Geology of the Coast Mountains, Embracing their Agricultural Resources and Mineral Productions," also portion of the Middle and Northern Mining Districts, by Dr. John B. Trask, state geologist, Senate Doc. No. 14, Sacramento, 1855, 95 pp. This report contains a description of the physical geography of the Coast Mountains; Geology of the Coast Mountains; Tertiary rocks of the Coast Mountains; Primitive rocks of the Coast Mountains; Volcanic rocks of the Coast Mountains; Geology of the San Bernardino Mountains; Stratified rocks of the San Bernardino chain of Los Angeles; Artesian borings; Soil and productions of Los Angeles; Mineral productions of Los Angeles; Country north of the American River; Mineral district of the Upper Sacramento Valley. Geology of the northern mountains; Local geology of the Northern Coast Mountains; Carboniferous limestone of the eastern part of Shasta County; Trinity County; Structure of the Sacramento Valley; Tertiary rocks and other deposits of the Sierra Nevada; Placer Mining; Quartz veins; Quartz mines, with description of the mines and statistics.

3. "Report on the Geology of the Coast Mountains and Part of the Sierra Nevada,

[3] These and the two following have been regarded for the last twenty-five years by the principal conchologists of the west coast as mutations of *A. Nuttalliana.*

[4] See Dr. W. H. Dall's comments on the Pectens of the West Coast in *Transactions Wagner Free Institute,* Vol. III., Part IV., p. 705, April, 1898, and "The Tertiary and Quaternary Pectens of California," by Dr. Ralph Arnold, U. S. Geological Survey, Professional Paper, No. 47, p. 90, Washington, 1906.

[5] Of the value of Dr. Trask's geological work I am not competent to express an opinion; it should, in common fairness, be judged by the standard of his day, rather than of the present time.

Embracing their Industrial Resources in Agriculture and Mining," by John B. Trask, state geologist, Assembly Doc. No. 9, 1854, 92 pp. Contains a description of the Geology of the Monte Diablo range; Salinas Valley, from Point Pinos to the Nacimiento River; Santa Cruz Mountains; Structure of the valleys of the Sacramento and San Joaquin; Review of the geological changes in the Coast Mountains and Monte Diablo ranges; Classification of the rocks of the Coast Mountains and Monte Diablo ranges; Position and relation of the volcanic rocks of the Tertiaries; Volcanic rocks preceding the Tertiary era; Most recent volcanic rocks of the Coast Mountains; Changes of level and river terraces; Soils of the Santa Clara valley and shores of the Bay of San Francisco; Valley of the Salinas; Soils of the Salinas, Pajaro Valley, Livermore Valley; Mineral resources of the Coast Mountains; Mineral districts, embracing parts of the counties of Nevada, Placer, El Dorado and Calaveras; Quartz veins and their relative age in California; Character and position of the older veins below the surface; Present government of metallic veins; Description of the mines, with a list of gold mines.

4. "Report on the Geology of Northern and Southern California, Embracing the Mineral and Agricultural Resources of those Sections, with Statistics of the Northern, Southern and Middle Mines," by Dr. John B. Trask, Assembly Doc. No. 14, Session of 1856, 66 pp. Contains a description of the physical geography of the Coast Mountains, lying north of the Bay of San Francisco; Geological structure of the Coast Mountains; Mineral character of the primitive rocks of the Coast Mountains; Soils of Petaluma County; Plains west of the Sacramento River; San Bernardino; Geology of Table Mountain, Tuolumne County; Carboniferous rocks of the northern district; Salines of the Upper Sacramento Valley; Description of mines, etc.; Analyses of saline waters from Lick Springs, Shasta County; Gold mines in operation in 1855; Table of altitudes.

5. "Report on the Geology of the Sierra or California Ranges," by John B. Trask; *Pharmaceutical Journal*, vol. 14, 1855, pp. 20–24.

His numerous papers on earthquakes in California from 1812 to 1865 need only to be mentioned here.[6] These have been listed by General Vogdes[7] as well as Dr. Trask's other papers. This list of titles I have quoted *in extenso* from the General's paper.

Dr. Trask's medical education, we learn from Dr. Kellogg, was broadly thorough. He successfully passed examinations in geology, mineralogy, technical and applied chemistry, proximate and ultimate analysis, microscopy, medical botany, surgery, theory and practise of medicine, and cognate sciences, completing the course of lectures required for the certificate of the Yale faculty, according to the laws of Connecticut. That he profited by and made good use of these studies is evident from his performance and the honorable recognition he received from various European and American learned bodies and honorary degrees from abroad for his researches in organic chemistry, mineralogy, microscopy and medical botany.

The following species of Californian mollusks, recent and fossil, have been named in his honor: (1) *Limnœa Traskii* Tryon; (2) *Helix* (*Epiphragmophora*) *Traskii* Newcomb; (3) *Actæon Traskii* Stearns; (4) *Meretrix Traskii* Conrad; (5) *Ammonites Traski* Gabb; (6) *Carbula Traski* Gabb; (7) *Nucula Traskana* Meek; (8) *Patella Traski* Gabb; (9) *Pecten Traski* Gabb.

[6] Dr. Trask's data are practically embodied in Dr. E. S. Holden's "Catalogue of Earthquakes on the Pacific Coast, 1769 to 1897," *Smithsonian Miss. Coll.*, 1087, Washington, D. C., 1898.

[7] "A Bibliographical Sketch of Doctor John B. Trask," etc., by Anthony W. Vodges, with portrait, pp. 27–30, *Trans. San Diego Society of Natural History*, Vol. I., No. 2, 1907. See, also, *Proc. Calif. Acad. Sciences*, Vols. I., II., III., and "Catalogue California Fossils," compiled by J. G. Cooper, M.D., in Seventh Annual Report of State Mineralogist, Sacramento, State Printing Office, 1888. "Remarks of Dr. A. Kellogg on the late Dr. John B. Trask before the California Academy of Sciences, July 21, 1879."

Numbers 2 and 3 are living and Quaternary, and 5–9, inclusive, are Cretaceous (and Eocene) of Cooper's Catalogue.

Through him the medical profession of the west coast was first made acquainted with the mode of preparation and therapeutic effects of Mentel's aluminated solution, Pravoy's solution of perchloride of iron, Monrel's salt and the syrup of superphosphate of iron and its combinations; liquid propylamin, an antidote for rheumatism of the acute type, liquid rennet or pepsin wine for gastralgia, etc., and other valuable medicaments.

Among the plants, the virtues of which he either discovered or made known to the profession were yerba santa (*Eriodictyon*), for rheumatism, gout, etc.; *Damiana*, a nerve tonic and aphrodisiac; *Grindelia robusta* for oak or rhus poisoning and asthma, in certain cases; yarrow (*Achillea millifolium*), which he proved to be an efficient emmenagogue; canchelagua (*Erythræa*, of the West Coast), a bitter tonic and antifebrile; *Aspidium argutum* root (kidney fern), as an antidote for the tapeworm; manzanita leaves (*Arctostaphylos*) as an antilithic kidney and bladder tonic; and tincture of *Kalmia latifolia* as an extraordinary sedative, etc.

In 1858, when I made his acquaintance, he commenced the publication, in conjunction with Dr. David Wooster, of the *Pacific Medical and Surgical Journal*, which, after many years of conscientious and laborious editorial work, passed out of his hands into the charge of other members of the profession.

In the great struggle of the civil war for the preservation of the union, he followed the flag as assistant surgeon of volunteers. As a physician he was skillful, quick and accurate in diagnosis, prompt and resourceful in practise, quite free from the acquisitive instinct, and like his Oakland friend, Dr. Newcomb,[8] and his old-time friend and collaborator in the academy, Dr. Kellogg, from whom I have largely quoted, "earnest and generous hearted, ever ready to serve those who needed his services without money and without price, and ever ready to lend a helping hand or do a kindly deed."

I knew them well and I could relate many incidents of my own knowledge, illustrative of their goodness and benevolence. In the twilight of old age, looking back to those days of frequent and sympathetic contact, brought together as we were by similarity of tastes and habits of thought, memory recalls their generous natures and sterling qualities, and inspires the hope that these men may not be altogether forgotten.

Robert E. C. Stearns

Los Angeles, Cal.

[8] Dr. Wesley Newcomb, born in the state of New York in 1808. He made Oakland his home in 1858, where he resided for about ten years. He is well known by his conchological writings, especially on the land shells (Achatinellidæ) of the Hawaiian Islands, where he practised medicine for five years. He died in Ithaca, N. Y., on January 26, 1892. See *The Nautilus*, Philadelphia, March, 1902.

SPECIAL ARTICLES

THE GRADING OF STUDENTS

The problem of how students should be graded in order to make the results of grading equitable is of interest to the psychologist both as a theoretical and as a practical problem. Its practical aspect must be of the greatest importance to any teacher in any subject, in school or college. Professor W. S. Hall[1] published a paper on this subject a few years ago, the conclusion of which is that average classes of students, doing honest work and marked equitably, will yield results which when tabulated should conform to the binomial curve, *i. e.*, the number receiving medium marks should far exceed the number receiving high or low marks. The solution of the problem, then, consists merely in the fulfilment of two conditions, honesty on the part of the student and equity on the part of the instructor when applying the marks agreed upon by the faculty. Actually, however, the problem is still far from its solution.

[1] "A Guide to the Equitable Grading of Students," *School Science and Mathematics*, Smith & Turton, Chicago.

Professor Hall uses the marks AAA, AA, A, BB, B, CC, C, D, and E; nine marks in all. He does not tell us, however, how these marks are to be defined. The mere reference to a particular curve of distribution does not define the marks unless the difference of ability represented by each two adjoining marks is identical. But Professor Hall tells us that he does not regard them as identical. AAA he regards as equivalent to 99 to 100 per cent. Per cent. of what? He does not tell us. Of questions permitting only an affirmative or a negative answer and answered correctly in oral or written examinations? I am not sure that he means this exactly and exclusively, since he speaks also of the grading of laboratory note books. But I shall assume that he means the percentage of correctly answered questions. AA is regarded as standing for 95 to 99 per cent. The distance between the centers of the abilities AAA and AA is, therefore, 2.5. If we examine the other distances in the same manner we find them to be 4.5, 5, 5, 5, 5, 7.5 and 10. If the horizontal coordinate is divided by a scale of such unsymmetrical units, reference to a symmetrical curve has little meaning. It seems to me that the chief fact brought out in Professor Hall's paper is this: If a teacher, in grading his students, proceeds on the principle that the number receiving medium marks should far exceed the number receiving high or low marks, the accumulated results of his grading are likely to agree with his principle. But who would expect this to be otherwise? No one, however, will expect uniformity of grading in a whole institution to result from the fact that each teacher is guided by that principle, unless the various marks are defined. Is it possible to define the marks used, as standing for definite percentages of right answers? I do not believe, judging from my own experience in teaching, that students can be ranked by such a mechanical method. And if a teacher insisted on ranking them by such a method, he would often find that the result does not agree with Professor Hall's binomial curve. I tested the native musical ability of seventy-one students. The nature of the test

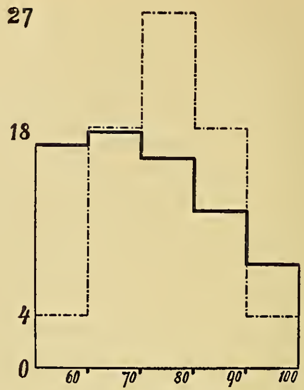

Fig. 1.

will be described elsewhere and its appropriateness demonstrated. The accompanying curve (Fig. 1) shows how the ability in question was *found* to be distributed (continuous line) and how it *should* be distributed according to Professor Hall (dotted line). There was in this case no distortion of the curve by either dishonesty of the students or any "personal equation" of the teacher. The grading consisted in the mechanical process of counting the right answers. Nothing is easier, of course, than to distribute the students in accordance with Professor Hall's curve, if we do what he has done and apply to the horizontal coordinate a scale of unequal units. But what is the use of it? Thus far I can not see any.

Five years ago the faculty of the University of Missouri voted that the grades of the institution should be A, B, C, D and E. What those grades should mean was left undefined, except that D and E were both called failures, with the distinction that D students were permitted to prepare privately for a second examination, and E students were not. It is highly interesting to see how the assumption that every teacher would know what the different grades stood for, has worked out in practise. I have collected the reports of forty teachers of the university during the last five years, all with two exceptions professors or assistant professors, and most of them connected with the College of Arts and Science. The result of this investigation is that the experiment started by the faculty five years ago must be pronounced a complete failure. And both students and faculty have before now felt it to be a failure. There is no uniformity of grading, but the greatest divergence. It has come to be admitted openly that a student who is anxious to win honors must be careful to elect his work under certain teachers and avoid others as much as possible.

In order to compare the grading of the different teachers, I have divided the total number of the students of each teacher during the last five years into three groups, one representing the 50 per cent. medium students, one the 25 per cent. superior students and one the 25 per cent. inferior students. Classes of less than four students were not taken into account at all, because they would have unduly increased the coefficient of variability without signifying anything corresponding thereto. The percentages of grading, on the other hand, are not perceptibly changed by this omission. A few of the forty teachers are no longer connected with the university. The two classes of failures have been combined into one, marked F, because a number of the teachers do not make any use of the grade D, not wishing to express the privilege of reexamination in the grade, since the student's rank is

Teachers	25 Per Cent. Superior Students			50 Per Cent. Medium Students				25 Per Cent. Inferior Students			Total Number of Students	Number of Classes	Coefficients of Variability			
	A	*B*	*C*	*A*	*B*	*C*	*F*	*B*	*C*	*F*			*A*	*B*	*C*	*F*
Philosophy	25	—	—	30	20	—	—	13	10	2	623	29	.2	.3	.8	1.2
Latin I	25	—	—	27	23	—	—	19	6	—	130	9	.3	.3	1.2	—
Sociology	25	—	—	27	23	—	—	7	13	5	958	47	.3	.5	.9	.9
Mathematics I	25	—	—	15	31	4	—	—	12	13	208	19	.6	.6	.8	.9
Economics	25	—	—	14	36	—	—	1	19	5	461	28	.4	.4	.7	.9
Greek	25	—	—	14	26	10	—	—	14	11	287	30	.4	.4	.5	.9
Latin II	25	—	—	11	39	—	—	1	19	5	577	32	.6	.4	.6	1.0
French	25	—	—	11	29	10	—	—	15	10	295	16	.3	.4	.4	.9
Political Science	25	—	—	9	30	11	—	—	16	9	592	?	.3	.3	.3	.4
Mathematics II	25	—	—	7	29	14	—	—	9	15	145	10	.6	.4	.4	.9
German I	25	—	—	5	39	6	—	—	14	11	586	28	.6	.4	.6	.8
Psychology I	25	—	—	5	36	9	—	—	15	10	907	37	.5	.4	.5	.7
German II	25	—	—	1	38	11	—	—	14	11	941	35	.3	.2	.4	.4
Elocution	20	5	—	—	50	—	—	6	19	—	917	12	.5	.1	.5	—
Geology	22	3	—	—	45	5	—	—	17	8	293	?	.2	.2	.3	.2
History I	14	11	—	—	42	8	—	—	19	6	779	21	1.0	.2	.5	.8
Zoology I	21	4	—	—	41	9	—	—	19	6	479	19	.6	.3	.5	1.1
Psychology II	19	6	—	—	41	9	—	—	20	5	238	9	.4	.2	.3	1.1
History of Art	25	—	—	—	40	10	—	—	20	5	685	55	.5	.3	.3	1.1
Bacteriology	20	5	—	—	40	10	—	—	21	4	263	20	.5	.4	.6	1.2
Freehand Drawing	18	7	—	—	40	10	—	—	15	10	506	32	.8	.3	.4	.9
Chemistry I	23	2	—	—	38	12	—	—	19	6	205	16	.4	.3	.4	.7
English I	21	4	—	—	37	13	—	—	17	8	964	33	.7	.3	.4	.8
Astronomy	13	12	—	—	37	13	—	—	20	5	225	17	.5	.3	.4	1.4
History II	11	14	—	—	37	13	—	—	20	5	806	35	.7	.2	.3	1.0
Zoology II	24	1	—	—	36	14	—	—	17	8	250	?	.6	.3	.4	1.0
German III	22	3	—	—	34	16	—	—	12	13	441	26	.6	.6	.4	.8
Chemistry II	9	16	—	—	32	18	—	—	25	—	21	4	1.4	.6	.5	—
Education	18	7	—	—	31	19	—	—	16	9	266	12	.5	.3	.2	.7
Mathematics III	19	6	—	—	30	20	—	—	6	19	182	10	.4	.3	.3	.4
Mathematics IV	25	—	—	—	29	21	—	—	15	10	380	24	.4	.3	.3	.7
Physiology	20	5	—	—	28	22	—	—	18	7	426	30	.9	.3	.3	1.1
Anatomy	19	6	—	—	28	22	—	—	14	11	544	25	.6	.3	.3	.8
Mathematics V	16	9	—	—	25	25	—	—	10	15	209	10	.4	.3	.2	.4
Engineering I	13	12	—	—	24	26	—	—	16	9	813	39	.6	.3	.2	1.0
Mechanical Drawing	18	7	—	—	22	28	—	—	13	12	558	28	.4	.4	.3	.9
Mechanics	18	7	—	—	19	31	—	—	11	14	495	12	1.1	.3	.3	.4
Engineering II	16	9	—	—	17	33	—	—	13	12	826	?	.3	.3	.3	.9
English II	9	16	—	—	12	35	3	—	—	25	1098	44	.8	.3	.3	.4
Chemistry III	1	11	13	—	—	47	3	—	—	25	1903	12	1.0	.6	.1	.3

not the exclusive condition on which the possibility of reexamination depends.

To eliminate as much as possible the personal element from the publication of the results of this investigation, I have not given the names of the teachers, but only the subjects taught, and in the case of several teachers of the same subject I have added Roman numerals for distinction. For the student of similar phenomena I have added the total number of records of each teacher, the number of classes, in order to indicate the average size of the classes, and the coefficients of variability. In the first case of the table the average total per cent. of A's is given as 55 and the coefficient as .2. This means that in a class of 100 students of this teacher it is just as probable that the number of A's will be between 44 and 66 as it is that the number of A's will be outside of these limits; and that it is three times as probable that the number of A's will be less than 66 per cent. as it is that it will be more. In the last case of the table the total percentage of A's is 1 and the coefficient 1. This means that it is three times as probable that in a class of one hundred there will be one or two A's as it is that there will be none.

Let any one look over the four columns of the 50 per cent. medium students and ask himself if he can see uniformity of grading. Above we see that none of the students of medium ability receive the grades of C or F, but all receive either A or B. Below we see that none of the students of medium ability receive the grades of A or B, but all receive either C or F. And yet, on the basis of these grades the faculty gives "honors," returns to their parents students who have "accumulated failures," compels students to take twice the same work if this happens to be required for graduation, and prevents students from taking up work in departments to which they are drawn by their natural inclinations and from which they might derive the greatest benefit for their later life. But let no one think that this proves that the University of Missouri is in a pretty bad shape. It is not likely that other institutions are better off. Only, no one has investigated the matter. Education is just beginning to realize that it is not merely an art, but an applied science.

Can anything be done to make such inequalities of grading impossible? There is no reason why one should believe that this could not be accomplished. I shall outline a method by which one might proceed.

It seems plausible to start from the assumption that the combined mental and moral ability which we want to measure is distributed among different people in accordance with the probability curve which describes, *e. g.*, the distribution of accidental errors in scientific observation. Fig. 2 shows such a curve. The

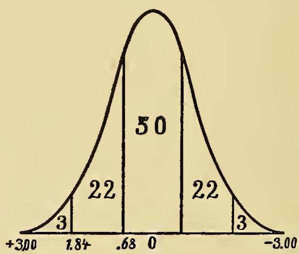

Fig. 2.

total area enclosed represents one hundred students making up the membership of a particular class. The first problem which confronts us is the division of this area. It seems best not to proceed entirely arbitrarily in this division, but to follow the custom already established. Whenever this curve is used for scientific purposes, its area is divided by verticals in such a manner that a middle area is cut out which is equal to the sum of the two areas left at the sides. The significance of this division is this: If we pick out a student at random from a crowd of one hundred, the chances are the same that we shall have a student of medium ability as that we shall have one who is not of medium ability. If the latter happens to be the case, he may be either a superior or an inferior student. Before we discuss the problem of further division, let us give an answer to the question to which of these groups of students the methods of teaching and of maintaining discipline should be adapted. Plainly to the 50 per cent. of medium students. If these are taught in such a way that they are able to grasp what is presented, the superior ones will take care of themselves, and a large percentage of the 25 inferior ones will derive considerable benefit from the instruction. The same holds true for the method of maintaining discipline, of insuring the necessary regularity and intensity of intellectual work in class and at home.

If these assumptions are made, it follows that in no case should the *highest* grade established in any institution be given to more than 25 per cent. of the students of a class on the average of a number of years. The *highest* grade, if there is any difference of grades at all, must mean distinction. But it ceases to have this meaning if it can be obtained by a student of medium ability. We have seen above that a large percentage of the medium students have been able to obtain the grade of distinction. This fact may be explained by the teachers who are responsible for it in two ways.

1. A teacher may be guided by the conviction that the very fact of a student electing his work under his instruction proves that he is a superior student and that he ought to obtain a grade higher than the average grade. The absurdity of this assumption can easily be shown. In order to show this it is by no means necessary to put all studies on the same level, in our opinion. Some may be more valuable, some may be more difficult, than others. But to decide this is not the teacher's task when he grades his students. If a student excels, this means, of course, that he excels among the students who are taking the same instruction which he is taking. An analogous case in the broader life of a nation will make this still more clear. If we say that a certain physicist is a distinguished scientist of the country to which he belongs, we do not mean that he ranks high among botanists, physiologists and geologists, but that he ranks high among the physicists. Important suggestions towards the solution of problems of this kind may be found in Professor Cattell's paper on "American Men of Science." In the same way, when a student is ranked as a superior student by his Latin teacher, this can mean only that he does better work than 75 per cent. of the students in Latin. Whether he is more intelligent than 75 per cent. of all the students in the institution is a question which his Latin teacher is not called upon to answer, and which not even the scientist to whose domain this question belongs, the psychologist, is able to answer at present, and, possibly, will never be able to answer. It can not even be said, in justification of giving the highest grade to students of the middle 50 per cent. group, that most of the students taking work under this special teacher are doing advanced work, and that this fact proves that they are superior students. If this argument were admissible higher grades would have to be used in college than in the high school, and here again higher grades than in the elementary school. If a student is said by his teacher of comparative philology to have distinguished himself, this can mean only that he has distinguished himself among the students who are taking work in comparative philology, and not that he ranks high among students taking first-year Latin.

2. A teacher may say that by accident he happened to have unusually good students. This is a sufficient explanation for giving students of a rather small class in a special year unusually high grades. But it is the very nature of an accident that it occurs but rarely. If a teacher feels that he should give six of ten students the highest grade, he should first ask himself if these students are so extraordinary that not in ten or twenty years is such a good class likely to be found again. If he does not feel that this is probable, he can not justify giving a majority of the class the highest grade. They ought to receive the second grade, however satisfactory their work may have been. They have no claim on the grade of distinction. Under no circumstances, therefore, can a teacher justify his grading if it is found that of the total

number of students having taken work under him during a number of years, some of the 50 per cent. medium students have received the highest grade.

Let us now consider the 25 per cent. inferior students. If most or all of these students fail under a particular teacher, there may be but little objection. But if we find, as we actually do, that even some of the medium students fail, we have the right to conclude that the educational principles of the teacher are unsound. Either his methods of teaching and of maintaining discipline are defective, are not adapted to the medium group of students, or his conception of what a student ought to accomplish is altogether one-sided. If a student of chemistry wants to pursue advanced courses in chemistry, it may be necessary that he have a better knowledge of elementary chemistry than the seventy-fifth in a series of a hundred can obtain. This is a matter to be decided between the teacher of chemistry and the student. But it is not a sufficient reason for regarding the student's work as a failure. He may have acquired a sufficient knowledge of chemistry to take up, say, elementary work in botany. It is the teacher of botany who should decide *how much* knowledge of chemistry his student ought to possess. But if the teacher of chemistry grades the work of a student of the medium group as a failure and compels the student to take the work over, he does injustice not only to the student, but also to the teacher of botany, he encroaches upon ground where not he, but his colleague of another department, has jurisdiction. It is no more justifiable to grade 25 per cent. or more of the students as failures than to give 25 per cent. or more the highest grade. Still another argument might be offered by a teacher who grades students of the group of the medium 50 per cent. as failures, in justification of his habits. The teacher of English, for example, may say that students are so poorly prepared in English that more than 25 per cent. ought to fail, ought to be made to take the course a second time. But the teacher, in grading thus, usurps a right which legitimately is not his. If the students are not sufficiently prepared in some lines, he ought to persuade those who are responsible for the entrance requirements that these requirements must be changed, must be raised in some respects. But if the students are once admitted to college, the teacher of a particular subject has to accept them and adjust his methods of instruction and grading to the medium group. He has no right to establish arbitrary standards for the classes which he teaches himself.

We have divided all students taking a particular kind of work into three groups, medium students, inferior students and superior students. Should we subdivide these groups?

Little can be said in favor of subdividing the medium group. That this group is the largest, is, in itself, no reason for subdividing it. A strong argument against subdivision is the fact that this would bring about unjust grading of a large number of students. The curve is highest for medium ability. If we divide the area by a vertical line, we must have a large number of students on one side differing by an almost infinitesimal amount of ability from a large number on the other side. If the teacher, nevertheless, has to give them different grades, the probability is that a considerable number will receive grades either too high or too low. This probability of injustice must be avoided as much as possible. It can be largely avoided if we make subdivisions only where the curve is comparatively low; and it is best, therefore, to give all the students within the central area of 50 per cent. the same grade. This conclusion differs slightly from that of Professor Cattell in his discussion of the same problem.[3] He places only 40 per cent. in the central group. His reason is that otherwise it would not be possible to have each grade represent the same *range* of different abilities and, at the same time, to comply for the sake of conservatism with the custom of having as many as 10 per cent. students receiving the highest grade. Now, as the table shows, this custom does not exist in the University of Missouri, where cus-

[3] "Examinations, Grades and Credits," *Popular Science Monthly*, February, 1905.

tomarily about 25 per cent. receive the highest grade. And to comply with *this* custom would mean more conservatism than one can be expected to possess. On the other hand, equal range of abilities for all grades is impossible, since the probability curve extends infinitely in both directions of the central point, so that the range of the lowest and of the highest grade must always—theoretically at least—be infinite. It further seems to me of more importance that the distances between the *average abilities* of the groups (represented by the position of the geometrical center of the group) be approximately the same than that the ranges be the same. I shall make use of this principle later on. Taking all these conditions into account, I am inclined to prefer 50 per cent. for the central group.

More advisable than a division of the medium group of students seems a subdivision in the group of superior students. To belong to the group of the 25 per cent. best is not a great distinction. It would be well, therefore, to separate from the group those who possess unusual ability. The manner of subdividing the group is a matter of convenience. We may proceed in the following way. In the probability curve (Fig. 2) the point of extreme ability, where the height of the curve is practically zero, is chosen as 3. The point of the vertical line which separates the superior from the medium students is then .68, as can be read off from any table containing the values of the probability integral. It suggests itself to divide the ability-difference between this point and the extreme point, 3, into two equal parts. The result of this division is the point 1.84. To the left of this point are then found 3 per cent. of all the students, as can again be read off from any table of the probability integral. We have thus divided the group into two parts in such a way that the best possible student is as much better than the best student of the second class, as this one is better than the best of the medium class. Let us, then, call the 3 per cent. just separated by the name of "excellent" and retain the name of "superior" for the 22 per cent. following.

In the same manner we may subdivide the group of inferior students, calling the 3 per cent. worst "failures" and retaining the name of "inferior" for the other 22 per cent.

I expect to meet with opposition when I restrict failures to such a small percentage. But I believe that 3 per cent. is a sufficient number in order to weed out those who have succeeded in entering college, but are entirely unable to do the work which they have chosen. I can not regard it as just to grade the other 22 per cent. as failures. But I do not mean by this that they ought to be permitted to take advanced work in the same line of study or to enter courses of other departments for which this particular study is required, or that they should receive credit for the whole number of hours. The teacher who gives these advanced courses and the teacher who gives the course of the other department must have the power to admit or to exclude these 22 per cent. students as he deems best. And the faculty should decide what fraction of the regular number of hours of credit they should receive. Similarly, the faculty should, as Professor Cattell has proposed, give more than the usual number of hours of credit to those students who have excelled the medium 50 per cent. To make all this possible the teacher must place each student in the group to which he belongs according to his rank. But those whose rank puts them in the fourth group should not be called failures in every possible sense, should not be regarded as having accomplished nothing. If a teacher instructs his class in such a manner that according to his own judgment 25 per cent. of them accomplish nothing, then the conclusion is justifiable that the teacher as a teacher has not accomplished anything, either.

The University of Missouri, as mentioned above, has two grades, D and E, both of which mean failure, but with this difference, that students who may be permitted to make up their deficiency by private work are graded D, whereas those who can receive subsequent credit for the course only by taking it over in class are graded E. To the present writer it remains incomprehensible why this decision of the method of making up a deficiency, which can be made only by the individual teacher in the individual case, should determine a difference of grade. The grade to be recorded on the books of the institution should signify the student's rank and nothing else.

We now have before us this entirely practical question: If an institution adopts a system of grading like the one proposed, in which 3 per cent. are called excellent, 22 per cent. superior, 50 per cent. medium, 22 per cent. inferior and 3 per cent. failure, how can the individual teacher, who is perhaps in charge of a class of only five or eight students, comply with the system? There is only one answer to this question: He must work out his method of grading for himself on the basis of his individual experience with the students. But he should be given one kind of aid by the institution which he serves. The institution should publish annually a statistical table showing how each teacher has graded all his students the last year and the last five years, so that each teacher can inform himself easily as to whether he has graded his students in accordance with the system adopted by the institution or has unconsciously applied an arbitrary standard of his own and thus introduced confusion into the system. There can be little doubt that this would soon result in a great uniformity of grading, and inequalities of the size described would be impossible, to the satisfaction of both faculty and students.

One problem is still left. How should the ability of the five groups of students be represented in order to compute the claims of various students for honors which are to be given to those having the highest rank of a whole student body. The University of Missouri prescribes for this purpose that the first grade be represented by 95, the second by 85, the third by 75 and the fourth by 65. These values are so arbitrarily chosen that any one can see that no scientific influence has been effective grading on the probability curve, as we have tried to do, we are able to give a reasonable answer to the present question. In Fig. 2 the ability of the average medium student is found at the point where the abscissa is 0. The ability of the average superior student is found near + 1, that of the inferior student near — 1. The ability of the average excellent student is found near + 2, that of the average failure student near — 2. All these differences of ability are represented by steps which are about equal. To avoid negative values, it would, therefore, be the simplest method to represent the different grades agreed on by the numerical values 5, 4, 3, 2 and 1, and to multiply these values by the number of hours of work for which each grade has been received. The students whose totals are highest—making allowance for the probable error, which is about .04, if the total number of grades recorded during the college course is about 40—have then the best claims for the honor as far as scholarship is concerned.

Max Meyer
University of Missouri

A NEW COLOR VARIETY OF THE GUINEA-PIG[1]

Experimental studies made in recent years show that color inheritance in mammals is a matter of considerable complexity, but not beyond the possibility of analysis. The more carefully the matter is studied, the clearer does the fact become that color inheritance, in all its phases, conforms with Mendel's law of heredity. The seemingly complicated results are due to multiplicity of factors concerned in the production of those results. If we confine our attention to one factor at a time, we find that its behavior is strictly and simply Mendelian. Each factor is either present or absent and in general the presence of a factor is dominant over its absence. It is only when two or more independent factors are simultaneously concerned that complications arise. Thus two simple factors acting simultaneously may produce a result different from that of either factor by itself.

In the issues of Science for January 25, 1907, and for August 30, 1907, I have advocated the view (first advanced concerning mice

[1] Published by permission of the Carnegie Institution of Washington.

by Bateson[2]) that in the pigmentation of guinea-pigs, three different kinds of pigment are produced, viz., black, brown and yellow. In wild guinea-pigs (Cavidæ) these pigments are so placed on the individual hair as to give it a banded appearance, and the banding is inherited as a factor independent of the colors present. In tame guinea-pigs this pattern factor may be wanting, together with one or more of the fundamental color factors, and this loss of color factors gives rise to a long series of color variations. But any mating which will bring together in one individual all of the four color factors will result in a return (reversion) to the coat condition of the wild Cavidæ.

In the issue of Science for August 30, 1907, I showed that, if the hypothesis of an independent color pattern (barring of the hair) is correct, it should be possible to produce a color variety of guinea-pig at that time unknown, one similar to the cinnamon-agouti variety of mice. In confirmation of the hypothesis, I may now say that this variety has recently been produced, and in the following way: Agouti-colored individuals were crossed with chocolates. The young were all agouti-colored. But when mated with each other these agouti young produced offspring of four sorts, agouti, black, cinnamon-agouti and chocolate. The cinnamon agoutis are a sharply defined and unmistakable new variety, differing from the wild (agouti) type in the total absence of black pigment from the eye, the skin of the extremities, and from the hair. The black young obtained from this cross, in generation F_2, were an unpredicted result which serves further to confirm the hypothesis of independent factors.

Let us now apply the hypothesis to the facts observed. The original agouti parents by hypothesis carry the four factors: (1) black, (2) brown and (3) yellow pigments, and (4) the barring pattern (agouti), and have completely the wild type of pigmentation. The chocolates, however, have hair entirely devoid of black pigment and unbarred. They lack, therefore, the factors black and agouti (barring).

[2] *Proc. Zool. Soc. Lond.*, 1903.

In crosses of chocolate with agouti individuals, agoutis only are obtained, as already stated, the presence of the factors black and agouti dominating their absence. Using symbols, B for black, Br for brown, Y for yellow and A for agouti, the parental contributions in this cross are: by the agouti parent, $B\,Br\,Y\,A$; by the chocolate parent, $Br\,Y$. The young, therefore, are heterozygotes of the formula, $B\,Br\,Y\,A \cdot Br\,Y$. Such individuals should, in accordance with Mendelian principles, produce ripe germ cells of four sorts: viz., (1) $B\,Br\,Y\,A$, (2) $B\,Br\,Y$, (3) $Br\,Y\,A$ and (4) $Br\,Y$. These four sorts should, on the theory of probabilities, be equally numerous. Each sort, if united with a germ cell having the same constitution as itself, should produce a different color variety, these four varieties being, respectively, (1) agouti, (2) black, (3) cinnamon-agouti and (4) chocolate.

The result should be visibly the same if a gamete united with one of another sort containing fewer factors than itself, but none of them different from its own factors. Thus the first sort of gamete should produce an agouti individual if united to either of the other three sorts. Allowing for such unions in their chance frequencies, we should expect the second generation offspring to consist of four visibly different sorts of individuals, on the average, in the following proportions; agouti, 9; black, 3; cinnamon-agouti, 3; chocolate, 1. Up to the present time there have been obtained, of agouti, 8; black, 4; cinnamon-agouti, 2; chocolate, 2. This is a perfectly normal Mendelian result, both qualitative and quantitative, and confirms in the most complete manner the hypothesis of an independent pattern factor. For, can a more severe test of the hypothesis be conceived than that by its application one should produce a wholly unknown variety?

A moment's consideration of this case shows what a really great advance in the theory and practise of breeding has been obtained through the discovery of Mendel's law. What a puzzle this case would have presented to the biologist ten years ago! Agouti crossed with chocolate gives in the second filial generation (not in the first) four varieties, viz., agouti, chocolate, black and cinnamon. We could only have shaken our heads and looked wise (or skeptical).

Then we had no explanation to offer for such occurrences other than the "instability of color characters under domestication," the "effects of inbreeding," "maternal impressions." Serious consideration would have been given to the proximity of cages containing both black and cinnamon-agouti mice.

Now we have a simple, rational explanation, which any one can put to the test. We are able to predict the production of new varieties, and to produce them.

We must not, of course, in our exuberance, conclude that the powers of the hybridizer know no limits. The result under consideration consists, after all, only in the making of new combinations of unit characters, but it is much to know that these units exist and that all conceivable combinations of them are ordinarily capable of production. This valuable knowledge we owe to the discoverer and to the rediscoverers of Mendel's law.

W. E. Castle

Zoological Laboratory,
Harvard University,
July 15, 1908

THE ORIGIN OF VARIETIES IN DOMESTICATED SPECIES

The great diversity of varietal forms, or races, amongst domesticated animals and plants, as compared with the corresponding wild species has always been a subject of remark, and it has generally been assumed that domestication, involving as it does radical changes in environment, induces variation. The considerations mentioned below indicate that we may have given too much prominence to the effect of domestication in inducing variation. It will be seen that, at least in many cases, domestication merely gives opportunity for the segregation and development of variations which may have existed practically unnoticed in the wild species.

The writer has previously shown that the poll character in cattle is a dominant Mendelian character, the dominance being somewhat variable, but the heterozygotes always being distinguishable from the extracted recessives. Let us suppose that a number of polled and horned cattle be allowed to interbreed freely. Let the number of the original polled cattle be a, and the horned cattle i, both types being equally divided between the sexes. The total number of cattle is $a+i$. The chance that in any mating the male shall be polled is $a/a+i$, the chance that it is horned is $i/a+i$. The chance that the female is of a particular type is the same. The following table (table I.) shows the probability of each of the various types of matings, and the corresponding probability of progeny of each type. Since the denominators of all the probability fractions in this table are the same, and since we are concerned only with the ratios between the types, only the numerators of the fractions are used.

TABLE I.

Ratios of Types of Progeny descended from polled (a) and horned (i) cattle, under conditions of random mating. (A = polled character, a its absence.)

Generation F_0.

	I	II	III
Type numbers	I	II	III
Type formulæ	AA	Aa	aa
Ratios of types	a	—	i

Generation F_1.

Matings M. F.	Probability of mating	Probability of progeny of each type		
I× I	$a \times a$	a^2		
I×III	$a \times i$		ai	
III× I	$i \times a$		ai	
III×III	$i \times i$			i^2
		a^2	$2ai$	i^2

Generation F_2.

Matings M. F.	Probability of mating	Probability of progeny of each type		
I× I	$a^2 \times a^2$	a^4		
I× II	$a^2 \times 2ai$	a^3i	a^3i	
I×III	$a^2 \times i^2$		a^2i^2	
II× I	$2ai \times a^2$	a^3i	a^3i	
II× II	$2ai \times 2ai$	a^2i^2	$2a^2i^2$	a^2i^2
II×III	$2ai \times i^2$		$a\,i^3$	$a\,i^3$
III× I	$i^2 \times a^2$		a^2i^2	
III× II	$i^2 \times 2ai$		$a\,i^3$	$a\,i^3$
III×III	$i^2 \times i^2$			i^4
		$a^2(a+i)^2$	$2ai(a+i)^2$	$i^2(a+i)^2$
	or	a^2	$2a\,i$	i^2

From which it is seen that after generation F_1 there is no tendency for the ratios of the three possible types to change, any such change being purely a matter of chance. It is assumed that there is no selective mating and that each type of mating is equally fruitful. This point has already been brought out by Hardy in SCIENCE, July 10, 1908, p. 49.

Hybrids of Higher Order

By a process similar to the above it may be shown that when the two types differ in respect of two Mendelian characters, or a single character consisting of two factors, the population tends to assume the following ratios for the various types:

TABLE II.

Type formulæ, " ratios:	*AABB*,	*AABb*,	*AAbb*,	*AaBB*,	*AaBb*,	*Aabb*,	*aaBB*,	*aaBb*,	*aabb*,
Generation F_0,	a								i
" F_1,	a^2				$2ai$				i^2
" F_2,	$(a^2+\frac{1}{2}ai)^2$	$a^2i(a+\frac{1}{2}i)$	$\frac{1}{4}a^2i^2$	$a^2i(a+\frac{1}{2}i)$	$a^3i+3a^2i^2+ai^3$	$ai^2(i+\frac{1}{2}a)$	$\frac{1}{4}a^2i^2$	$ai^2(i+\frac{1}{2}a)$	$(i^2+\frac{1}{2}ai)^2$
" F_3,	$(a^2+\frac{1}{4}ai)^2$	$\frac{3}{2}a^3i+\frac{3}{8}a^2i^2$	$\frac{9}{16}a^2i^2$	$\frac{3}{2}a^3i+\frac{3}{8}a^2i^2$	$\frac{1}{2}a^3i+3\frac{1}{4}a^2i^2+\frac{1}{2}ai^3$	$\frac{3}{2}ai^3+\frac{3}{8}a^2i^2$	$\frac{9}{16}a^2i^2$	$\frac{3}{2}ai^3+\frac{3}{8}a^2i^2$	$(i^2+\frac{1}{4}ai)^2$
" F_n,	a^4	$2a^3i$	a^2i^2	$2a^3i$	$4a^2i^2$	$2ai^3$	a^2i^2	$2ai^3$	i^4

That is, the proportions of the various types tend to assume the relative numbers shown in the last line of the above table, and thereafter there is no tendency for these ratios to change. It is interesting to note that the terms of the last line of table II. may be obtained from those of the last line of table I. by multiplying by $a^2+2ai+i^2$ (= the square of $a+i$); thus, multiplying a^2 the first term in the last line of table I., by $a^2+2ai+i^2$, gives the first three terms of the last line of table II.

If the original population consists of two types which differ in respect of three Mendelian characters, the ratios of the twenty-seven resulting types in the final population may be obtained from the last line of table II., as that was from the last line of table I.

The fact that in such a mixed population, with no selectional mating, and with equal fruitfulness of the various matings, there is no tendency for the relative numbers of the various zygotic types to change, offers a rational explanation of the rapid development of races having strikingly different characteristics, when a species is first brought under domestication. Let us consider for a moment the condition of the wild species. Amongst our wild gray squirrels are occasionally seen black specimens; also albinos. These varietal characters have originated presumably by the loss, either gradually or in any other manner, of a character formerly possessed. This change may have occurred at any time in the history of the species, or even before the species existed in its present form. There is no tendency, with random mating, for the new characters to spread through the species. In fact, there is probably a tendency toward their elimination by natural selection. Such a tendency, however, would operate very slowly in the case of a recessive character, which is transmitted unseen in far more individuals than those showing it (under the conditions assumed). It is entirely possible that all the varietal variations which are possible to this species actually exist in the wild species, each in exceedingly small proportions, because it has originated in a very small fraction of the species, and does not tend to spread over the species unless favored by natural selection. Should the species be domesticated, the art of the breeder, who would naturally be attracted by new types that crop out (which occurs when heterozygotes are mated) would seize these forms and establish races from them.

It is a fact noted by many investigators, and especially insisted on by de Vries, that most races of domesticated species are derived from the wild form by the loss of one or more hereditary characters. That these race peculiarities are, generally speaking, recessive to the wild form is well established, and the reason therefore is apparently clear. But that these peculiarities may have originated ages ago in the wild form, and been transmitted almost unnoticed, has not hitherto been suggested. We have seen above that such may be the case. Furthermore, peculiarities that may have had indefinite time in which to develop are not greatly in need of a theory of "saltatory change" to explain their abundant development in domesticated species.

W. J. Spillman
U. S. Department of Agriculture

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION B—PHYSICS

The summer meeting of the American Association for the Advancement of Science, Section B, was held in the Wilder Laboratory of Dartmouth College, Hanover, N. H., June 30, 1908. This was a joint meeting with the American Physical Society. There were two sessions, one in the forenoon and one in the afternoon. The attendance at each was about seventy. Professor Edward L. Nichols, president of the American Physical Society and president last year of the American Association for the Advancement of Science, was the presiding officer.

The titles and abstracts of the sixteen papers presented are given below:

Light Pressure on Black Surfaces and on Thin Plates of Glass (with experimental demonstration): G. F. Hull, Dartmouth College.

Some years ago E. F. Nichols and Hull proved the existence experimentally of a pressure due to light upon a silvered glass surface. Maxwell had proved theoretically that such a pressure exists. By Larmor's theory, however, the pressure on a glass surface should be zero. Professor Hull showed experiments which do not justify Larmor's conclusion. He exhibited an apparatus in action which showed the comparative effects obtained by allowing radiation of the same intensity to fall successively upon four kinds of surface. The results of such a comparison show the pressures to be as follows:

	Deflection
1 glass vane	1.0
2 glass vanes	1.7
Enclosed black vane	5.6
Silvered vane	11.5

These results indicate that Larmor's conclusion is incorrect. Maxwell's formula gives results quantitatively agreeing with the above measurements. For example, the values indicated for the above four cases by applying Maxwell's formula are 1.0, 1.83, 5.86 and 11.2, respectively.

(At the conclusion of the paper the president of the Physical Society, who was presiding, congratulated the section that all its members had been able to see for themselves an effect due to a force so small that the possibility of showing its actual existence had not been hoped for by eminent physicists until a very few years ago.)

Changes in Density of the Ether, and Some Optical Effects produced by it: Charles F. Brush, Cleveland.

This paper described two series of careful experiments, conducted on different lines, the results of which afford strong evidence in support of the following hypotheses:

1. The ether passes slowly, and *not* freely, through glass and presumably through other bodies.

2. The ether is susceptible of change in density. It may be dilated and presumably compressed in a glass vessel, the phenomenon lasting long enough to be observed with ease.

3. While dilation of the ether does not alter materially, if at all, the velocity of the light waves in it, it does reduce the amplitude or energy-carrying capacity of both long and short waves, *i. e.*, of low heat and actinic radiation.

The apparatus and experiments were fully described by means of a fine set of lantern slides, many of which showed photographic effects obtained during the experiments themselves.

On Oscillations in the Metallic Arc: W. G. Cady, Wesleyan University.

Two types of oscillations occurring in an electric arc light were considered. The first are produced in the iron arc in free air, with a frequency of about 1,500 per second. These seem to be mechanical and were dismissed with brief comment. The second type was considered more at length. They are of much higher frequency and occur with electrodes of various substances, but best when one electrode is either copper or silver, the arc burning in illuminating gas. The oscillations are most intense with high voltage and a current between one ampere and the point at which the arc changes to a glow. To gain an idea of the maximum potential difference across the arc during one cycle an apparatus for obtaining a point discharge in hydrogen was connected in parallel with the arc. The results indicate that the effect is an exceedingly rapid change back and forth between arc and glow discharge, of a frequency of something like a million per second. Experiments were described on the use of a resonating circuit near the arc, and on the connection of a capacity and self-inductance across the arc.

A Study of Overcast Skies: Edward L. Nichols, Cornell University.

The spectrophotometric measurements which formed the basis of this paper were carried out by means of a portable apparatus which could readily be set up during the travels of the author in Europe, and gave the opportunity to compare the skies of widely different localities and different times of day. The relative intensities of the different color-components were very different with different kinds of sky. The radiation was scarcely ever selective but almost always of the "black body" type. There is, however, almost always an absorption band in the violet during the middle of a bright day in mountainous regions. Its development is coincident with the gathering of a slight mist.

The illumination from an unclouded sky is about the same as from a completely clouded sky. More light comes, however, from a sky which is partly covered with clouds than from either. The so-called "cumulus" clouds produce especially good luminosity.

Demonstration of Wilson's Cloud Experiment, etc.: G. F. Hull, Dartmouth College.

This consisted of a demonstration of several improved forms of lecture experiments, as follows:

1. A very simple and satisfactory form of Wilson's "cloud" experiment, showing the conditions under which the cloud is obtained.

2. Wehnelt's tube, in which electrons sent out by a "button" of calcium compound in an exhausted tube were shown experimentally to be present.

3. An improvement on Mayer's floating magnet experiment, consisting of passing a single turn of wire around the circular glass vessel, in which the small vertical magnets are made to float. By sending current through this wire the effect of surface tension at the boundary is entirely eliminated. The stable configurations of magnets are different from those secured when a central control magnet is used. But the fields due to the current and to a central magnet are easily superposed.

Interest in the floating magnet experiment has been recently revived by J. J. Thomson's theories regarding the structure of atoms.

The Influence of Temperature on the Fluorescence of Uranium Glass: R. C. Gibbs, Cornell University.

The glass used was a block of canary glass. The light from a mercury arc was sent through this glass, whose temperature was changed in a measurable way through about 400 degrees Centigrade. Results will be published in the *Physical Review.*

Some Electrical Properties of Silicon: Frances G. Wick, Cornell University.

The silicon used was made at Niagara Falls. The following properties were noted:

1. In its resistance it was found to change with temperature as carbon does and not as the metals.

2. The thermo-electric power with respect to lead was found to be 220, which is larger than for any other substances except selenium and tellurium.

3. It was found also that, as with selenium and tellurium, the Hall effect was large in silicon.

4. Rods of the element were used as one element in voltaic cells, but without developing any special promise of usefulness as compared with copper, etc. In its position in the electromotive series it is very near copper.

A Study of Short-time Phosphorescence: C. W. Waggener, Cornell University.

All good measurements since the time of Becquerel show about the same kind of luminosity-decay curve. The recent work which forms the basis of this paper was designed to see if this form is characteristic of substances which lose their luminosity in an exceedingly short interval, say within one seven-hundredth of a second. The apparatus used was that devised by Nichols and Merritt a year or two ago. It was found that practically the same form of decay curve characterizes substances of this class as those whose period of decay is longer.

An Experimental Study of the Recovery of Selenium Cells: L. S. McDowell, Cornell University. (Read by title.)

A Comparative Investigation of Dispersion and Electric Double Refraction in Liquids: H. E. McComb, University of Nebraska. (Presented by Professor C. A. Skinner.)

This study showed in general that the change in refractive index follows the same law as that of the constant of electric double refraction. Six liquids were studied. Five of them showed this agreement, but one (di-methyl-aniline) showed no definite relation between the two constants.

Electromagnetic Mass and Energy: Daniel F. Comstock, Massachusetts Institute of Technology. (Read by title.)

Effects of Absorbed Hydrogen and of Other Gases on the Photoelectric Activity of Metals: V. L. Chrisler, University of Nebraska. (Presented by Professor C. A. Skinner.)

Following the method used by Holman (*Phys. Rev.*, August, 1907) the effect upon its photoelectric activity of using a metal as cathode and as anode in a glow current, has been investigated. The effect of surrounding it by different gases has also been tested.

Using fourteen different metals, they showed, without exception, a decreased photo-electric current by continued use as a cathode surrounded by hydrogen. On the contrary, when used for a moment as an anode surrounded by the same gas they showed a marked increase in activity. With some metals the photo-electric current was thirty times as great after using as anode as after use as cathode. This effect was obtained with conducting hydrogen; exposure to non-conducting hydrogen increases the activity, but much less rapidly.

The activity of the metals practically vanished after extended use in either helium or oxygen, nor could any trace of recovery be obtained by use as anode in the same gases. In nitrogen use as cathode did not wholly destroy the activity; with silver alone an increase was obtained by use as anode, slight but definite. Carbon was like silver in this respect.

When the activity had been reduced to a vanishing quantity by use in other gases, it was readily regained by introducing an atmosphere of hydrogen. A gradual disappearance of hydrogen accompanied this increase in activity. After use as cathode in hydrogen, the metal became negatively charged; after use as an anode it was positively charged. These results are readily explained if hydrogen on being absorbed or given off by the metal, carries with it a charge of negative electricity. Whether immediately or indirectly, hydrogen appears to be the prime agent in rendering metals photo-active.

A New Method for Determining the Difference of Potential between a Metal and a Solution of One of its Solids: A. W. Ewell, Worcester Polytechnic Institute.

The experiments of Ayrton and Perry on this subject were repeated with some modifications. A glass vessel was covered with tinfoil which was connected to the needle of a Dolezalek electrometer. Its terminals were connected to those of a 40-cell battery, earthed at the center. A metal electrode placed in a solution of one of its salts was also earthed. One volt gave a deflection of 8 cm. Copper in copper sulphate solution, zinc in zinc sulphate and mercury in potassium chloride were used in the measurements.

The Isothermal Layer of the Atmosphere: W. J. Humphreys, Mt. Weather Meteorological Observatory.

The temperature of the atmosphere decreases more or less uniformly with increase in elevation above the surface of the earth until an elevation of from 30,000 to 60,000 feet is reached, where the temperature is $-50°$ to $-60°$ C. From this elevation up as far as balloons have gone the temperature remains practically constant. This is explained as the result of radiation, mainly from the moisture in the air, which will have an effective radiating surface of great extent in comparison with elevations reached by balloons. The means of locating this surface was considered. The relative proportion of the different constituents of the air is different at different elevations, the proportion of water vapor being relatively great in the lower layers. Calculation shows the temperature of this "effective radiating surface" to be about $-33°$ C. (The calculations were carried through in detail before the joint session.)

Coefficients of Expansion at Low Temperatures: H. G. Dorsey, Cornell University.

Curves were drawn with temperature and expansion as coordinates. Temperatures used ranged from 113° C. (absol.) to 213°, and were secured by the use of liquid air. Selenium and hard rubber gave nearly a straight line, while zinc and gold gave very irregular curves. A second sample of gold of greater purity (obtained from the U. S. mint) gave a straight line. Fiber cut in three different directions with respect to the direction of its grain, was also used.

The full paper is published in the July number of the *Physical Review*.

A. D. Cole,
Secretary Section B.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Friday, August 28, 1908

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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., or during the present summer to Wood's Hole, Mass.

THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING[1]

FROM THE STANDPOINT OF THE PROFESSOR OF ENGINEERING

I feel that in this discussion we engineers occupy rather an unfortunate position, on account of the fact that we are compelled to assume the position of critics. The student comes to us from the teachers of mathematics, presumably equipped with a knowledge of that subject, and it becomes our duty to teach him subjects in which he makes use of this preparation, and to find out whether he has learned to use mathematics as a tool. However, I believe that only by friendly criticism can progress be made, and that every one ought to be willing to accept such criticism when given in the proper spirit. I had much rather be criticized than criticize others, and we teachers of engineering hope that we are always ready to receive suggestions, not only from other teachers, but from practising engineers.

I must first insist that for the engineer mathematics is to be regarded as a tool—not as something which is studied simply for the development of some mental powers, but for the ability which it ought to give a man to *do* something—to use the results and methods which he has been taught in solving the problems of his profession.

There has been a good deal of discussion in the past as to the value of mathematics simply as a means of mental training, without reference to its use, and perhaps most of us remember the paper by Sir William

[1] Continued from the issue of August 7.

Hamilton written seventy-six years ago, in which he maintains that there is no one of the subjects in the curriculum which develops a smaller number of mental faculties or develops them in a more imperfect and inadequate manner than mathematics. I have never seen what has seemed to me a conclusive refutation of Sir William Hamilton's main arguments, and for my part I am disposed to agree with him in general, and to assign a comparatively low value to mathematics simply as a training, aside from its applications. I have not observed that students trained in this subject are able *to reason* any better than students who have ignored mathematics; indeed, I believe that many non-mathematical subjects afford a better training in reasoning than the study of mathematics. This view may perhaps be justified by remembering that mathematics, aside from geometry, deals with questions of quantity and number, but not with questions of quality. The student puts certain fixed data into his mathematical machine and grinds out the result. He does not learn to observe and to discover the finer and more elusive, but equally important, sources of error likely to occur in the ordinary questions of daily life, because he is dealing with a rigid, unyielding, logical machine. In this way his mind may become hardened—he deals with rigid demonstrations and is unwilling or unable to appreciate or submit to a less rigid method, which is often the only possible one. The best student of mathematics is frequently one of the poorest of engineers. Give him fixed data and he will get the proper result, but he may be entirely incapable of attacking a practical problem, or of deciding what the proper data are.

I have not observed that students of mathematics are, as a rule, more *accurate* than other students, or that a training in the branches of mathematics above arithmetic leads to accuracy. Indeed, it more often appears to pervert the sense of perspective, and to lead students to work out a result to several figures in cases where a smaller number only may be significant. Mathematics does not train the *observation*, neither does it train the *imagination*, except in the geometrical branches, which are now comparatively neglected since the powerful modern methods in analysis have been introduced.

Hamilton only allowed, as I remember, that mathematics adequately trained one faculty, namely, that of *continuous attention:* but I fail to see that this is trained any better by the study of mathematics than by that of language, chemistry or by other natural sciences. Unfortunately, as at present taught it does train the memory, in a way that it ought not to do. The ordinary student of mathematics subordinates *perception* to a *memorization* of formulæ and rules.

I believe, therefore, that from the point of view of the engineer, mathematics should be taught with the object of giving the student power to use it as a tool. With reference to this I think it is fair to say that the consensus of opinion among engineering teachers and practitioners is that the results of the present mathematical training are very poor. The average student who has completed his mathematical course is frequently quite helpless when called upon to attack a concrete engineering problem, and it is a common remark by civil engineering students that they did not really learn any mathematics until they studied mechanics or the theory of structures. The results seem to be almost equally poor no matter what institution the student comes from, for in my classes there have been students from most of the principal universities and technical schools in the country and I have failed to notice any great difference in them in that respect.

They very generally lack the power to *do anything* with the mathematics which they have been taught.

With reference to the reasons for this state of things, I venture to state what seem to me to be some of them, and the suggestions which have occurred to me by which possibly the results might be improved.

1. In one of the previous papers a statement was made that many students who studied advanced algebra in the technical schools had not studied algebra in the preparatory schools for the two years previous. This illustrates what I believe to be one failing in our so-called system of education, namely, the lack of continuity. The remedy is to reform and simplify the curriculum, and to unify and simplify the entrance examinations to our colleges and technical schools. So long as these entrance examinations are so extended and cover so large a range of subjects, our preparatory schools will be unable to carry out their true purpose, which is, as it seems to me, no less and no more than that of all education, namely, to train a man *thoroughly* in a few things and to give him the power to do some little thinking for himself and to take up new subjects without assistance.

2. The great inherent difficulty which teachers of mathematics as well as teachers of every other subject meet with is the attitude of the student, and his inability to realize the seriousness and the importance of his work. I am fond of expressing my view in regard to this by the statement that the school is not a restaurant, but a gymnasium; not a place where a student comes to be filled up, but a place where he finds apparatus and the instruction, by making use of which he may strengthen his mental muscles.

The manufacturer can take his raw material and shape it into the form which he desires. The raw material of the teacher is the student, but the teacher can not take this material and shape it; he can only show it how it can shape itself. I believe, however, that much may be done in impressing upon students the proper attitude which they should take toward their work, and by a proper cooperation between teachers and parents, which is unfortunately lacking as a rule in this country, and the responsibility for which must largely fall upon the parents.

3. I believe that one cause of the poor results in mathematical teaching is that too great a stress is laid upon *analysis*. Mathematics is, of course, divided into geometry and calculus, using the words in their widest sense. Geometry is concrete; and the mind perceives the steps in a geometrical demonstration. This branch, the oldest branch of mathematics, however, has been largely supplanted by the modern analytic methods which have been developed during the past three centuries, largely to the detriment, it seems to me, of the educational results obtained. Analysis is abstract—it is a powerful machine, an invention for doing certain things. Into one end of the machine we put the data; we turn the crank, and the result comes out with absolute correctness so far as is warranted by the data. Now I believe that too much stress is laid on these analytical processes; that the student is not urged to visualize his results, to express them geometrically and to interpret his equations. I warmly second the remarks of Professor Ziwet with reference to descriptive geometry, which I believe should be treated as a branch of mathematics and taught more thoroughly, as it is taught in Germany. For my part, I derived as much benefit from my study of descriptive geometry, and afterward from the study of projective geometry, as from any other mathematical studies. These studies train

the imagination, which analysis does not do. But in the use of analysis, the first step, namely, the formulation of a problem, is really concrete. This, too, is neglected in our usual courses. Our examination papers are full of questions which involve simply the analytic processes—the differentiation, the integration, the twisting and turning of equations, while much less attention is paid to the formulation in mathematical language of practical problems. Our students, therefore, when they meet a practical problem, are unable to select or judge of the correctness of the data, and even if they can do this, are unable to formulate the data as a preliminary to the solving of the problem by the use of the mathematical machine.

One of the great defects which I find in students of mathematics is one already referred to, namely, that they do not *interpret their equations*. The average student who has completed his mathematical course, for instance, has not the slightest conception of what a parabola is. I make this statement advisedly, because I have tested it again and again for years. If he could tell you what a parabola really is in his mind, he would probably tell you that it was a curve of more or less beauty represented by letters. Perhaps he could tell you what the letters are, but give him a concrete problem and he would convince you immediately that he did not *know* what the letters mean.

4. Another defect, as it seems to me, in our present methods, is the lack of training in mental operations. In the good old days *mental* arithmetic was taught, but that seems to have gone out of fashion, with so many of the other good old methods. Ask the ordinary graduate of our mathematical courses to tell you the square of 20.75 without using pencil or paper and he will look at you open-mouthed with astonishment, but if he had really grasped the meaning of the binomial theorem and had learned to do a few "sums" in his head, any grammar-school boy would, of course, be able to give the result immediately.

5. Another reason for poor results is, I believe, inadequate class-room methods, and especially the use of the lecture system. In Germany, where the students in the universities have had the advantage of a thorough preliminary training, they may be able to appreciate lectures on mathematical subjects, although I doubt even this in the case of the average student. For students in our American universities, however, I believe that lectures in mathematics are almost useless, except for a very small number of students; and yet, I am told that even in some of our high schools mathematics is taught to a considerable extent by lectures. The lecture system is easy for the teacher. It involves no cross-questioning, no endeavor to discern what is going on in the student's mind, no adaptation of question with the object of putting him on the right track.

Again, some mathematical exercises are conducted by sending the students to the board, each with a problem to solve, and then marking that on the correctness of their work. Occasionally a formal explanation of his problem is required of the student. This, again, seems to me to be a mistaken method. Many a student can go through a demonstration of a principle, or solve a problem by substitution in a formula, while knowing nothing of the real meaning of the subject. In my opinion class-room instruction should be conducted by the Socratic method—by question and answer—the teacher endeavoring to put and keep the student upon the right track by showing him what he can do for himself if he will only learn how.

6. Reference has been made to the kind of teachers of mathematics. Personally I

believe that in teaching the subject to engineering students the best results would be obtained if the teachers were engineers, or at least if they were near enough to being engineers to take an interest *in the concrete problems themselves* as distinct from their solution. If I am correct in the belief that mathematics should be taught as a tool, then it can be taught best by those who know how to use it as a tool. Unfortunately, however, it is difficult to get engineers who are sufficiently interested in mathematics and sufficiently masters of that subject, who are willing to devote themselves to teaching. The men who are interested in the problems prefer to devote themselves to those problems, and to go into practical work. It is not necessary, however, as suggested above, that the teachers of mathematics should be engineers if only they will take an interest in the problems themselves, and in the point of view which the student should take. They can do this by cooperation with the engineering teachers, by attending engineering courses, and, perhaps, by a little more realization than they now have that their work is preliminary to other and more important work, and that as a matter of fact if the engineering student does not learn to use his mathematics as a tool it is practically of no value to him. For the engineer, mathematics is the servant, and the mathematical teacher should aim to teach the subject in such a way as to obtain as nearly as possible the results which intelligent engineering teachers and practitioners desire to have obtained.

George F. Swain
Massachusetts Institute of Technology

FROM THE STANDPOINT OF THE PROFESSOR OF MATHEMATICS IN THE ENGINEERING COLLEGE

We must not take too seriously what engineers have to say in an educational discussion, nor take too much to heart their views on the mathematical curriculum. Practising engineers are not in the habit of thinking very continuously on any educational question, although, of course, they must not confess inability to respond when they are called upon for pedagogical opinions. Every practitioner in the law would doubtless express views concerning legal education if summoned to do so, but he would be a rash educator who would attempt to follow their advice without much circumspection. I, myself, prefer to judge of the engineer's views upon educational matters by studying his actions rather than his words. The things engineers "do" may be taken as a true expression of their deliberate judgment—what they "say" is often ill thought out and in contradiction to their deeds. I therefore prefer to judge of the present needs in the mathematical instruction for engineers by the actual tendencies that I observe in the evolution of technology itself.

What are the great changes that the engineering profession has made in technical science in this country in the last quarter of a century? The changes are quite obvious and not difficult to state. In former days engineering technology was founded chiefly upon current practise rather than upon established principles; it was more closely allied to the crafts than to science. Not only is that day past, but it is no longer the case that technical science looks entirely to pure science for its fundamental material. It has so grown that it is investigating for itself and, in greater and greater measure, developing the basal principles for its own needs. There are very few American treatises in pure science which will compare in scientific thoroughness with several treatises which have lately issued from the engineering press. This is a very hopeful sign in the growth of knowledge—to see applied science and pure science approaching each other at numerous points, so that it is increasingly difficult to distinguish any line of demarcation between them. In this change, *science is not sacrificing any of its strength nor compromising its ideals.* It is *technology* that is changing—that is becoming less empirical, more systematic, more quantitative, more scientific.

With these well recognized changes in applied science before us, what should be our attitude toward the mathematical science that is necessarily associated with engineering education? What is technology really requiring of the basal sciences? Judging the engineers by their acts and not by their words, what is the real demand that they are making of the physicist, of the chemist or of the mathematician? Is the demand to teach physics or chemistry in this or that particular way, or is the demand of a profounder and more radical sort? The most superficial observation shows that the demand is of the latter kind. The engineer in this twentieth century is saying to the physicist, and chemist, and mathematician: "Know more science. Discover more facts in electricity—in light—in all properties of matter. Give to the world more men like Kelvin, Hertz, Helmholtz. Fill the shelves with ten times the knowledge we now have." These words more truly express the real pressure that engineers are putting upon workers in pure science, than do the words they have uttered in this discussion. As a single example, note that the great electrical and other manufacturing companies are impatient at the rate at which pure science grows, and large sums are spent by them each year in the search for new truth and in filling up the gaps in existing knowledge.

The real demand of the engineer is not for better instruments or tools with which to do his work, nor is the demand for more difficult projects to test his skill, nor even for more capital with which to construct them. The real demand is for more knowledge, more science, and for more of the spirit of science in technology and in technical education. I take as my text a saying of Ostwald: "*Science is the best technology.*" If we teach a trade and not a science the time is largely wasted. If we teach *dyeing* and not *chemistry,* the graduate is already out of date when he begins his career, and he has not the fundamental principles wherewith to bring himself abreast of the times. I therefore regard it of greatest importance that mathematics be taught to engineering students with real enthusiasm for the science itself. It should be taught by men who themselves are actively contributing to the growth of mathematical science. The present spirit of engineering science is such that no instructor in any of the basal sciences is satisfactory who does not see that it is his duty not only to teach what is old, but to be interested in and to take an active part in the development of what is new.

I regard of secondary importance the particular things we do in the mathematical course in the engineering school. Different instructors, equally successful, will have different opinions. Various changes and improvements have been tried at various institutions. At the University of Wisconsin we have made innovations whenever we thought it best, but I regard them all of secondary importance to the first requirement of all, namely, that we demand the right sort of teachers, and that the teaching be done in the right sort of scientific spirit.

The only imperative requirement put upon the mathematics in engineering schools that does not rest as heavily upon the mathematics of the ordinary college course is the demand for compactness. It is possible that there is some room in the courses in colleges of pure science for the whims and fads of the various instructors, for at some later place in the course the balance may be restored. This, however, is not true in a school of engineering. There is very little room for the practise of fads and new schemes. It is easy to exaggerate the need of a special sort of subject matter in mathematics and a special class of problems for engineering students. We are apt to make some very foolish mistakes, if we undertake to change too freely the scientific material that is presented to engineering students. A good engineer is worthy of the best science and the best instruction that can be brought to him—he himself would be the first to object if a different program were carried out.

I have had a little experience in employing engineering graduates in engineering work. In the past ten years I have given employment, in various capacities, to about one hundred and thirty engineering graduates. This work has been scattered over quite a wide territory and the men have come from the institutions of the east, from the Pacific Coast, from the Mississippi Valley and from the south. I have been able to judge within the limits of my experience what the young engineering graduates know, and what they have forgotten. I find it true that the boys have forgotten a great deal of the material they had in college, and that they have remembered other things. They remember the manual and the mechanical things—how to swim, how to ride a horse, how to fish, how to play ball, how to run the level, how to work the plane table, and how to do stadia work. Now what have they forgotten? The men have forgotten the intellectual things—hydraulics, electrical science, thermodynamics, etc. The human mind possesses an unlimited capacity for forgetting. But my experience shows that the young men forget their hydraulics just as quickly as they forget their mathematics or their mechanics. The engineer in the field observes that a boy remembers the right end of an instrument and seems to be amazed that the same man does not know the right end of an integral sign. He therefore concludes that the mathematics has not been "taught right." If he will compare intellectual things with intellectual things he will find that a miscellaneous group of engineers will pass as good an examination in mathematics ten years after graduation as they would pass in thermodynamics or hydraulics.

It grates on me to hear mathematics spoken of as a tool. Mathematics is to the engineer a *basal science* and not a tool. The spirit of that science is of more value to the engineer than the particular things that can be accomplished. The engineer need not be a mathematician, but he needs to think mathematically, and, to my mind, he needs the power of mathematical thought more than skill in manipulating a few mathematical tools in mechanical fashion. There are already too many factory-made products turned over to the college by the secondary schools. I make a fundamental contrast between the engineer with his mind endowed with the power of creative and rational design, and the artisan with his hands equipped with tools for physical construction. A great engineer must be trained in correct seeing and thinking, and must have the power of reasoning concerning some of the highest abstractions of the human mind. In this aspect mathematics is not a tool—it is a basal science.

Chas. S. Slichter
University of Wisconsin

At the close of Professor Townsend's address he urged the desirability of technical schools offering more elective advanced work in mathematics. It may not be out of place, therefore, for me to call attention to the fact that in the Massachusetts Institute of Technology we have offered and given, among others, the following courses: advanced calculus, vector analysis, fourier series, least squares, theory of surfaces, theory of functions, elliptic functions, hydrodynamics and differential equations of mechanics and physics. Some of these subjects are required in one or more of our courses, but not in any one of the larger engineering courses, which are taken as the basis of Professor Townsend's tables. This elective work, therefore, while valuable in many respects, is not the main work of the mathematical department.

The mathematical teacher is in the engineering school primarily to teach to students of engineering the amount of mathematics which is necessary to them for the proper understanding and practise of their profession. The object is to give the student a grasp of mathematical concepts and processes through their use, as one learns grammar by speaking a language. Hence there is no place in the required mathematics of a technical school, nor indeed in the first courses in a college of liberal arts, for the refinements of modern "rigor." At the same time there should be no patience with a loose or unscientific presentation of first principles. The teacher himself must be thoroughly conversant with modern thought, else he will teach falsehood for truth, and must be enthusiastic in his interest in his subject, else he will fail to inspire his pupils. Hence the teacher of mathematics should be primarily a mathematician and not an engineer. It is hard to find an engineer who has any knowledge of mathematics other than a small fragment which he habitually uses, and any elementary teacher whose instruction goes to the very limits of his knowledge is sure of failure. It may, of course, be possible to superimpose a mathematical training upon an engineering one, but in that case the engineer becomes a mathematician and my contention that mathematics should be taught by a mathematician is not invalidated.

On the other hand, the mathematician should know something of the uses to which an engineer wishes to put mathematics. For that reason such meetings as this are helpful, but I must confess to feeling a little disappointment in not obtaining from the engineers any new light on the concrete problem which confronts the teacher of mathematics in an engineering school. I have met the same disappointment elsewhere in similar meetings. It has happened, elsewhere if not here, that engineers will tell the mathematicians what and how they should teach, in apparently total ignorance of the fact that what the engineer promulgates as a new gospel has been the commonplace thought of the mathematician for years. This ignorance may be due to the fact that the engineer remembers his own training of twenty or thirty years ago and does not know that improvements have taken place. That such is the case may be seen by a comparison of modern with older text-books. Such criticism from the engineers is amusing, but another kind of criticism is not. I refer to the kind which seizes upon the failure of a student to have learned mathematics thoroughly as evidence of poor aims and inefficient teaching of the mathematical instructor. We all know that students pass through our classes and graduate from our schools whose attainments are not what we wish, but while the mathematical teacher delivers his product to the engineering departments and hears of his comparative failures, the engineering professor delivers his product to the world and rarely hears of the specific blunders of his students. Another unfair criticism is sometimes heard from the professor of engineering who says that students can not use their mathematics, when the truth is they have simply forgotten some particular fact, formula, or process, which is a fad of that professor. It is unfair to test mathematical training by tenacity of memory or mere quickness in reasoning.

I have said that we must teach our students to use their mathematics. Now in the application of mathematics to a concrete problem there may be distinguished three steps:

1. The interpretation of the data of the problem into mathematical language.

2. The formal operations upon the expression or equations thus obtained.

3. The interpretation of the results back into the terms of the original problem.

The first and third of these steps are really the most important, but there seems to be a popular impression that the second comprises the whole of mathematics. This impression is doubtless responsible for some criticisms of the educative value of mathematics. It is true that relatively a great amount of time must be spent in the classroom in teaching the mechanical processes involved in the second step, and many students in school and college get no farther. To object to the amount of time spent in this way and to demand, as some do, that we confine our time to teaching general principles and applications is to talk as sensibly as a fond mother who objects to a child beginning his musical education by playing finger exercises instead of tunes. The technique of mathematics must be learned first, but the student who never gets beyond the technique has not learned mathematics.

The teacher of mathematics should, then, use all possible means of teaching the first and third of the above steps and should bring his pupils to think of them as the real thing. For that purpose he should seek for applications and illustrations from as wide a range of subjects as possible. He will find himself handicapped, however, in using many problems of real scientific or engineering importance because of the ignorance of his pupils, especially in the first year in the technical school. To illustrate a new mathematical principle by an application to a science with which a student is not familiar is to befog and not illumine the subject. Hence there is something to be said in favor of some of the much-criticized problems of the older textbooks. To my mind a problem is successful if it causes the student to take the three steps just enumerated and is couched in terms familiar to the student, even though it may not be "practical." On the other hand, a type of problem lately coming into use, in which the student is given some formula from a science of which he knows nothing, and is asked to find, say, a maximum value, is as fruitless as if the problem were stated in terms of x, y and z, unless it may serve to convince a sceptical student that the matter he is studying has some practical application.

And this leads me to the most important thing I have to say, and that is that after the mathematical professor has done his utmost to teach the use of mathematics the engineering professor must take up and complete his work. I doubt if any one really learned the use of mathematics in a first course. Facility in using mathematics comes from actual use and not from the solution of illustrative examples. In the course in mathematics the student expects his problem to be solved mathematically and has his mind alert to find the solution, and that too with mathematical principles fresh in his mind. In a course in engineering, his point of view has widely changed. The practical problem has now his main interest, mathematical concepts are in the background, and he often fails to see the possibility of using mathematical principles until he is trained to do so by the professor of engineering. If the professor, through lack of knowledge or lack of interest, avoids the use of mathematics, the student will soon lose the little he has learned.

In other words, the mathematical training of a student is not complete when he leaves the department of mathematics. It is possible that better results could be obtained if the mathematical department had more time, say for a course in applications of mathematics to miscellaneous problems. But, as a rule, in our technical schools the department of mathematics is allowed barely time to teach the necessary technique with what illustrations and applications can be squeezed in. Hence the mathematical department delivers to the engineering department an unfinished product and it is the engineer's duty to teach the student to use the mathematics he has learned. Unfortunately, the professor of engineering is too often a poor mathematician and avoids this duty.

One of the hardest things a student has to do is to combine two different domains of knowledge, each somewhat unfamiliar, so that he may work freely in both at once, using each as a help in the other. It is this difficulty which makes analytical geometry traditionally hard, and which the student meets again when he studies any form of applied mathematics. It is partly to help overcome this difficulty that we have just made a rearrangement of our mathematical instruction in the Massachusetts Institute of Technology. We no longer have courses in algebra, analytic geometry and differential and integral calculus, but have combined these into one "course in mathematics" extending through two years. Into this course the elements of analytic geometry and of calculus are introduced early and continued late. We hope thus to give these principles more time to become completely domiciled in the student's mind. We have also been enabled to carry out two principles: the first is to introduce no subject until some use is to be made of it, and the second to handle each problem by the method best adapted to it, rather than by the methods of the particular branch of mathematics which one might at the moment be studying under the old classification. We hope in this way to increase the efficiency of our mathematical teaching.

F. S. Woods
Massachusetts Institute of Technology

The program shows three standpoints from which discussion is to emanate. I occupy no one of them. It is true I have had some engineering practise, but I can not be termed a practising engineer. I have had charge of mathematics for engineering students in two engineering colleges, but for nearly a decade now I have not met students in mathematics; and, indeed, I have taught, all told, but an insignificant amount. I am in somewhat close touch with engineering students, but they belong to a particular field, namely, mining, which is possibly less dependent on mathematics than are other branches of engineering. My view-point is, therefore, somewhat of a compromise or average of the three specified in the announcement.

The present discussion seems to me significant. It may bring forth results. In fact it seems to have had some immediate consequences. Last evening after the dinner I heard a very clever mathematician admit that he felt really humble, and I heard a well-known engineer say that to his great surprise some mathematicians had a human side. I asked a pure mathematician sitting near me to show me his human side, but he only shrugged his shoulders. Perhaps he was not yet sufficiently humbled.

This occasion appears to me to be significant, but as showing conditions which exist rather than as forecasting future changes. It is a symptom of the approach—the arrival, perhaps—of healthful conditions rather than a cause. It may, of course, in its turn become a cause, and operate toward good results. That is not so certain. At the moment it indicates conditions surrounding the teaching of mathematics to engineering students, including the relations between the teachers of mathematics and those of engineering which have been the growth of many years. Those young and virile gentlemen whom we all delight to honor, the Woodwards, have been striving for decades to bring about a closer relation between the teaching of mathematics and the subsequent study of practise of engineering. Ten years ago at the Toronto meeting of the Society for Promotion of Engineering Education I presented a paper looking to this end.[2] There are gentlemen here present who discussed that paper and who may perhaps recall the remarkable unanimity between the teachers of mathematics and those of engineering as to the results most to be desired in teaching mathematics to engineering students, and, indeed, as to the best available methods for producing such results. This movement is old. Most of the ideas which have been brought out here were first conceived a long time since. Nevertheless, it is good to get together and talk them over, and such discussions may result in help to the individual teacher.

We have heard here much of the ideal which the engineering school should set before itself, but it might well be asked what problem is presented first to the school as a matter of fact? President Woodward put it in part when he spoke of the difficulty of getting the right men in the schools when operators are so eager for good men and are competing on the basis of "so much per month." And what do the employers demand? They call for men who can do something, men who can think in a logical and common-sense way, but, withal, when they leave the school can be put to some immediate use. The first problem confronting the engineering college is how to meet this demand, for the demand must be met in some degree at least or the college will cease to train men.

It is inevitable that the character of this demand shall influence largely what the school must do. The call is not for men highly trained in mathematics, however much we may feel it ought to be. It is for men who know well a little mathematics, and who can do something with it, who can use it "as a tool." And, however obnoxious that expression may be to a mathematical teacher, he who forgets or disregards the fact which lies behind it will surely weaken his instruction of engineering students.

I do not defend the specification of the employer, I point to the fact with which we must deal. Personally I am inclined to find fault with it, but the matter rests largely in the hands of the practising engineer. He, though he often objects to the college product, is to a great extent responsible for its general make-up. In the long run and within reasonable limits he can have what he wants. Sometimes he is inclined to require too much technical knowledge on the part of the graduate. His brother teaching in the college in order to meet his requirement says to the teacher of mathematics I must have those students ready earlier with their mathematics. This fact, together with the general tendency in the colleges to raise the standards, causes

[2] See *Proceedings* of Society for Promotion of Engineering Education, Vol. V., 1897, p. 139.

the mathematical training to be crowded into the first year and a half or two years, when the student is least mature. More of it is being pushed back to the secondary school, and, in turn, into the grades. Mathematical concepts are difficult, and with President Woodward I am inclined to think we are demanding too much, and calling for it too soon. Covering less ground and at a slower pace will help to make better engineers.

The student comes to the engineering school with the notion that he is to be filled up with a lot of technical knowledge, the items of which will be used by him when he is a practising engineer. He seems unable to comprehend that he is in college to acquire mastery over his own powers. He is eager for useful facts and of course he forgets most of those he learns not a great while after leaving college. The forgetting is to be assumed. Under such conditions the task before the teacher of mathematics, and quite as well before the teacher of engineering, is to do his utmost to train his student to think logically and accurately about things. To this end there seems to me nothing so efficient as the solution of a large number of carefully chosen problems. Indeed what is one's life, if it be active, except meeting a never ending succession of problems which must be solved if success is to be gained? If you can teach your student to take vigorous hold of a problem, to first assemble all the facts which bear on the question, then from the facts to reason logically to a sound and safe conclusion, you have started him well whether his aim be engineering or otherwise.

Of transcendent importance is the teacher, his personality, his attitude toward his work, his knowledge of his students, not as a class, but of each as a human being. If we can procure the teacher who can idealize his work, who can show sustained enthusiasm for it and perform cheerfully the drudgery we heard mentioned a few minutes ago, we can safely leave detailed methods to him. Whatever methods such a man adopts in the classroom are likely to be effective.

Fred W. McNair
Michigan College of Mines

THE BRITISH MUSEUM OF NATURAL HISTORY

On July 28 a deputation, which included Mr. F. Darwin (Cambridge), Professor Cossar Ewart (Edinburgh), Professor Sedgwick (Cambridge), Dr. Marr (Cambridge), Professor Hickson (Manchester), Professor Bourne (Oxford) and Professor Graham Kerr (Glasgow), waited on the Prime Minister (Rt. Hon. H. H. Asquith, K.C., M.P.) in support of a petition sent to the late Prime Minister last autumn requesting that advantage should be taken of the present vacancy in the directorship of the Natural History Museum to hold an inquiry into the methods by which the museum is governed. The deputation was introduced by Sir W. Anson, M.P., Mr. Rawlinson, M.P., and Sir H. Craik, M.P.

According to the account in *Nature*, Professor Sedgwick said that zoologists thought it desirable to at once call the attention of the government to the desirability of instituting an inquiry into the methods of administration of the Natural History Museum, and that, if necessary, a widely signed memorial could be sent later on. In concluding a very full statement, Professor Sedgwick said:

> We are here to ask for a full official inquiry into the organization and administration of the Natural History Museum with a view to a reasonable treatment of the matter in the immediate future by his majesty's government.

Mr. Francis Darwin especially referred to the subordination of Cromwell Road to Bloomsbury. He said:

> Quite apart from the welfare of the Natural History Museum, it seems unfair to expect of the principal librarian that he should be responsible for Cromwell Road in addition to his other heavy

responsibilities. Nor can it be to the advantage of the British Museum that its principal officer should be so occupied. But it is when we look at the other side of the question that the faultiness of the arrangement becomes fully obvious. To choose a man distinguished for his technical knowledge and then to fail to give him reasonable freedom in the employment of his training and experience seems as bad a plan as it is possible to conceive. . . . I believe I am right in saying that when the late director was appointed his freedom was curtailed. It was, I think, unavoidable that in these circumstances difficulties should arise, and I feel very strongly that we ought to make the recurrence of such difficulties impossible; and this can only be done with certainty by making the Natural History Museum an independent unit.

This view was supported by Professor Bourne, who stated that

The Natural History Museum will not be placed upon a satisfactory footing until it is placed under the control of a body of trustees separate from that which is responsible for the control ot the British Museum at Bloomsbury.

Professor Hickson pointed out that, notwithstanding the representations made by men of science during recent years,

No changes or reforms had been effected, and the administration is practically the same now as it was before the collections were removed from Bloomsbury, and that for seven months the museum has been deprived of the services of both a scientific director and a keeper of zoology.

Professor Ewart directed attention to the present unsatisfactory method of appointment of the director and of the subordinate members of the staff of the Natural History Museum; Professor Kerr said that, owing to the dissatisfaction which exists amongst men of science, it is "essential to hold a careful inquiry into the whole question of the organization and administration of the Natural History Museum before coming to a decision as to the remedial measures to be adopted," and Dr. Marr directed attention to the inadequate representation in the museum of those important branches of geology which are distinct from botany and zoology.

The Prime Minister, according to an official report which has been supplied, replied as follows:

He expressed his profound satisfaction at meeting so many eminent men of science. He pointed out that, as regards the administration of the museum, the trustees are a statutory body with whom the government were powerless to interfere. He confessed himself still unable to grasp in what way the museum failed to perform its functions. The arguments advanced by so many of the deputation as to the management by the trustees applied equally to the Bloomsbury museum. The trustees, men of wide experience and great distinction, were equally cognizant of natural history and archeology. He announced that the trustees were about to appoint a keeper of zoology, and that it was not intended to abolish the directorship, but only to wait to ascertain who was the best man for this responsible position. He sympathized with the view that the director should have a free hand in the management of his department, and promised to convey to his fellow-trustees of the British Museum all that the deputation had suggested.

LECTURES IN CONNECTION WITH THE INTERNATIONAL CONGRESS OF TUBERCULOSIS

In connection with the congress, which meets in Washington from September 21 to October 12, a series of special lectures will be delivered in Washington and elsewhere by eminent foreigners. The names of the speakers and the cities in which they will lecture are as follows:

"Studies in Tuberculosis in Domestic Animals and what we may learn regarding Human Tuberculosis": Bernard Bang, of Copenhagen, at Washington, October 3.

"Les nouveaux procedes de diagnostic precoce de la Tuberculosis": A. Calmette, of Lille, France, at Philadelphia, September 26.

"La Lucha contra Tuberculosis en la Republica Argentina": Emil Coni, of Buenos Ayres, at Washington, October 2.

"The Causes which have led to the Past Decline in the Death Rate from Tuberculosis and the Light thrown by this History on Preventive Action for the Future": Arthur Newsholme, of Brighton, at Washington, September 29.

"Social Life and Tuberculosis": Gotthold Pannwitz, of Berlin, at Philadelphia, September 24.

"The Anti-tuberculosis Program—Coordination of Preventive Measures": R. W. Philip, of Edinburgh, at Boston, October 6.

C. H. Spronck, of Utrecht, at Boston, October 7.

"Tuberculosis of the Heart, Blood and Lymph Vessels": Andres Martinez Vargas, of Barcelona, at New York, October 9.

"The Evolution of the Treatment of Pulmonary Tuberculosis": Theodore Williams, of London, at Philadelphia, September 25.

"La Lutte Contra la tuberculose dans les grandes villes par l'Habitation; methodes scientifiques modernes pour sa Construction" (joint lecture): Dr. Maurice Letulle and M. Augustin Rey, at Washington, September 30.

Dr. L. Landouzy, of Paris, at Baltimore, October 5.

"Biology of the Bacillus": Dr. A. A. Wladimiroff, of St. Petersburg, at Washington, September 28.

"Collateral Tuberculosis Inflammation": Professor N. Ph. Tendeloo, of Leiden.

THE INTERNATIONAL FISHERIES CONGRESS

A FURTHER announcement of the congress, to be held from September 22 to 26, states that at 9:30 A.M. on September 22 the foreign delegates will be received by the secretary of state in the Diplomatic Reception Hall of the State Department. The initial meeting of the congress will be held at 10 o'clock in the hall of the National Geographic Society, where addresses of welcome on behalf of the United States will be delivered by Hon. Oscar S. Straus, secretary of commerce and labor, on behalf of the District of Columbia by Hon. Henry L. West, commissioner of the district, and on behalf of the American Fisheries Society by Dr. H. M. Smith, president of the society. The meeting of organization will be held in the banquet hall of the New Willard Hotel, Pennsylvania Avenue and Fourteenth Street, on the afternoon of September 22, at an hour to be announced. The regular sessions of the congress will be held daily, morning and afternoon, at times to be announced, at the New Willard Hotel. The president of the United States will receive the members of the congress at the White House. The secretary of commerce and labor will give an evening reception. Luncheons will be tendered by the American Fisheries Society, the Blue Ridge Rod and Gun Club and the Alaska Packers Association, respectively, and there will be a subscription banquet at which the official representatives of foreign governments will be the guests of the congress. Visits to places of interest and other entertainment have been arranged for by the local reception committee. Arrangements have been made to permit members who so desire to inspect the important fisheries of New England. An attractive itinerary has been arranged embracing the entire week following the sessions of the congress and including visits to New York City, Narragansett Bay, Woods Hole, Boston and Gloucester, at each of which places local committees and individual residents will provide demonstrations of fishery methods and incidental entertainment. The methods of oyster culture employed on the great New England beds, the pound-net fishery, the purse-seine fishery, inspection of fish markets and vessels, the methods of deep-sea research, and other matters relating to the fisheries will be shown. Special itineraries will be arranged for members who may desire to visit other fisheries and hatcheries, and letters of introduction will be furnished.

SCIENTIFIC NOTES AND NEWS

MR. F. J. SEAVER, assistant botanist of the North Dakota Agricultural College, has been appointed director of laboratories in the New York Botanical Garden.

DR. W. H. WELCH, of the Johns Hopkins Medical School, will deliver, on November 20, the principal address on the occasion of the dedication of the new building devoted to experimental medicine of the Medical College of Western Reserve University.

SIR GEORGE HOWARD DARWIN, professor of astronomy at Cambridge, has been elected a corresponding member of the Berlin Academy of Sciences.

THE Royal Astronomical Society, London, has elected corresponding members as follows: Dr. E. B. Frost, director of the Yerkes Observatory; J. G. Hagen, S.J., director of the Vatican Observatory; M. Benjamin Baillaud, director of the Paris Observatory; C. L. W. Charlier, director of the observatory at Lund, and Johannes Franz Hartmann, of the Astrophysical Observatory at Potsdam.

The Alvarenga prize of the College of Physicians, Philadelphia, for 1908 has been awarded to Dr. William T. Shoemaker for an essay entitled "Retinitis Pigmentosa."

The Denny gold medal, provided for by the late Peter Denny, LL.D., and granted each session for the best paper read before the Institute of Marine Engineers, London, has been awarded to Mr. Robert Elliott, B.Sc., for his paper on "Repairs to Ships," read during the session 1907–8.

Dr. Wm. T. Glazebrook is acting president of the second Optical Convention, which will meet in London in May of next year.

Dr. Kurt Wegener has been appointed director of the Observatory of Samoa.

Dr. Franz Lincke, of Göttingen, has been appointed director of the aeronautic department of the Physical Society at Frankfort.

Professor Simon Newcomb, U. S. N. (retired), was received in audience by Emperor William, on August 17, at Wilhelmshohe, after which he was invited to luncheon. Professor Newcomb thanked the emperor for the order Pour le Mérite for Science and Arts bestowed upon him three years ago.

Dr. Adolf Wüllner, professor of physics in the Aachen Technical Institute, has celebrated the fiftieth anniversary of his doctorate.

Dr. N. L. Britton, director of the New York Botanical Garden, and Mrs. Britton left New York for Jamaica on August 22, expecting to return at the end of September.

Dr. William W. Keen, who has been abroad for more than a year and a half, has returned to Philadelphia.

The president of the British Board of Trade has appointed Lord Rayleigh, O.M., Professor J. J. Thomson, F.R.S., Dr. R. T. Glazebrook, F.R.S., Sir John Gavey, C.B., and Mr. A. P. Trotter, to be the British delegates to the International Conference on Electrical Units, which is to assemble in London on October 12. Mr. W. Duddell, F.R.S., and Mr. M. J. Collins, of the Board of Trade, will act as secretaries to the British delegates.

King Edward has made the following appointments: David W. Finlay, M.D., F.R.C.P., London, professor of the practise of medicine in the University of Aberdeen, to be one of the honorary physicians to the king in Scotland, in the room of Sir Thomas McCall Anderson, M.D., deceased. Sir William Macewen, F.R.S., M.D., regius professor of surgery in the University of Glasgow, to be one of the honorary surgeons in Scotland, in the room of Sir Patrick Heron Watson, M.D., deceased. James Little, M.D., regius professor of physic in the University of Dublin, to be one of the honorary physicians in Ireland, in the room of Sir John Thomas Banks, K.C.B., M.D., deceased.

Dr. Friedrich Paulsen, professor of philosophy, at Berlin, died on August 14, from cancer, aged sixty-two years.

The death is also announced of Dr. K. Zoeppritz, observer in the Geophysical Institute at Göttingen, and known for his work on atmospheric electricity.

The ninth International Congress of Geography was held in Geneva from July 27 to August 6, and was preceded and followed by interesting excursions conducted by local geographers. The occasion was also notable as the jubilee celebration of the founding of the vigorous Geographical Society of Geneva. The division of the assembly into numerous sections, including a number of new divisions of science not admitted to previous geographical congresses, much increased the interest in the papers, though it disposed of the program long before the congress adjourned. American geographers were represented by Professors Davis and Johnson, of Harvard; Brigham, of Colgate; Cleveland, of Williams; Fenneman, of Cincinnati; Leverett, Hobbs and Scott, of Michigan; and Professor Simon Newcomb and Dr. D. T. Day, of Washington.

The French Association for the Advancement of Science, which has been meeting at Clermont-Ferrand under the presidency of M. Paul Appell, professor of mathematics at the Sorbonne, adjourned to meet next year at Lille. The meeting of 1910 will be held at Toulouse. One of the addresses at the recent meeting was by Sir William Ramsay on the results of his researches into radioactive substances.

At the meeting of the Paris Academy of Sciences on August 10, Mme. Curie stated that working in collaboration with Mlle. Gleditch, she had been unable to confirm Sir William Ramsay's experiment, by which copper appeared to be transmuted into lithium by radium emanations. With copper receptacles containing distilled water absolutely without any trace of lithium certain traces of that metal made their appearance after 24 hours under the application of radium. The same result took place in the case of a quartz receptacle. Mme. Curie and Mlle. Gleditch thereupon used a platinum apparatus. They placed in it distilled water and used copper salts produced in the laboratory entirely free from lithium. These copper salts were then exposed to emanations of radium, and no trace of lithium was discovered.

Among guests from abroad who attended the recent Sheffield meeting of the British Medical Association were Professor Axenfeld (Freiburg), Professor Bouchard (Paris), Dr. Bossi (Genoa), Dr. Depage (Brussels), Professor Fuchs (Vienna), Dr. A. M. Gilchrist (Nice), Professor Axel Holst (Christiania), Dr. Jacoby (Brussels), Professor Kolli (Bern), Professor Von Kronig (Freiburg), Dr. Just Lucas-Championnière (Paris), Professor Luigi Mangiagalli (Milan), Professor Alb. Neisser (Breslau), Dr. Noiré (Paris), Professor Onodi (Buda Pesth), Dr. Sabouraud (Paris), Professor Zweifel (Leipzig), Professor Tillmanns (Leipzig), Dr. C. Willems (Ghent), Professor Ambrose Monprofit (Angers), Professor Alb. Plehn (Berlin), Dr. Marc Armand Ruffer (Alexandria), Dr. J. G. Willmore (Alexandria), Dr. E. Marchoux (Paris), Professor Pozzi (Paris), Professor Gilchrist (Baltimore), Professor Garceau (San Francisco), Professor Holt (New York), Dr. Charles Leonard (Philadelphia), Dr. J. B. Murphy (Chicago), Dr. H. H. Pratt (Baltimore), Dr. Marcy Riverton (New Jersey), Dr. Maurice Richardson (Boston).

At the International Zoological Congress, to be held at Graz in 1910, the subject of the Emperor Alexander III. prize is "The Intervention of Mechanical Phenomena in the Transformation of Animal Forms," and the subject of the Emperor Nicholas II. prize, "A Monographic Study of the Group of Plathelminthes." The essays must be sent in by June 1, 1910, to the general secretary, M. Blanchard, 226 Boulevard St. Germain, Paris.

We have received from Dr. F. A. Bather an announcement of a double index to the generic and specific names in E. Desor's "Synopsis des Echinides Fossiles," preceded by a "Note sur les Dates de Publication," by M. Jules Lambert. Further information may be obtained from Dr. Bather at the Natural History Museum, South Kensington, S.W.

Consul General Richard Guenther, of Frankfort, notes that at the annual meeting of the Association of German Engineers lately held at Dresden, announcement was made that the great work of compiling and publishing the new technical dictionary, which was conducted under the auspices of the association, had to be stopped because it was found that the expenses would amount to more than four times the estimates. Mr. Guenther adds: "The great progress in science and industries had created a vast mass of new terms and matter largely in excess of what had been estimated at the beginning. This stoppage is to be greatly regretted, as the want of a new technical dictionary and encyclopedia is acutely felt by thousands of persons engaged in scientific research, in all lines of commerce and production, in literature, journalism, and in the administration of state and municipal government. It is, however, satisfactory to note that the executive board of the Association of German Engineers has made strenuous efforts to take up and complete this valuable work, and has succeeded in obtaining therefor the aid of the federal government of Germany and of the ministry of education of the Prussian kingdom."

We learn from *Terrestrial Magnetism and Atmospherical Electricity* that arrangements are being made to secure in cooperation with the Canadian government, magnetic observations on the eighteen-months' cruise of the Canadian steamer *Arctic* (formerly the *Gauss*), among the Arctic Islands north of the Magnetic North Pole. Mr. W. E. W. Jackson has been detailed by the minister of marine and fisheries, to duty on the *Arctic*. Magnetic, meteorological, electric and tidal observations will be attempted. Dr. Bauer recently visited the *Arctic* at Quebec, commanded by Captain J. E. Bernier, and arranged with him and Professor Stupart at Toronto regarding the magnetic and electric instruments and accessories to be supplied by the Department of Terrestrial Magnetism and as to the methods of work to be followed.

The London *Times* states that Mr. C. Kenrick Gibbons has presented to the Zoological Gardens a large number of the small fresh-water fish from Barbados known as "millions" (*Girardinus poecilloides*). These little fish, which have been placed in a tank in the tortoise house, are of special interest because of their supposed action in preventing malaria. Malaria is very much less common in Barbados than in other West Indian islands, and it has been suggested that this freedom is due to the presence of enormous quantities of the "millions" in the fresh-water pools. The little fish are very voracious, and destroy large numbers of the larvæ of mosquitoes that spread malaria. The males are about half an inch long, with brilliant iridescent colors, and large black spots on the sides. The females are considerably larger and less highly colored. It is understood that experiments are going to be made with the introduction of these fish into tropical countries where malaria is prevalent.

There is, it appears, in Great Britain a National Canine Defense League, which claims that 1,250 medical men have signed a petition in favor of a bill now before Parliament exempting dogs from vivisection, and further that 388 members have given their written promise to support the measure.

UNIVERSITY AND EDUCATIONAL NEWS

The College of Agriculture and Mechanic Arts, of Hawaii, was established by act of the legislature last March. The new college will be located at Honolulu. A site for the campus and buildings has been secured in Manoa Valley, commanding a fine view of the ocean. Professor John W. Gilmore, of the Pennsylvania State College, has been chosen president. The college will open on September 4.

On August 15, fire destroyed the main building of the large barn of the Massachusetts Agricultural College, at Amherst. Two valuable Holstein and Jersey bulls and eleven calves, together with a large quantity of hay and farm machinery, were also burned. The loss is estimated at about $40,000.

Two upper floors of Curtis Hall, used as dormitories, at Tufts College, were destroyed by a fire of unknown origin on the 16th instant, with damage of $5,000.

Professor Otto Frank, of Giessen, has been elected professor of physiology, at Munich, to succeed the late Professor Carl von Voit.

Dr. Nagel, of Berlin, has become professor of physiology at Rostock.

Dr. Curt Hensel, professor of mathematics at Marburg, has been called to Leipzig.

THE HARVARD BUSINESS SCHOOL

The Official Register of Harvard University in its issue of this week contains the first detailed announcement of the Graduate School of Business Administration which will be opened to students on October 1, under the direction of Dean Edwin F. Gay. The unique feature of the school, both in Harvard experience and in the educational world, is that the new school starts with the requirement of a college degree for admission. Upon that foundation of liberal education it rests a severe two years' course, partly prescribed and partly elective, leading to the degree of Master in Business Administration and representing work in the following special fields: Banking and finance, accounting and auditing, insurance, industrial organization, transportation, commercial law, economic resources, and public service. Courses in French, German, and Spanish Correspondence will be offered with the special object of enabling graduates of the school to read and write letters in these languages and to understand the accepted forms of business correspondence. Two of the most important courses to be offered will be entitled respectively: "Corporation Finance" and "Industrial Organization." Among those who have been engaged to lecture on Corporation Finance are Herbert Knox Smith, Commissioner of Corporations in the U. S. Department of Commerce and Labor; Frederick P. Fish; Professor Edwin S. Meade, of the University of Pennsylvania; James F. Jackson, ex-chairman of the Massachusetts Railroad Commission; C. C. Burlingham, of New York, receiver of the Westinghouse Company; Judge C. M. Hough, of the U. S. District Court for the Southern District of New York; F. A. Cleveland, of the New York Bureau of Municipal Research, and G. W. Wickersham, the New York lawyer. Among those who have been engaged to lecture on Industrial Organization are Frederick W. Taylor, ex-president of the American Society of Mechanical Engineers, and a leading authority on factory organization; J. O. Fagan, a signalman employed by the Boston and Maine Railroad, the author of the recent articles in the *Atlantic Monthly* entitled "Confessions of a Signalman," and Russell Robb, of the firm of Stone & Webster, Boston.

One of the most important features of the school will be the practical work required of each student in the summer. The object of this work will be twofold, first, to teach the student from practical experience and observation the elements of business that can not be taught in the class-room, and, secondly, to bring them in contact with the men with whom their life work is to be done. The school does not pretend to graduate men who will begin at the top or high up in their several lines of business. It does aim to teach them how to work and how to apply powers of observation, analysis, and invention to practical business problems.

DISCUSSION AND CORRESPONDENCE

CONCERNING TWO DEFECTIVES

To the Editor of Science: Inquiries from various parts of this country show that the newspapers have given wide publication to a yellow telegram from San José concerning the Lick Observatory. It was reported that the observatory carpenter, going violently insane, had driven the astronomers and a party of visiting students out of the buildings, that the telescopes were at the mercy of his wrath, and that he was overcome and put under restraint at the expense of a struggle. The facts are that the carpenter became mildly insane; that no one left the buildings on his account; that he was watched and could have been apprehended at any time; that he was not near the telescopes; and that he submitted meekly to arrest by the sheriff. A competent jury would probably decide that this mild lunatic was less harmful to the public than the penny-a-liner who took advantage of millions of helpless newspaper readers. Is the Associated Press at the command of such as he?

W. W. Campbell

SORES ON COLTS

To the Editor of Science: Some ten or twelve years ago I had about fifty colts born on my farm. When they were foaled, they appeared without a blemish. But within ten days after, the hair would fall off a spot averaging two inches long and a half inch wide, leaving a raw sore, which would, in the course of ten days, heal over, leaving a scar. Shortly after, a new crop of hair covered the spot, which by its different "sheen" would render the location of the "sore" visible for several months. The location of this sore is invariably in the hollow of the hock joint, upon the external facies of the leg, with the long diameter perpendicular as the colt stands, thus being somewhat diagonal to the Tendo Achilles. Fifteen years of close observation shows it to be an invariable feature of a colt's life in Louisiana. A number of years ago I called the attention of Dr. W. H. Dalrymple, of Baton Rouge, La. (who needs no introduction from me), to the sore; and he informs me that by his subsequent observations it seems to be universal at least in America. Asiatic horses not yet having been observed in this respect. I feel sure it is a feature of a horse's life universally.

Many times I have amused myself by telling the owner of a colt, when I had informed myself of its age, that "your colt has a sore on each of its hinder legs."

"When did you see it?" replies the owner.

On my rejoinder that "I have never even seen the colt," he would naturally "say remarks."

The attention of biologists is called to this fact, and *theories* requested—as the writer has none.

L. S. Frierson

SCIENTIFIC BOOKS

The Animal Mind. By Margaret Floy Washburn. New York, The Macmillan Co. 1907. Pp. x + 333.

In this book the author has brought together a wide series of facts which represent the main results achieved in the field of animal behavior during the last few years. It is designed both as a text-book in comparative psychology and as a ready and a convenient reference book. The volume will be of untold value to the general scientific reader, and to the comparative psychologist who has confined himself somewhat narrowly to a particular phase of animal behavior.

The material gathered together in this volume has been arranged in a logical and systematic way. The book affords, consequently, easy orientation into any given phase of the field. The style of presentation is clear and readable. It is the hope of the reviewer that this volume may fall into the hands of the general reader and thereby serve as a counter-irritant to a number of books which deal presumably with the "truth about animals." Certainly any one who has had the benefit of ordinary college training can read the book with profit.

Miss Washburn's opening chapters deal intelligently with the difficulties in the way of observing the reactions of animals; with the methods of observing such reactions; with the methods of interpreting observed facts; and with the evidence for the presence of mind in animals as inferred, on the one hand, from structure and, on the other, from behavior.

In the chapter on the mind of the simplest organisms the author treats first of the structure of the lowest organisms, next of the observed facts about their behavior, and then attempts to construct from these data the kind of mind such organisms must have—if they are conscious. This attempted construction of the mind of lower animals is a somewhat forlorn and hopeless task. The necessity of such a task is felt mainly by those psychologists who think of mind largely in terms of structure.

The chapters dealing with the sensory discriminations in animals are especially well done. Under the heading of Sensory Discrimination: The Chemical Sense, Miss Washburn brings together a vast amount of material taken from the experiments made upon animals ranging from the cœlenterates to the vertebrates. The many research articles dealing with this subject are scattered and inaccessible. The author has done a real service in bringing them together and giving them systematic treatment.

In the chapter on hearing the author, while giving a good résumé of the field, makes the mistake of saying that birds have no cochlea. I quote her in detail as follows (p. 119):

> The cochlea is supposed to be the portion of the human ear upon which the power to distinguish pitch differences rest. *Yet birds have no cochlea* [italics mine], though if we grant that animals which produce sound are those which are able to hear them, some birds at least must be capable of pitch discriminations of wide range and great acuteness. The powers of imitation so often evidenced in bird song are proof that this is the case.

Edinger's statement concerning the cochlea in birds is as follows:

> The cochlea is only slightly developed in fishes, but in birds it reaches a fair development.[1]

Wiedersheim has the following to say concerning the cochlea of birds and reptiles:

[1] "Anatomy of the Central Nervous System, etc.," Hall's English translation, 5th edition, p. 91.

Bei den ersteren wächst die Schnecke immer weiter canal-artig aus (Ductus cochlearis) und erfährt schliesslich bei Crocodiliern und Vögeln eine Krümmung sowie eine schwache Spiraldrehung. Hand in Hand damit geht eine immer schärfere Differenzierung der Lamina (Membrana) basilaris und der Papilla acustica basilaris. Beide strecken sich mehr und mehr in die Länge, und zugleich ist eine Scala tympani und vestibuli schon deutlich angelegt.[2]

It is barely possible that the author had in mind the lack of the arches of Corti in the auditory apparatus of birds. This is admitted by comparative neurologists;[3] but a well-marked basilar membrane is at hand. It will be remembered that one consideration which led Helmholtz to abandon the notion that the arches of Corti alone are responsible for the sensing of the differences in pitch and to assign that function to the fibers of the basilar membrane was due to the fact that birds possess the latter structure but not the former.

The author treats of Spatially determined Reactions and Space Perceptions, in two chapters. She discusses here: reaction to a single localized stimulus; orienting reactions; reaction to a moving stimulus; reaction to a retinal image; reactions adapted to the distance of objects. The various reactions considered in this part of the book should in all probability be treated together, but it is somewhat a stretch of the imagination to deal with them under a title so suggestive of organized mental life. Aside from this point we must comment upon the value of the organization of this complex material. Those of us who have followed in some measure the advances made in the study of the lower organisms know what a tremendous task it must have been to go through this field and to gather up the important facts and then systematically to organize them into a readable whole.

The latter part of the book deals with the modification of conscious processes by individual experience; the memory idea; and some aspects of attention.

The book as a whole is so well done that we venture the opinion that its usefulness will continue for several years to come. Its arrangement is such that the results of later researches as they appear from time to time may be easily incorporated into successive editions.

JOHN B. WATSON

THE UNIVERSITY OF CHICAGO

A Pocket Handbook of Minerals, designed for use in the field or class-room with little reference to chemical tests. By G. MONTAGUE BUTLER, E.M., Assistant Professor of Geology and Mineralogy, Colorado School of Mines, Golden, Colorado, United States Deputy Mineral Surveyor. 16mo, pp. ix + 298. 89 figures. Morocco, $3 (12/6 net). New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1908.

This book is designed for both field and class work and to fill a space between works "too cumbersome" for the field and works "so condensed as to confuse rather than aid."

Two hundred species are described in terms of those characters which the author considers best help in their determination, and preference is given to the so-called "physical features." Each species is described in the same fixed order and certain chosen characters are brought into especial prominence by the use of heavy-face type so that "a mere glance at a page will often suffice to recall the appearance of a mineral."

In the selection of important characters as indicated by heavy-face type, very great prominence is given to cleavage and very little to blowpipe or acid tests. It is certainly to be questioned whether in the field with average specimens, not usually crystals, even the trained mineralogist can determine more than the existence or non-existence of marked cleavage and in certain instances the approximate cleavage angles. The blowpipe is usually as available as the goniometer or microscope.

Following the descriptions of species, which occupy 270 pages, are some ten pages of miscellaneous tables including lists of commercially

[2] "Vergleichende Anatomie der Wirbelthiere," funfte Auflage, p. 324. Cf. also the monumental work of Retzius on the auditory organs of vertebrates.

[3] C. Hasse. See Helmholtz's "Sensations of Tone," p. 146.

important ores, retail prices of cut gems, values of metals and minerals; then follows an admirable glossary in which, however, some of the fundamental terms, such as crystal, mineral and polarize, are not defined with scientific accuracy.

The tables which follow the index are summaries of the descriptions, characters in parallel columns and minerals in order of description.

The book is of convenient size for the pocket and embodies much easily accessible and useful information. In spite, however, of the fact that it is, as explicitly stated, designed for the determination of minerals, its value in the absence of all systematic schemes would seem to be rather to refresh the user's memory as to the characters of known or suspected minerals, than as a guide to the determination of unrecognized material.

A. J. MOSES

Analysis of Mixed Paints, Color Pigments and Varnishes. By C. D. HOLLEY, Ph.D., and E. F. LADD, B.S., Professors of Chemistry, North Dakota Agricultural College. New York, John Wiley & Sons. Pp. 235.

This book presents in a more accessible and considerably enlarged form the results of the work done in connection with the enforcement of the North Dakota paint law. It gives the latest and best methods for the analysis of the substances mentioned in its title, and, what is still more valuable, the composition of these articles as found on the American market.

The method for the analysis of linseed oil, however, is incomplete, no mention being made of the process for detecting fish oil in it with certainty.

Incidentally it furnishes a striking commentary on the honesty and integrity of the American paint and oil trade. The authors' investigations showed "white leads" which contained no lead carbonate and but five per cent. of lead sulphate; other pigments were found which were branded in a manner calculated to mislead. Not content with this sort of fraud, water, in some cases to the extent of twenty-five per cent., was mixed with the paints and these put up in packages which were 10 to 13 per cent. short in weight or measure! The authors have done a real service in showing up such conditions.

The work is one of the best contributions to the literature of these subjects that have appeared, dealing not only with analyses, but also with specifications, and the application and testing of paints on a large scale, and should be in the library of every one having to do with the subjects treated.

A. H. GILL

SPECIAL ARTICLES

SOME CONDITIONS AFFECTING VOLCANIC ERUPTIONS

IN the study of such natural phenomena as are difficult to investigate by reason of inaccessibility, or of danger to the observer, it is natural and often advantageous to consider some analogous, but less obscure phenomenon and, from a careful study of this, to deduce the laws which govern the former. A case in point is that of a volcano in eruption which, by its very nature, prohibits close inspection, but with which a certain degree of parallelism is found in the action of geysers. More than thirty years ago Fuchs called attention to the similarity existing between the two, comparing the column of water in the geyser tube to the lava in the interior of a volcano and stating that geysers "ont encore une grande importance en ce sens qu'ils nous permettent de nous faire une idée claire des phénomènes qui produisent les éruptions volcaniques." (K. Fuchs, "Les volcans et les tremblements de terre.") In the light of modern volcanological science, however, this generalization of the term "éruptions volcaniques" will be found too sweeping, for it is clear that the action of a trachytic volcano, whose highly silicious magma is at best in a viscous state, can with difficulty be considered as analogous to that of a geyser where fluidity is the most evident characteristic. A comparative study of the two phenomena should, therefore, be prefaced by the explicit statement that the volcano in consideration is of the basaltic type, with lava which is liquid at the temperature of action, and consequently subject to the laws of hydrostatics. With this understanding let us examine for a moment the points of analogy and of difference between the two.

In the lower portions of the geyser-tube the water becomes heated by conduction above 100° C. Ebullition can not take place because of the pressure of the water above, and the excess of heat represents stored energy—a latent force which will manifest itself upon relief of the pressure due to the above standing water column. This latter may be considered as divided into an indefinite number of zones each having a critical temperature depending on its position, that of the surface layer being 100° C. The column of water is progressively heated from below by conduction and convection until the water of some zone attains its critical temperature; boiling takes place, relieving the pressure on the water just below, which, in its turn, bursts into ebullition, and thus a progressive reactionary movement is set up with a rapidly increasing amplitude of vibration until most of the energy latent in the superheated depths is set free, completing the eruption. The action is often begun by a raising of the water, which, at some zone, is near its critical temperature, into a position of lesser pressure, when boiling will begin and the reactionary process be initiated—in either case it will be noted that it is the rapid diminution of pressure by the act of ebullition which institutes the vibratory process. The reader will here recall that, in the bursting of steam boilers, the action is also thought to be multiple, the too rapid escape of steam from a broken part resulting in the sudden liberation of energy latent in the superheated water, thus completing the explosion.

Let us now consider the action of a basaltic volcano, assuming the central conduit to be filled with liquid magma up to the crater. The lava in the conduit below the crater will be subjected to a pressure increasing proportionately with the depth, and the water and other gases occluded in the magmatic material will, under such conditions of pressure and temperature, be possessed of an enormous latent force of expansion. An upforcing of the lava column or a rapid increase of temperature may, therefore, precipitate an eruption by instituting a reactionary process of gaseous expansion exactly as in the case of the geyser. The greater dimensions of the volcano, together with the density of the magma, will render this reactionary process more gradual than in the geyser; inertia and momentum will prolong the vibratory periods, and days instead of minutes may be required to bring about the culmination. It may, indeed, be questioned if, in many cases, an elevation of the lava column, or an increase in its temperature would be sufficiently sudden to initiate the reactionary process, but this may be brought about in another way. An interesting point of divergence from the geyser lies in the height of the volcanic cone within which the lava may rise to a considerable elevation above the earth's surface. Pressure of the lava column on the walls of the cone aided by explosions from below and the re-fusing power of the magma may fissure the cone and permit of a lateral outflow. If this is sufficiently rapid to considerably reduce the level of the lava, the pressure on the magma below is greatly diminished and gaseous expansion takes place, an immense amount of vapor is set free to do battle with the solid materials (due to collapse consequent to the withdrawal of a large quantity of lava), and a great eruption is thus produced. In my opinion, we need not conclude that the rapid gaseous expansion extends to the greater depth of the volcanic conduit and much less to the fire-pocket itself, where the magma, by reason of pressure, may be in a pasty or quasi-solid condition, but the active expansion would be limited to a zone whose depth will bear a certain relation to the original height of the lava column and the difference of level resulting from the outflow. The greater the difference of level the deeper will be the zone of active expansion and the sum total of energy released. The more *rapidly* the disleveling is produced, the more violent will be the explosive effects, although the total quantity of vapor expanded may be independent of this rapidity, *providing always that the lateral drainage is sufficiently rapid to produce the difference of level.* For it is precisely this which makes the difference between a catastrophal eruption of this class and one which is merely a phase in the progression of an eruptive period. Terminal or subterminal lava streams, or the sluggish forms of lateral outflows can not produce a material reduction in the level of the lava—the former by reason of their location and the latter because the slow drainage is continually compensated by alimentation from below; there being no rapid diminution of pressure, there is consequently no abnormal expansion.

In considering further the points of divergence between geyser and volcano it would seem that, aside from the obvious dynamic and caloric disproportion—that is, the relative insignificance of the former in size, mechanical power and heat energy—a fundamental difference lies in the relative proportions of water and temperature. In the geyser the heat is moderate while water is abundant and, after an eruption, may freely flow into the central conduit, which it occupies in mass. But in the case of the volcano we may imagine that the water can reach the fire-pocket only by capillary infiltration and under such conditions of temperature and pressure as will cause its intimate union—possibly through complete dissociation—with the heated materials with which it comes in contact, forming thus an incandescent, eruptive magma. And this will be the case whether the temperature results from chemical combination of the water with oxidizable material (Davy), from mechanical friction and compression (Mallet) or from the retained original heat of the earth. The magma will augment in quantity, in temperature and in expansive power with the progressive infiltration of water, and, with its occluded gases will seek a vent at the earth's surface. If there exists, instead, a universal magma with already occluded water gases there will still be the same proportion of water to temperature.

But what is perhaps the most important point of difference between geyser and volcano—and to this all the preceding forms but an introduction—is that in the former, actual eruption is determined and brought about by conditions existing within the geyser itself, while in the latter this is not the case. The geyser is truly automatic, the volcano is not. In studying the development of volcanic eruptions one is irresistibly led to the consideration of modifying and controlling forces acting from without and which may even be extra-terrestrial. It is not denied that, given the progressive delivery of active volcanic material from below, an eruption would in time occur even without external influence, but it is claimed that, under actual conditions, eruption will inevitably be precipitated before such a time. If this is true, the study of such modifying influences becomes of the greatest importance, especially in connection with the foretelling of eruptions, and it is only from a profound conviction of its usefulness that the writer ventures to bring forward at this time an old and abandoned hypothesis—that of the luni-solar influence. I believe that the discredit into which this theory has fallen since the days of Palmieri is due partly to a not unnatural reaction from his somewhat extreme views on the subject and partly to a misunderstanding of the mode of action, the few attempts which have been made to show a correspondence between the lunar phases and volcanic phenomena being rather inconclusive. Riccò, in an interesting pamphlet,[1] gives tables showing, in four cases, a coincidence between luni-solar combinations and the eruptions of Stromboli, but neither the coincidence here nor the lack of it in five remaining cases seems very definite, because the time of the eruptions is merely given as the "date of the beginning of the periods of singular activity." External influence upon earthquakes has been more generally studied, Schmidt having presented[2] a carefully prepared summary of the effect of lunar distance, luni-solar positions,

[1] "Sulla influenza luni-solare nelle eruzioni, del Prof. Riccò."

[2] "Stud. üb. Vulk. u. Erdbeben," Leipzig, 1881.

barometric pressure, time of day, time of year and weather upon earthquakes, but each of these is considered separately, while it is only by combination that they are rendered effective. Falb, in a very studious work rarely quoted,[8] considers the luni-solar combinations with conclusions favorable to their coincidence with seismic movements, but the aggregate conclusions of all who have examined the subject do not form a definite and harmonious result. I believe this to be due in part to the very elaborateness of the methods used in treating an essentially simple subject and to taking into consideration a great number of very slight earthquakes and eruptive phases whose entry into the calculation has led to erroneous conclusions—it is like including the mortality of infants in computing the length of human life. I propose, therefore, in this paper, to make a preliminary examination of the subject as it has developed under my own studies during the past two years.

It will be impossible, however, to enter at this time into an exhaustive study of all the possible manifestations or transformations of energy by which the luni-solar influence may affect terrestrial volcanism—tidal action, atmospheric electric potential, electro-magnetic telluric currents, etc.—but, without excluding these, we may for the present simplify our conception of the influence by considering it as productive of a *gravitational disturbance of the terrestrial mosaic.* Imagine such a body as the earth subjected to the varying attraction of the sun and moon, now on one side of both, now revolving between the two like the armature of a giant dynamo in its field of magnetic force; with the moon in such close proximity as to exert a considerable *difference* in attractive force at the earth's center and at the nearest and farthest peripheral points and with an orbit so elliptical as to vary its distance by a factor of more than one tenth. And then consider that in the crust of this revolving earth sphere there exist volcanoes, which are at times in a condition of potential eruption and rock strata in a condition of stress amounting to potential faulting, and it will readily be seen how small is the power required to touch off these little accumulations of latent energy in proportion to the enormous forces involved. Note that the celestial influence is here considered as being exerted merely in the releasing of stored energy and not as being directly concerned in the accumulation of the latent forces. Note also that we have now cast off the restriction imposed earlier in this paper as to the type of volcano to be considered, all types being affected by the external influence.

Let us now consider in detail that which we have defined as "gravitational disturbance." When the sun and moon are in line with the earth, their combined attraction tends to deform the earth sphere to an ellipse—the tendency is resisted and a condition of stress results. When in quadrature their influence is largely neutralized and these changes, in connection with the earth's diurnal rotation, may be considered as the basis of the gravitational disturbance.

The greatest luni-solar gravitational effect, for these latitudes, will be produced when the sun and moon are at opposite ends of a diameter through the earth's center (opposition) and having a north and south declination respectively of 23° (solstice) and with the moon in perigee. These positions would also tend to produce the greatest ocean tides, but we should avoid considering this influence on the basis of tidal action—it is because of this, in my opinion, that much misunderstanding has arisen. We have not to do with a liquid ocean, where, under luni-solar attraction, a moving wave-form would produce, at the times of maximum effect, very high and very low tides, but we must consider a mosaic globe composed for the most part of solid materials in which the effects, although not of such amplitude as to be visible, will be more powerful and less ephemeral. We may imagine the mean luni-solar effect upon the earth during the several days of each favorable position to be a tendency to positive deformation of the sphere. This will result in a diminution of lateral pressures due to terrestrial gravitation

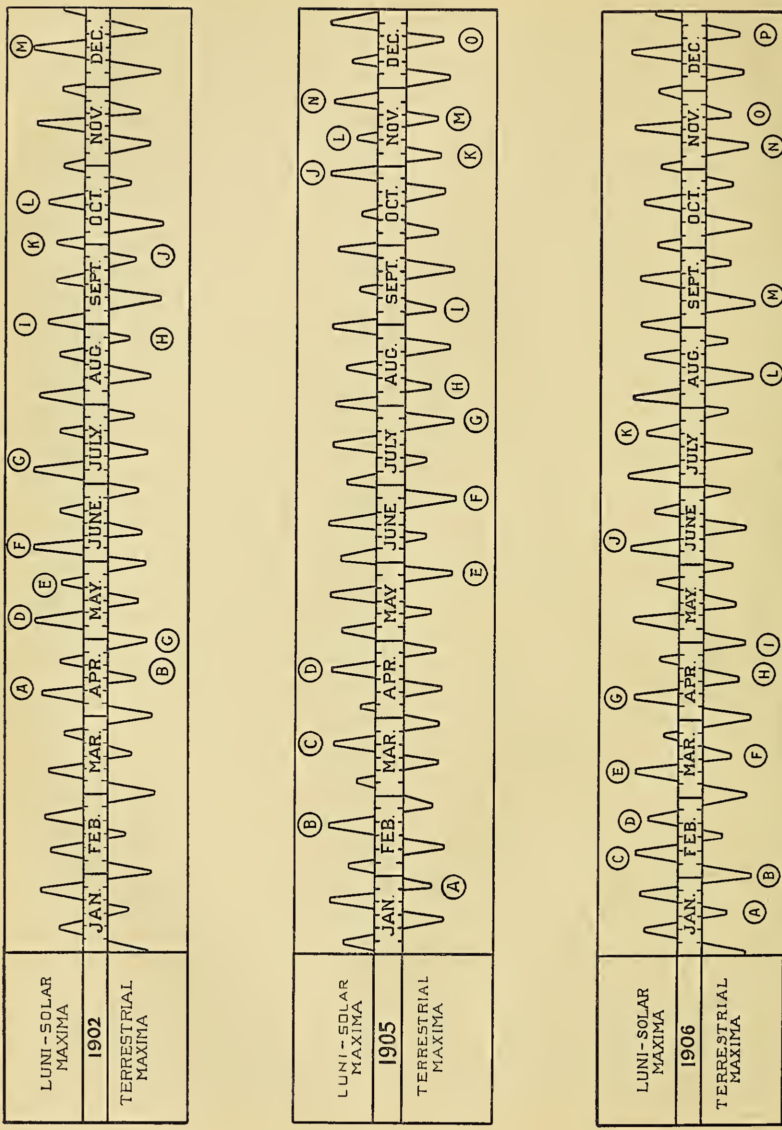
[8] "Grundzüge zu einer Teorie der Erdbeben und Vulkanausbrüche," Rudolf Falb, 1869.

and will be equivalent to a condition of uplift throughout the mass, fissures will tend to widen, and gases in magmatic material will expand. The extreme of this effect will, therefore, tend to favor the emission of gases from volcanic magma, to determine the explosive crises of an eruptive period and to bring about the culmination of great eruptions.

The *minimum* luni-solar influence will be produced when the sun and moon are in quadrature with the earth, with zero declination (equinox) and with the moon in apogee. But it should be noted here—and this is a most important point—that this celestial minimum constitutes a *terrestrial maximum*. The virtual neutralization of the luni-solar distorting power gives full sway to terrestrial re-formation, the results of which, although the converse of those we have just considered, are fully their equal in importance. These periods of maximum terrestrial action will result in a general increase of lateral pressures, tending to the compression of fissures and to the breaking of strata in a condition of stress. The increased pressure on the firepocket and lava-filled fissures of a volcano will force the magma to a higher level, bringing up fresh lava at a higher temperature and tending to cause lava flows; it will readily be seen how slight a compression of a fissure 40 km. in depth would be required to upforce a large amount of lava into the crater of a volcano. Powerful explosive effects may also accompany this phase, being due to the upforcing into the conduit and crater of active, high-temperature lava, and, although of a different character from the paroxysmal gaseous emission of the luni-solar maxima, these explosions may be more effective in rupturing the cone because acting against the pressure of a high lava column; they are, therefore, productive of lava flows and often initiate in this way the progressive reactionary process which will lead up to a catastrophal culmination coinciding with the succeeding luni-solar maximum. As the term *luni-solar minimum* would be confusing as applied to a condition which produces a positive effect, I prefer to designate this phase by the term "terrestrial maximum" as contrasted with "luni-solar maximum." We may, therefore, classify the two orders of maxima with their effects as follows: *Luni-solar maxima* equals *opposition* or *conjunction* plus *perigee* plus *declination*, tending to precipitate explosive crises, paroxysmal emission of gases and the culmination of great eruptions; and *terrestrial maxima* equals *quadrature* plus *apogee* minus *declination*, tending to cause lava flows, rupturing explosive effects and earthquakes. While earthquakes may be caused by either order of maxima, it will in general be found that the great tectonic earthquakes follow, as we should expect, a terrestrial maximum, while those of the volcanic or intervolcanic[4] type may succeed either order of maxima. Earthquakes lag, as a rule, a day or two behind the culmination of the maximum. As the two orders of maxima are complementary, it is obvious that the greatest possible effect will be produced when strong ones occur in proximity, *i. e.*, when a very favorable luni-solar maximum is followed by a very favorable terrestrial maximum, or *vice versa*. We may even suppose, given the general ascensional tendency of the volcanic magma, that a sort of pumping action may take place, a terrestrial maximum forcing lava upwards, a luni-solar maximum holding it there by gaseous expansion, a renewal of the terrestrial effect upforcing more lava, etc. It is possible that such an action may play an important rôle in the formation of new volcanoes, in the production of eccentric eruptions, in the reestablishment of communication between fire-pocket and crater through an obstructed conduit and especially, perhaps, in the eruptive processes of all trachy-andesitic volcanoes with their viscous, highly silicious magma. The compression and elongation stresses due to these alternating effects may also be a potent source of heat.

In plotting a curve of the two orders of maxima I have traced these above and below a medial zone representing an interval be-

[4] Mercalli thus classifies the Calabrian earthquakes, believing that these result from the movements of deep-seated magma.


LUNI-SOLAR MAXIMA
1902
TERRESTRIAL MAXIMA
LUNI-SOLAR MAXIMA
1905
TERRESTRIAL MAXIMA
LUNI-SOLAR MAXIMA
1906
TERRESTRIAL MAXIMA
JAN.
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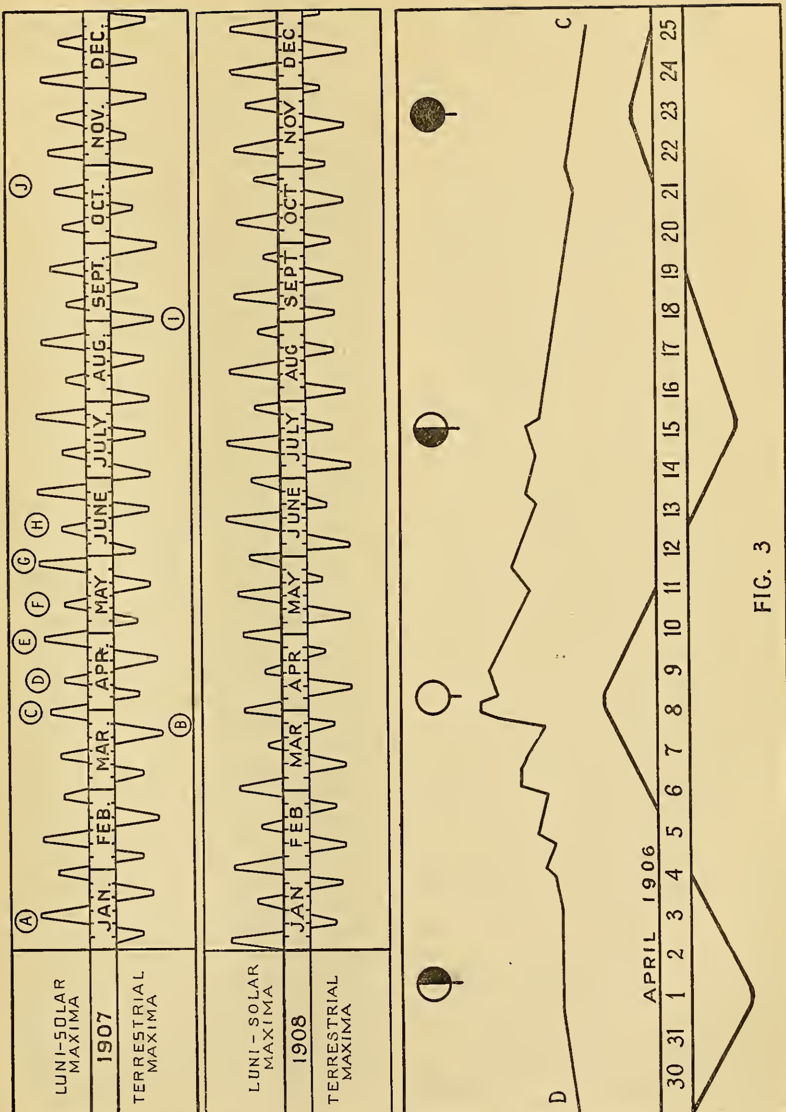
LUNI-SOLAR MAXIMA
1907
TERRESTRIAL MAXIMA
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
A B C D E F G H I J
LUNI-SOLAR MAXIMA
1908
TERRESTRIAL MAXIMA
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
APRIL 1906
30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
C
D

FIG. 3

tween conjunction or opposition and quadrature. The values assigned to the various contributory phases are arbitrary, being merely such as have resulted from a brief study of the subject, and as such may be modified by future observations. The effect of conjunction seems to be a little less than that of opposition, but I have given it the same value as the latter; perigee is very powerful. I have used the following values for the luni-solar maxima: Opposition or conjunction 20 points, perigee 20, and half the actual degree value of declination—for example: with moon and sun in opposition, moon in perigee and north and south declination 20°, the result would be: Opposition 20, plus perigee 20, plus declination 10, equals 50. If the moon were in apogee the result would be 20 points less; if the declination were zero the result would be 10 points less, etc.

For the terrestrial maxima, below the medial zone, the values are the same but inversely applied, thus: quadrature 20, apogee 20 and zero declination 10 points. Declination differences in alignment of sun and moon for opposition and conjunction are deducted from the declination values. Difference and supplement in right ascension and the right ascension itself are neglected as being of little importance, and no account has been taken of the earth's perihelion passage nor of the difference in power of sun and moon. The declination values of quadrature are very difficult to assign and it is here that most of the inaccuracy will be found—it is a problem for the astronomer. When any maximum occurs just before or after perigee the point of the maximum is inclined toward the date of perigee. The apogee-perigee values are taken from sinuous curves traced within the medial zone but which do not appear on the finished chart.

On the basis just outlined I have prepared the accompanying curves for 1902, 1905, 1906, 1907 and 1908. In comparing these with some volcanic phenomena occurring in these years I have preferred—in order to avoid any possible personal bias—to quote from the published observations of others, especially of that most accurate observer and indefatigable student of Vesuvius, Prof. G. Mercalli. These observations were made by him without consideration of astronomical influences and were published before I had made his acquaintance. The accompanying curves were made by me according to the above rules and in ignorance of Mercalli's observations.

Referring now to the chart for 1905, I will translate from his "Notizie Vesuviane (anno 1905)," making only such excerpts as relate to the greatest activity during each month.

January: "In the night of the 25th and 26th the explosions took on a character purely *strombolian*[5] with high projection of incandescent material (every four or five minutes)," see (*A*) on chart. The reader will here wish to ask why this did not occur on the date of the first terrestrial maximum, which is more accentuated than (*A*), but it should be noted first, that (*A*) follows a strong *luni-solar* maximum with which it forms a cycle, and it should be remembered also that the active periods we are now considering are comparatively unimportant and may be influenced by local conditions—the interesting and fundamental fact is that even these occur on some maximum of the curve. February: The activity was quite uniform during this month, but the culmination seems to have occurred on the 22d, when the incandescence at the crater—on other days spoken of as "sensible" —is parenthesized as "rather strong." This is close to (*B*). March: "On the 18th and 20th the incandescence was so vivid as to be visible as far as Naples at 6:45 P.M. while it was yet day . . . the new interclosed conelet . . . presented two points separated on the west by a profound depression, where, during the night of the 19th and 20th, I observed permanent incandescence due to a small outflow of lava or at least to the elevation of the

[5] Mercalli's use of this term, now generally adopted, signifies an emission of luminous materials, incandescent fragments and white vapors as contrasted with "vulcanian" which indicates the ejection of non-luminous blocks and bombs with abundant detritus presenting the appearance of black smoke. The terms are descriptive of the *character* and not the force of the explosion.

magma to the edge of the said depression," (*D*). May: In this month occurred the great event of the year—the lava outburst which initiated the long period of lava emission culminating in the catastrophal eruption of April, 1906. Mercalli writes: "In the night of the 25th–26th, after the strongest explosions, the entire surface of the terminal conelet was aglow. The *maximum* occurred on the 26th: by day I saw columns of white vapors without ashes which rose to a thousand meters above the crater; at 5 P.M., although yet day, already there commenced to appear the incandescence of the projected magma: later the ejected scoriæ formed streaks of fire on the external flanks of the cone. At 8:30 P.M. a strong explosion commenced with a very vivid *white light,* certainly due to flames; there followed after a few seconds the usual red color of the bits of incandescent magma. . . . During the day of the 27th the explosions and trembling of the ground were noticed as far as the Hotel Eremo. At about 5:30 P.M. the custodians of the upper station of the funicular railway felt strong earth-shocks. A little later, viz., at 6:15, there opened a first mouth of outflow," etc., (*E*). June: "About the 24th the increase of the outflow was accompanied by a strong explosive activity of the mouth where there was formed a conelet of scoriæ projected from a large eruptive fumarole, (driblet-cone of the English). . . . During the 23d and 24th the explosions were strong but mixed: in the evening they began with dark jets to which quickly succeeded the projection of incandescent scoriæ. On the 25th the explosive activity was very strong until evening (about 7 P.M.) when a portion of the interclosed terminal conelet collapsed," (*F*). July: "Often the lava flowed for a considerable distance covered by preceding lavas, then welled up again from 'pseudo-mouths.' Rapid changes succeeded from the breaking and perhaps the re-fusing of the lava crust at the times of increase. For example, in the early evening of the 29th the principal stream flowed for the most part covered; while instead, a few hours later (between 9 and 12 P.M.), I saw the stream all continuous and very vivid, especially in the lower part," (*G*). August: "The *maximum* occurred on the 8th: then the projectiles reached the edge of the crater of 1872 and the windows and doors of the lower funicular station were rattling," (*H*). September: "The morning of the 8th, between four and five o'clock (the lava) crossed the roadbed of the railway, covering it for about 120 meters, after having demolished in part the large stone wall which the firm of Cook had constructed to protect the lower station of the funicular," (*I*). October: The activity was generally great throughout the month, but I think the culmination is indicated by these words: "After 3 A.M. of the 28th–29th, very violent explosions commenced which shook the two stations, upper and lower, of the funicular." The station master wrote me: "After 3 A.M. a formidable first shock opened up a series of shocks which seemed as though each would dislocate the entire funicular," (*J*). November: . . . "Slight increases (in the lava flow) occurred on the morning of the 6th (*K*) and on the 11th, 17th and 26th (*L*) (*M*) (*N*) . . . the explosions became rather strong on the 5th and 6th," (*K*). December: "After the 16th, a second, more central mouth gave mixed or vulcanian explosions: from the 16th to the 21st and especially on the evening of the 17th a considerable quantity of ash rained as far as the lower station of the funicular. All the while the strombolian action of the other mouth continued," (*O*). In a summing up for the year Mercalli states: "The elevation of the magma to the edge of the crater (19th–20th April) and the explosions accompanied by *flames* (26th of May) signal the two most important maxima of the strombolian dynamism," (*D* and *E*). "In coincidence with the second strombolian maximum there was instituted a sub-terminal outflow of lava," (*E*).

Mention should also be made of the great Calabrian earthquakes on September 8 (*I*) and on October 30 (*J*), and of a volcanic earthquake at Naples on November 26 (*N*).

Mercalli's "Notizie Vesuviane" for 1906 are not yet published. The activity was very great during the first months of the year, with a marked increase in the lava output on February 2 (*B*)—chart for 1906—and an explosive maximum on February 7 (*C*), for an account of which see the New York Sunday *Herald*, April 1, 1906. The great Vesuvius eruption culminated on April 8 (*G*) and the reader is now referred to Fig. 3 which represents Mercalli's dynamic curve of the eruption —D. C.—to which I have added the astronomical data and the luni-solar and terrestrial maxima curve extended horizontally to fit the scale of Mercalli's diagram. Note how well the progressive reactionary process, of which we have spoken before, is exemplified in the dynamic curve from April 4, working up with increasing amplitude of vibration to the great culmination on the eighth, and note the general correspondence with the maxima curve throughout the entire eruption.

Assuming that we had had this luni-solar and terrestrial maxima curve at the beginning of 1906, it may be well to ask ourselves here if we could have predicted the eruption? Knowing the potential condition of Vesuvius at the time, we should probably have expected the eruption during the maxima combination (*C*) preceded by (*B*), but, that failing to be the crisis (although the activity was then very great), I think that we could have predicted it for April 8 (*G*), preceded as this was by a very strong terrestrial maximum. I have before pointed out that the length of the line joining two different maxima is a measure of the influence. In any event, we could have been morally certain that the eruption would have been precipitated by the strong maxima which follow—in other words, that the summer would not pass without a great eruption.

The San Francisco earthquake of April 18 showed the normal trifling lag behind the terrestrial maximum (*H*), but at Formosa an earthquake occurred on April 14, and another on March 17 (*F*). Other severe earthquakes occurred during the year in Iceland, November 8, 9 (*N*) and November 22 (*O*); Kopal December 22 (*P*); Sicily September 13 (*M*); Calabria January 17 (*A*) and June 10 (*J*); Central Asia August 13 (*L*); India March 10 (*E*) and July 21 (*K*); Columbia January 31 (*B*); West Indies February 21 (*D*); and Saxony April 28 (*I*).

On the curve for 1907 the five explosive crises of the great eruption of Stromboli are shown at (*D, E, F, G, H*), for a full account of which, with dynamic curve, the reader is referred to the *Brooklyn Institute Museum, Science Bulletin*, Vol. 1, No. 7. Mauna Loa was in eruption January 10 (*A*) and Jaggar reports a violent disruptive explosion of Bogosloff on September 1 (*I*). Severe earthquakes occurred at Jamaica, January 14 (*A*), and March 25 (*B*); in Mexico, April 14 (*D*); Bitlis, March 31 (*C*); San Miguel (Azores) April 2 (*C*); and in Calabria, October 23 (*J*).

In order to look backward a little I have selected 1902 as being rich in volcanic manifestations and have prepared a curve for that year. The great explosive crises of Pelée occurred on May 8, June 6, July 9, August 30 and December 16. Professor Lacroix writes ("La montagne Pelée et ses éruptions") "Le 8 Mai s'est produit le phénomène terrifiant qui, en quelques minutes, et peut-êtres moins, a anéanti S. Pierre et ses 28,000 habitants" (*D*). Nuées ardentes 20 Mai (*E*) et 6 Juin (*F*). "Une brusque recrudescence paroxysmale le 9 Juillet" (*G*). "Le 24 Août une secousse de tremblement de terre est ressentie dans toute l'île" (*H*). "Un grand paroxysme se prepare, il éclate le 30 Août" (*I*). Nuée ardente 16 Decembre (*M*).

At St. Vincent: "A la fin d'Avril 1902 ils (earthquakes) augmentèrent, . . . le 29 Avril il ne se produisit pas moins de 18 secousses au Morne Rouge (*C*)." "Le 7 Mai eut lieu la grande explosion (*D*)." "Un nouveau paroxysme s'est produit du 15–16 Octobre" (*L*).

The Pelée paroxysm of July 9 does *not* correspond with the curve. The writer would call special attention to this, the only notable exception in the entire series of events, in the hope that some explanatory observation may be forthcoming which shall give greater precision to the making of future curves.

At Izalco (Salvador) there was a violent eruption September 29 (*K*).

Heilprin ("Mt. Pelée and the tragedy of Martinique") mentions severe earthquakes in Guatamala, April 18 (*B*) and September 26 (*J*); Finland, April 10–11, and Lake Baikal, April 12 (*A*); Caucasus, April 17 (*B*).

Finally, to turn from the past to the present and future, I have plotted the curve for 1908—a clean page upon which the reader may make his own observations. The Chilapa (Mexico) earthquake and the sudden disappearance of the lake in Oregon will be found to correspond well with the curve. The earthquake registered by the Washington seismograph May 15 and calculated to have occurred at a point about 3,000 miles distant should, if our conclusions are correct, be of volcanic origin, corresponding, as it does, with a luni-solar maximum. From the condition of Etna during 1907 the writer freely predicted an eruption during the present year and, with the aid of the curve, localized it to the spring and summer months. At the time of writing (May) news has come of the initiation of the eruption and it will be interesting to follow its course in connection with the curve and to see if its crises and culminations correspond with the maxima of June 15, July 14 or August 13.

In conclusion the writer desires to state that he fully realizes the crudity and incompleteness at present of this working theory, and his object in bringing it forward at this time, instead of elaborating it by further study and observation, is to stimulate the criticism of others in order that the truth may be the more rapidly advanced. The importance of being able to foreknow the dates in each month when volcanic and seismic manifestations will take place is too obvious to require emphasizing and these data, in connection with research work localized at volcanic and seismic centers, should carry us a long step forward along the line of definitely predicting all such events. During the past two years the writer has often made use of this foreknowledge in planning his visits to volcanoes at interesting times and in absenting himself for preparation work during the intervals of quiet, and it was principally by means of the luni-solar curve that the crisis in the eruption of Stromboli last year was shown to have already occurred when warships had been sent with a view to deporting the 4,000 inhabitants. A resort to this extreme measure was thus rendered unnecessary and this application of our working theory forms a good example of its practical utility.

The present activity of Etna should form a good control and will undoubtedly be of aid in the computing of future curves.

Frank A. Perret

THE LOCATION OF EMBRYO-FORMING REGIONS IN THE EGG

The relation between the visible substances of the egg (nucleus, yolk, pigment, oil, etc.) and the regions of organ-formation has attracted the critical attention of embryologists in recent years. No little diversity of opinion has been expressed as to the rôle played by these substances; whether they represent organ-forming regions, or whether they are only indicia, at most, of more profound changes, is at present the central point of dispute. The separation and stratification of many of these substances by means of the centrifuge has made possible the further analysis of the problem. I wish to put on record here the results of an experiment that bears very directly on the interpretation of the location of organ-forming regions of the egg of *Arbacia*.

As first shown by Lyon, the egg of the sea-urchin may be stratified into four regions by means of the centrifuge. The nucleus is driven into the axis of rotation (secondary egg-axis) and comes to lie near the lighter pole of the egg. Cleavage takes place in most cases at right angles to the stratification. I have been able to demonstrate that the cleavage planes stand in no relation to the original egg axis. Nevertheless, the typical cleavage system generally appears. The primary axis of the embryo, however, bears no fixed relation to the stratification. The fundamental question to settle therefore is what factor determines the location of the embryonic axis.

This point I have been able to determine by means of the "attachment funnel" (micropyle?) of the egg-membrane. Boveri has shown that the funnel corresponds to the point of attachment of the egg to the wall of the ovary. It lies opposite to the point of formation of the micromeres in the normal egg, and therefore also opposite to the gastrula pole of the egg. I find that in the centrifuged egg of *Arbacia* the micromeres also appear opposite (or as nearly so as possible) to the attachment funnel, without regard to the stratification of the materials.

Miss G. B. Spooner, working with me, has demonstrated that wherever the micromeres lie on the centrifuged egg there also the gastrulation takes place. Putting together these facts, it is evident that the axis of the embryo derived from the centrifuged egg is the same axis as that of the normal egg. In other words, the location of the nucleus, of the oily matter, of the yolk, and of the pigment of the egg has no determinative influence on the location of the embryonic organs. These visible materials are not organ-forming, nor do they act as initiators of organ formation. Even removal of the nucleus from its normal relations to the egg-axis has no baleful influence on the development.

The results demonstrate that the location of embryo-forming regions is a cytoplasmic and not a nuclear phenomenon. Boveri's classical experiment with dispermic eggs, which he brought forward in order to demonstrate the importance of the nucleus in the early development, receives an entirely different interpretation in the light of these facts. The conclusive demonstration of the location of the primary axis furnished by the experiment given above leads to some far-reaching conclusions concerning the factors of development, and the supposed value of the grosser materials of the egg as organ-forming substances:

1. By means of the centrifuge it is possible to drive the nucleus, the yolk, and pigment granules through embryo-forming materials of the egg without necessarily affecting the polar relations of these materials, and without necessarily injuring them for further development.

2. The displaced nucleus does not return to its original position before cleavage, and its new location determines the position of the first plane of cleavage. There is no essential relation between this plane of division and the planes of the embryo.

3. The embryonic axis is determined in the egg, but whether it is the outcome of an arrangement or gradation of materials which are not affected by the centrifuging, or whether it is due to a hidden structural basis ("organization") can not perhaps be determined from the evidence. When all the facts are taken into consideration, however, the former alternative seems to be more in accord with the results.

4. After centrifuging and before cleavage there is to some extent a remixing of the separated substances, but this partial return shows no evidence of redistribution in the direction of subsequent organ-formation, but is due to movements connected with karyokinesis.

5. The possibility that formative substances are present other than the visible substances here referred to must, of course, be admitted, but such materials are in the egg of the sea-urchin not seriously disturbed by a centrifugal force sufficient to separate the visible substances of the egg. On the other hand, I have found for the egg of the frog that a speed higher than that necessary to separate the grosser materials interferes with the normal development, and in such cases it seems not improbable that more fundamental materials become displaced.

6. The experiments do not show conclusively the origin of the bilaterality of the embryo, but they do show that this is not caused by the stratification, *nor by any particular cleavage plane*, nor by the position of the nucleus.[1] The inference that bilaterality is also "given" in the egg seems therefore most plausible.

T. H. Morgan

Woods Hole,
August 17, 1908

[1] The evidence on which this statement rests is only partly given in the present communication.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 4, 1908

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING[1]

WHAT IS NEEDED IN THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING? (*a*) RANGE OF SUBJECTS; (*b*) EXTENT IN THE VARIOUS SUBJECTS; (*c*) METHODS OF PRESENTATION; (*d*) CHIEF AIMS.

By CALVIN M. WOODWARD, Professor of Mathematics and Applied Mechanics, and Dean of the School of Engineering and Architecture, Washington University.

I want to emphasize the point which Mr. Scott has just touched on, and that is that we often attempt too early to teach the subjects that require mature and reflecting minds. I want to tell you a story, a true biography of some one you all know of. He went through, in the city of New York, the whole range of mathematics, including analytic geometry and calculus. He learned his formulæ and definitions and "passed" in some manner, but, he told me, he did not know anything about them. He believed he was a dunce, and whenever he was required to make an intelligible demonstration, he could not do it; his teachers and his parents concluded that he was a dunce in mathematics, and could

[1] General discussion following the presentation of four formal papers (see SCIENCE, July 17, 24 and 31, 1908), and of the eight prepared discussions (see SCIENCE, August 7 and 28, 1908). Presented before Sections D and A of the American Association for the Advancement of Science and the Chicago Section of the American Mathematical Society, at the Chicago meeting, December 31, 1907.

never do anything in it. He would have gone through life with that notion, if some one had not offered him an appointment to West Point. He doubted his ability to pass the entrance examination in arithmetic; but his friends advised him to get an arithmetic and study. He bought a book and sat down and read the book through, and to his astonishment he found it easy. He passed his examination with flying colors. He entered West Point and graduated at the head of his class in mathematics, and is now at the head of a high grade technical school. If it had not been for the opportunity of going again over his whole course of mathematics, he would have gone to his grave thinking he had no capacity for mathematical analysis. That comes from poor or premature teaching.

I am opposed to putting college mathematics in high schools. Those young people may get a glimmer of it, but they get false impressions from it which are hard to remove. I have been teaching mathematics for forty years or more, and have been teaching applied mechanics for the same time. I taught Rankine for twenty-five years. It has always been my duty and my privilege to make my students see what mathematics was good for. And I want to defend the teachers of high school and freshman mathematics from what I think is unjust criticism. It is charged they do not make their students understand what mathematics is good for. It is simply impossible for them to do so, as I can do in mechanics. A man is very fortunate who can teach mathematics and then show what it is good for. I am old enough to quote a little of my early experience. I am led to it by something Professor Swain said in regard to mental processes. There is nothing so valuable to mathematical success as a clear grasp of fundamental principles. When I was preparing for college I gave all my time to Latin and Greek. I had done all my freshman mathematics and was reputed to be strong on that branch, when a new teacher came into the school who said, "Here's a new book in intellectual arithmetic, and I would like to have every student in the school go through it." It was fun for me, of course, but I went through the book from A to Z; no other mathematics that I ever studied did me so much good. The teacher's maxim was, "Take hold of the thread at the right end." That was the secret of his splendid teaching. I have applied that maxim to every branch of mathematics I have ever studied or taught. I have learned to take hold of mathematics at the right end, and in a measure I have taught my students to do so.

By B. F. Groat, Professor of Mechanics and Mathematics, School of Mines, University of Minnesota.

Most of the speakers have stated that what they were about to say had already been said by preceding speakers. I am going to try to state a general principle I have not heard clearly put since I came here. During the lunch hour Professor Slaught said that he had not heard a single general pedagogical principle brought out. I am going to take the honor to myself, to give expression to what seems to me to be a general educational principle.

Mathematics is mathematics and engineering is engineering. There is just as much art, science or principle in the teaching of mathematics as there is in the teaching of engineering and these two subjects should be distinguished, separated and kept separate. If you are going to teach engineering you must teach the pure principles. If you are going to teach mathematics you have got to teach pure mathematics. Let it be pure or applied mathematics, it is the *principle involved* which must be taught. If this rule is not adhered to we shall find ourselves teaching something different from that which it was intended to teach.

The principle is that the technical courses in our engineering schools must be separated from our general educational courses. The technical courses are for the purpose of fitting the man for a special life work which is to come later on. The general education which he should have, by way of preparation, should precede his technical course as far as possible.

The straight technical course should be given as a course of two years extent, while the general and preparatory subjects should precede in a three- or four-year course.

The University of Minnesota has adopted a five-year engineering course. This is along the lines I am recommending and I prophesy that it will soon be extended to other schools and separated into two parts.

Let your professor of engineering teach engineering and your professor of mathematics teach mathematics. That is the general pedagogical principle I want to announce.

By C. S. Howe, President, Case School of Applied Science.

I have been very much interested in the discussion of this subject because for thirteen years I was a professor of mathematics in an engineering school and during the past five years I have been endeavoring to reconcile the differences between professors of mathematics and professors of engineering. One thing in this discussion which strikes me as very peculiar is the sad lack of knowledge displayed by the engineering professors as to what is being done in mathematics in their own schools. I believe from my experience and from what I have seen in other institutions that the professors of mathematics are teaching mathematics most admirably as mathematics, but they are not teaching mathematics as a department of engineering. I do not believe that mathematics should be taught as a department of engineering. Mathematics is a science in itself and should be taught by specialists in that science if our students are to be trained in the proper way. The professor of mathematics has two duties to perform. One is to teach his students the principles of mathematics—that is, to teach them to reason and to understand why certain processes are right and why others are wrong. The student must also be taught how to use his mathematics so that he can solve any problem as soon as that problem is expressed in mathematical terms. Another duty of the mathematician is to teach the student to be exact. Unless the engineer is exact, unless he can obtain definite and reliable results in his engineering work, he can not succeed in his profession. This accuracy must be very largely taught in the mathematical department and much of the time and care bestowed upon classes is for the purpose of accomplishing this result.

I believe also that the professors of engineering are teaching engineering thoroughly and well. The difficulty which we are discussing to-day is not in the teaching of mathematics alone nor in the teaching of engineering alone, but in the connection between the two. The technical student is, I believe, taught pure mathematics well, but when he enters the class in engineering he finds that he has to deal with mathematics under a new form—that is, the particular engineering subject he is studying must be translated into mathematical terms and this is where he frequently meets with great difficulty. The student in algebra who has learned to solve equations of the first degree may have great difficulty with problems involving equations of the first degree because he has not learned to state the problems in mathematical language. So the student who begins electrical work finds certain problems containing known and unknown quantities, but not yet expressed in mathematical terms. Now I can not believe that it is the duty of the professor of mathematics to teach the student to express problems in the various branches of engineering in the form of equations or other mathematical terms. In order to do this it would be necessary for him to understand all the various branches of engineering and it is manifestly impossible for him to do this. The professor of civil engineering understands the problems of that subject and he should show the student in his department how to express these problems in such terms that the student can deal with them mathematically. The same may be said of each of the departments of engineering. When the professors of engineering have taught their students to state the problems of their own departments in mathematical language, then the student who has had the course in mathematics ought to be able to solve the problems, and if he can not he has not been taught his mathematics thoroughly or so much time has elapsed since he studied the subject that he has forgotten some parts of it.

Again, I believe that the professor of engineering should ascertain in a general way how mathematics is being taught in his institution and in just what form the student is using certain terms so that he may express his own problems in a way familiar to the student. If, for instance, in calculus the mathematical department has been using derivations, the professors of engineering in writing their problems should use differential coefficients and not attempt to express problems in terms of differentials. I know from experience that many professors of engineering do not do this and their students are confused by a difference of terms and not by a lack of knowledge of the subject. It is evident that the professors of engineering must conform to the methods of the department of mathematics because the department of mathematics can use but one method while the five or more departments of engineering might have several different methods. It is obvious, then, that for the sake of simplicity one method must be used and that method must be the method of the department of mathematics.

I also believe that the professor of mathematics should occasionally confer with the professors of engineering in order to find out from them just what mathematical subjects engineering students are weak in and what subjects it is especially desirable to have them well trained in and to see that his students are taught these things. Friendly conferences between the departments are of great value and should be encouraged by both the mathematicians and the engineers.

By Clarence A. Waldo, Professor of Mathematics, Purdue University.

In the table of hours for mathematics in the various institutions cited by Professor Townsend, the largest total stands against Purdue. Also a whole semester is assigned to trigonometry. Both of these conditions are in a measure due to the fact that we have recently passed through a transitional period in which for engineers solid geometry has been relegated to the secondary schools. The first semester was formerly divided between solid geometry and trigonometry. Now it is wholly given to the latter, while the second semester is set aside to college algebra. Experience shows that for the ordinary student college algebra is more difficult than trigonometry and this determines their order in our program.

Placing trigonometry first and giving it so much time has developed with us several interesting facts.

1. Being easy to understand and having interesting applications, it naturally follows secondary work.

2. While trigonometry is easy to understand, yet to acquire facility in its use and absolute mastery over it as a fundamental science requires close and long-continued study, yet the student, ambitious to become an engineer, quickly sees that he must have facility in this subject and mastery over it.

As a subject of study, therefore, at the beginning of a young man's college career it is well adapted to give power and to instill habits of thoroughness, application, concentration and mastery.

3. Engineers have been recommending that a generous amount of time shall be given to trigonometry, at the expense of the calculus if necessary.

4. The subject is used to review and emphasize much of the preparatory mathematics, while it is also used to clear the way for that which is to come.

Another peculiarity in which Purdue stands almost alone we are quite prepared to defend. We do not crowd the pure mathematical work into the first two years, much less into the first year, but give it an hour less in the second year, than the first, yet at the outset of the third year, with his first course of calculus fairly mastered, we have the student well prepared to begin attack upon theoretical mechanics and kindred subjects. However, with two hours a week during junior year devoted to the further exploration of the calculus carried on side by side with its application to studies of a nature more or less professional, like thermodynamics, the student is likely to come finally into living contact with calculus ideas. Through three years, then, mathematical ideas are held persistently and prominently before the mind of the student, so that at the end of that time the mental change which I call the mathematical transformation is quite complete. If you are intent upon making a physical transformation by which a weak man becomes robust and powerful, you give one, two or three years for the muscles to grow and the chest to expand through long-continued and systematic exercise. Similarly the average student does not become habitually mathematical and exact in his thinking unless you give him careful direction and devote plenty of time to his development. The man who uses his memory and copies slavishly must disappear. In his place must stand the man of trained intellect, thoughtful, persistent, rich in expedients, powerful in attack. To produce him there are on the mathematical side two indispensable requisites, thoroughness in the fundamentals, and a sufficient time to make the mathematical attack of a problem habitual and natural, and to give such a control of and power in the use of the tools of mathematics that the solution of a problem of average difficulty shall be easy and pleasurable.

In the required mathematical part of the engineering courses at Purdue these are the considerations that determine the distribution of the work in the four-year program, and all of the time we are teaching not alone the particular subject that happens to be named in the curriculum—but mathematics.

Some years ago it was my fortune to study descriptive geometry under Marx and Von Derlin in Munich. They taught their subject from the standpoint of the mathematician rather than that of the draftsman. They made their students visualize geometric form in space and by the use of that power discover methods of solving on paper synthetic problems of much difficulty. The German schools teach descriptive geometry as a mathematical subject, the American schools as a body of problems to be solved by rule on the drawing board. The former method makes descriptive geometry the finest discipline of the four years' course; from the other method little educational benefit arises. Some years ago at the Rose Polytechnic, where for a time we taught descriptive geometry in the German way, it was not unusual to meet students who declared enthusiastically that they got more real good from this subject than from anything else in their entire course.

I would ask the new committee to inquire how and by whom descriptive geometry should be taught?

By C. B. Williams, Professor of Mathematics, Kalamazoo College.

The teachers of mathematics in the small colleges of the middle west are preparing many men for work in the better technical schools. From our standpoint there is substantial agreement between the two representatives of the Massachusetts Institute of Technology (Professors Wood and Swain). They expressed themselves so differently that one might easily fail to see how closely they agree. Both want longer and stronger courses in mathematics in the secondary schools. I would like to know the college teacher of mathematics who does not agree with them. They want more mathematics taught and to have it taught better, to have longer and more consecutive mathematical courses in the secondary and primary schools. In other words, the faculties of the technical schools and colleges are working toward the same end, that is, to have more effective courses in primary and secondary mathematics so that college students can do more and better mathematical work. If we could have properly prepared students, we could turn out the kind of men the better technical schools should have.

The engineers and teachers of engineering have insisted that the most necessary qualification for a real engineer is that he should be able to realize his mathematics, to "think mathematically," as they express it. The mathematicians want the same thing. We are trying to make use of and to train the faculty of geometric intuition, to emphasize the functional notion and to develop functional thinking. There is substantial agreement that the best way to do this is through geometry, with perhaps some help from elementary mechanics. It is true that sometimes we are tempted to use too big and complicated machines for little problems, but this is only because we are attempting to develop methods powerful enough to solve big problems.

By J. B. Webb, Professor of Mathematics and Mechanics, Stevens Institute.

Every practical problem requiring mathematics for its solution consists of three parts:

(*a*) An *Analysis,* which resolves the problem into its elements, examines these in the light of natural laws, rejects unimportant ones and defines the relations existing between those upon which the solution depends. This involves the adoption or discovery of methods of measuring the elements, so that they may be expressed quantitatively by symbols, and of the reduction of the relations between them to the standard mathematical forms of expression. The result is a *mathematical statement of the problem* by one or more *equations.*

(*b*) A *solution* of the equations by which the relations sought for between the quantities are clearly expressed or the quantities put in proper form to have their values calculated.

(c) The *interpretation* of the result, which involves a translation of the same from the mathematical language in which it has been obtained into the original language of the problem and a discussion of the practical bearings of the same.

In conversation with a fellow mathematician at this meeting he surprised me by saying that he expected a problem to be put into mathematical language before it was submitted to him and I presume he did not feel bound to interpret his results. Now if "pure mathematicians" regard practical problems in this way, engineers and other practical men have just cause for finding fault with "pure mathematics," and to teach mathematics in this way is to render it valueless to most students. Personally I should refuse to undertake a problem unless I made the analysis and interpretation as well as the solution.

In many if not in most problems the analysis and interpretation are the main parts. They require a broad knowledge of practical conditions and of other sciences and are far more interesting than the mere solution, especially as they often bring into play a large amount of ingenuity and invention, as well as imagination and judgment. A mathematician who can not make the analysis and interpretation of a problem is not to be trusted with the solution and an engineer who is fully competent to make them had better undertake the solution himself or put the whole problem into the hands of a mathematician fully competent to undertake it.

There is no excuse for a "pure mathematician" remaining ignorant of the practical side of the problems he teaches, and his mathematics will not be interesting or trustworthy. Let him cultivate the acquaintance of the truly educated engineer, who will be only too glad to discuss problems with him and give him all the practical information he needs. But there are too many engineers who are not truly educated and who know less about mathematics than the "pure mathematician" does about practical things, and they ought to cultivate the acquaintance of the mathematician and rub off the worst parts of their ignorance before they attempt to criticize the teaching of mathematics. But it is much easier to find fault and say that they never found any use for such and such mathematical branches, when they never gave them enough attention to make them of any use.

Every mathematical teacher should teach all three parts of a problem, but the average engineering student is so indifferent to real progress and his limited time is so taken up with other things that he may get through his course knowing very little about mathematics, no matter how well it may be taught.

Students with fair ability that really want to learn a particular subject can do it even under indifferent teachers, but unless students exert themselves to learn, the best teacher can not put knowledge into them. Discuss the subject to the limit, analyze and adjust the engineering courses to a nicety, write new text-books, adopt new systems and get new teachers and the thing will remain about as it is; teachers will teach and students will expect them to, while only a few will learn, whether the teacher expects them to or not.

By H. T. EDDY, Dean of the Graduate School and Professor of Mathematics and Mechanics, College of Engineering, University of Minnesota.

Complaint has been made that in our teaching of mathematics we do not pay due attention to psychological and pedagogical principles. I want to consider for a moment the application of two of these principles.

First, it is necessary for the engineering student to have an ample undergraduate course in mathematics, and such an extended drill in and habitual acquaintance with its processes that when he has forgotten nine tenths of it, just as he will of this and all other subjects which he studies in college, what remains with him will be a sufficient equipment in this line for his professional career. In other subjects his residuum of knowledge is easily refreshed and increased. Not so in mathematics. The stock of mathematical knowledge of which he is easily master on entering his profession will practically be the end of his attainments in that direction. Restricting the course in mathematics to bare essentials is suicidal, for of it a small fraction only will remain as a permanent possession, and that fraction is likely to be smaller, the smaller the amount originally attempted.

Second, the teacher of mathematics is prone to think that a clear presentation of mathematical truth on his part, and a logical demonstration by the student, are all that is required in this subject. But important as these things assuredly are, they are insufficient to produce successful results. The question is one in which human interest is really of more importance than logic, for mathematical knowledge can not be successfully imparted unless genuine interest on the part of the student can be in some way aroused. It goes without saying, that the teacher must first of all have that interest himself or he ceases to be a fit teacher. How he will awaken interest in his pupil depends upon his own personality. Many do this by help of problems which elucidate and apply the principles. Just here lies the reason for the usual inability of professional engineers to teach mathematics. They have no interest in mathematics itself. It is the engineering problem alone that interests them. To this matter of interest, or the lack of it, may be traced the failure which is apt to attend the separation of classes into divisions according to scholarship, for in that case the divisions made up of poor students lose the impetus to be derived from the interest which the good students exhibit in their work in which all participate to some degree.

By S. M. Barton, Professor of Mathematics, University of the South.

While standing here in the heart of the modern, bustling city of Chicago, and listening to this discussion, my mind goes back to the ancient city of Tarentum and her distinguished governor, Archytas. Archytas, while an able mathematician, was too practical, as we learn, to suit the ideas of the Platonic School, who objected to his mechanical solutions of certain mathematical problems as interfering with pure reasoning. Now, while I take an immense interest in applied mathematics (what mathematician at this day would not?) yet I confess to a feeling of sympathy with Plato in his condemnation of Archytas. At any rate I wish to enter my protest against a possible tendency to degrade mathematical teaching to the memorizing of thumb-rules, and to urge the advantage of a strong backbone of pure mathematics in our engineering courses.

I read with interest a paper presented at the Ithaca meeting of the Society for the Promotion of Engineering Education, by Professor Arthur E. Haynes of the University of Minnesota, in justification of the use of the expression "engineering-mathematics." I must say I was at first somewhat shocked by the expression, for I had always believed that *mathematics is mathematics* take it when and where you will. While I would agree heartily with much that Professor Haynes said, and I do not doubt that his courses are interesting and instructive, yet I question the wisdom of drawing any sharp distinction in the college curriculum between the mathematics given to the engineering student and to any other class of students.

I find myself differing absolutely from the gentleman from the Massachusetts Institute of Technology, who apparently sees no beauty, much less utility, in the higher branches of pure mathematics. How Professor Woods, who has, by the way, written such a sound text-book on mathematics, can live amicably in the same state, much less in the same college, as his engineer-colleague, I am at a loss to understand—perhaps they have an occasional fight. But, joking aside, there is a dangerous tendency to adopt rules (slide and mental) and short-cut, approximate solution to the utter exclusion of rigid proofs. Is it wise to make a mere machine of the young engineer, even if thereby he becomes rich faster or grows poor less slowly? I freely admit, however, that too much theory would be disastrous, and that there is great room for improvement in the teaching of mathematics. The student should be taught how to use his mathematics, and the existing gap between theory and practise be bridged. While affording every possible facility to the student for making experiments, collecting data, becoming expert in handling instruments, making calculations, etc., I urge that we give them, one and all, a good rigid course in *pure* mathematics.

By Arthur E. Haynes, Professor of Engineering-Mathematics, University of Minnesota.

I have been called upon, by name, to defend the use of the term, "Engineering Mathematics." The justification of the term will be found in my paper on the subject in Volume XIV. of the Proceedings of the Society for the Promotion of Engineering Education. As the paper was not read before this association, many of the members present are not acquainted with its contents.

In brief, the reasons there given for the use of the term are:

(*a*) Because of the main object of the study of mathematics in engineering courses, viz: its use as a tool.

(*b*) Because of the proper method of teaching the mathematics of such courses.

(*c*) Because of the content of the mathematics of such courses.

It is not a degradation of mathematics to make it practical, it is rather an added glory. It is as justifiable to use this term as to use the corresponding terms agricultural chemistry, agricultural botany, engineering drawing, etc. We do not degrade chemistry or botany or drawing by the use of these terms: but their employment is justified by the objects of the study, by the methods required in teaching them and by their content, as in mathematics.

It has been suggested that a less thorough study of mathematics is advocated. In reply to this, may I quote from an article in Volume VIII. of the Proceedings of the Society for the Promotion of Engineering Education, on "The Teaching of Mathematics to Engineering Students," where in speaking of such teaching I said:

(*a*) It should be of such a character as to produce an enduring stimulating effect upon the mind of the student.

(*b*) It should give the student the power to properly interpret mathematical language, and to accurately and skillfully use it.

(*c*) To secure these results, the teaching must be based upon a proper order of studies and carried forward in a rational, intelligent manner.

By Arthur S. Hathaway, Professor of Mathematics, Rose Polytechnic Institute.

In a paper on "Pure Mathematics for Engineering Students," published in the *Bulletin* for March, 1901, I expressed opinions which coincide with those given here to-day. I then said that instruction in mathematics for engineering students should have two objects (1) to develop an engineering mind, and (2) to develop mathematics as an instrument of research for the engineer. I came to these conclusions at that time as a result of inquiries made of graduates of several institutions, who were in engineering practise, and of their employers. From the latter, I have had the statement that it is inadvisable to place a man in the higher positions in engineering who has not had a good mathematical training, especially, in the calculus, which, they assert, develops those modes of thought which are necessary to the engineer.

I wish to call your attention to the fact that the fifty-four hours of analytical dynamics credited to Rose Polytechnic Institute on this chart are spent on applied calculus. There is a regular course of one hundred and forty-four hours in Rankine not mentioned here, which is given by my colleague, Professor Gray. In applied calculus we take up problems which require the use of the calculus, such as motions in constant, elastic and central fields, the bending of beams, the twisting of shafts, problems in electricity, in chemistry, etc. We take problems gathered from all sources, text-books, magazines, engineering professors, and discuss them in the class-room, with special reference to the analysis and its mode of application.

By Edward V. Huntington, Assistant Professor of Mathematics, Harvard University.

I desire to call attention to the fact that besides the analogy of mathematics as a tool or instrument, there is also the perhaps more significant analogy of the mathematician as the discoverer of quantitative relations which already exist in the problems themselves. Logarithmic relations between varying quantities, for instance, are not dragged into the problem from some artificial tool-chest, but are already present in the problem, and are analyzed out of the problem much as the precious metal is analyzed out of the ingot by the metallurgist. The practical mathematician is simply a scientist specially trained to perceive the quantitative aspects of physical phenomena.

By Donald F. Campbell, Professor of Mathematics, Armour Institute of Technology.

We have had a number of good ideas set before us in the last two days—ideas which we ought to make an effort to crystallize. I think that the present time is the psychological moment to have a committee appointed to draw up a report on mathematics for colleges of engineering. This report perhaps might be in the nature of a symposium, but it would be especially valuable if it considered in detail the subjects which should be emphasized in a course in mathematics for engineering students. These, however, are merely suggestions. I would not hamper the committee in their deliberations by outlining any particular course which they should pursue. The only condition which I would impose is that the committee be representative enough that all of us can look towards their report with the utmost confidence.

I would move that the chairman be empowered to appoint a committee of three, these three to increase their number to fifteen, chosen from among the teachers of mathematics and engineering and the practising engineers, these fifteen to constitute a committee authorized by this meeting to make such a report on mathematics for colleges of engineering as in their opinion will be of service to teachers in such institutions, and to submit this report when completed to the Chicago Section of the American Mathematical Society.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS[1]

THE ninth International Geographical Congress, which began with a reception on Sunday, July 26, ended on August 6 with a banquet given by the Council of State of the Canton of Geneva. The congress has been marked by one unique feature—its unprecedented length. Hitherto a week has been the limit of the session of these congresses, and why the Geneva congress should have been protracted to the weary length of thirteen days it is difficult to surmise.

On the social side Geneva has hardly been surpassed by any city in which the congress had previously met. From the president of the republic downwards every one has vied in making the 750 members of the congress feel that they were welcome.

The membership was thoroughly representative, and the discussions in the sections, as well as the daily intercourse outside the sections, between geographers of all nationalities, are sure to lead to good results, to a clearer conception as to the field of geography, and as to the best methods of solving the many problems with which it has to deal. As usual, the educational side of the subject gave rise to much discussion, a good deal of it of little value from the practical point of view, but still not without its uses. Perhaps on the whole the discussions on glaciation in the section devoted to that subject were of wider bearing and of more scientific value than those in any other section; but they had as much to do with geology as geography, as, indeed, was the case with subjects brought before certain other sections. Geography has quite a wide enough field of its own, without having to burden itself and overweigh a congress with matters outside its sphere. Perhaps the lecture that attracted most attention and had the widest hearings was that of M. Ch. Lallemand on the "Respiration of the Earth." M. Lallemand gave a clear exposition of the researches of Professor Eckert, of Potsdam, which seem to show that there is a daily tide on the surface of the earth, of small dimensions may be, but absolutely real. Other lectures deserving special mention were those of Professor Oberhummer, of Vienna, on Leonardo da Vinci and his influence on the geography of his time, and on the great cities as individuals; of Dr. Filchner, on his masterly exploration in Eastern Tibet and the region between the Hoangho and Yang-tsze; and of M. Alexandre Monet, on the Scarab containing the record of the circumnavigation of Africa under King Necho, this last leading to a vigorous discussion. Dr. Otto Nordenskjöld's account of the results of his Antarctic expedition, though not altogether new, suggested several interesting problems. An unusual feature was the exhibition, with interesting explanations by Frau Wegener, of a remarkable collection of Chinese paintings collected by herself, and supplementary to some extent to her husband's account of his expedition in central China.

At the London congress in 1895 a committee was appointed at the suggestion of Professor Penck, now of Berlin, for the purpose of securing international action for the construction of a map of the world on the scale of 1 to 1,000,000, about sixteen miles to the inch. The scale has been adopted as a sort of standard scale, but otherwise little progress has been made. At Geneva those interested in the scheme decided to form a committee for the purpose of agreeing upon lines on which the proposed map should be constructed. After one or two meetings the committee came to definite conclusions, not only as to the scale, but also as to the symbols to be adopted to represent the various features on the map, the lettering to be used, the size of the sheets, the initial meridian (Greenwich), the use of the metric system (along with others if desired by individual states), and other points.

[1] Abridged from an article in the London *Times*.

These proposals were adopted at the concluding meeting, and will be submitted to the governments and societies of various countries, and it is earnestly to be hoped that steps will at once be taken to carry the proposals into practise, and so prepare the way for a standard map of the world. Similar steps were taken for the formation of an International Cartographic Association for the issue of standard maps showing at a glance the progress of exploration in each country. Another scheme brought before the congress was that of M. Lecointe, of Brussels, for the establishment of an International Polar Commission. The congress agreed that it was desirable to submit the scheme to the governments interested, but there is a strong feeling in certain influential quarters that any such scheme is unnecessary, at least so far as those countries most interested in polar exploration are concerned. The proposal of Captain Roncagli, secretary of the Italian Geographical Society, for the establishment of an International Bureau for the dissemination of commercial information as to new countries was approved, apparently without realizing what it implied. Another resolution adopted by a large majority was that France should adopt the Greenwich meridian, that the hours of the date should be enumerated consecutively from midnight to midnight, and that all public clocks, including those of railways, should be regulated according to the legal hour. A commission which may lead to interesting results was agreed to for the creation of a collection of photographs illustrating the various forms of the earth's crust, and another for the more thorough exploration of the Atlantic Ocean and the Mediterranean.

After a keen debate as to the next place of meeting—Lisbon, Budapest and Rome having put in claims—the last-named was adopted, and the date fixed for 1911, when Italy will celebrate the fiftieth anniversary of her independence.

REPORT OF THE BRITISH FISHERIES COMMITTEE

The report of the committee appointed to inquire into the scientific and statistical investigations now being carried on in relation to the fishing industry of the United Kingdom has been published. The committee, consisting of Mr. H. J. Tennant, M.P. (chairman), the Hon. C. H. W. Wilson, M.P. (now Lord Nunburnholme), Sir Reginald MacLeod, Under-Secretary, Scottish Office, Mr. N. W. Helme, M.P., Mr. Archibald Williamson, M.P., Mr. P. Chalmers Mitchell, D.Sc., F.R.S., Mr. J. Stanley Gardiner, F.R.S., the Rev. W. S. Green, C.B., chief inspector of Irish fisheries, Mr. R. H. Rew, Board of Agriculture and Fisheries, Mr. L. J. Hewby, treasury, with Mr. A. T. Masterman, D.Sc., Board of Agriculture and Fisheries, as secretary, was appointed to "inquire into the scientific and statistical investigations now being carried on in relation to the fishing industry of the United Kingdom by the fishery departments of the government, the Sea Fisheries Committees, the International Council for the Exploration of the North Sea, and the Marine Biological Association; and to report what work of this character is required in the interests of the fishing industry, and by what methods or agencies it can be most usefully and economically carried out in future."

In its report the committee submits recommendations which are summarized as follows:

1. The establishment of a central council for the United Kingdom which shall have control of public funds for fishery investigations of a national and international character.

2. The strengthening of the Board of Agriculture and Fisheries as the central fishing authority for England and Wales, and the provision of additional funds to this board for the encouragement of local work.

3. The continuance of adequate provision to the Fishery Board of Scotland for local scientific research.

4. The continuance of international co-operation in scientific and statistical investigations upon a definite and permanent basis.

5. The continuance of the annual grant of £1,000 to the Marine Biological Association of the United Kingdom.

The central council should, it is suggested, subject to certain qualifications, be empowered:

1. To expend, or allocate and direct the administration of, such funds as may be voted by Parliament for scientific investigations into questions affecting the common interests of the sea fisheries of the United Kingdom.

2. To draw up such schemes of investigations as the council shall from time to time deem desirable for the solution of practical problems affecting the sea fisheries generally.

3. To arrange for such statistical investigations as the council may deem desirable with the departments charged with the duty of collecting fishery statistics, and to place so far as practicable such statistics on a uniform basis throughout the United Kingdom.

4. To arrange for the coordination of schemes of investigations under their direction with any similar schemes undertaken by other nations interested in fisheries frequented by British fishermen.

5. To select, direct and, if necessary, to equip any agents for the conduct of such investigations as they may require to be carried out.

6. To take over or acquire vessels properly equipped for fishery investigations.

7. To present to the treasury and to each of the ministers having charge of fishery departments an annual report on the progress of the investigations under their direction and on the results from time to time obtained.

SCIENTIFIC NOTES AND NEWS

THE honor of knighthood has been conferred on Professor A. G. Greenhill, F.R.S., the eminent mathematician of the Ordinance College, Woolwich.

SIR WILLIAM RAMSAY was made an honorary doctor of medicine at the University of Jena on the occasion of the celebration of the three hundred and fiftieth anniversary of its foundation.

DR. GEORG QUINCKE, professor of physics at Heidelberg, and Dr. Friedrich Hildebrand, professor of botany at Freiburg, have celebrated the fiftieth anniversary of their doctorates.

DR. REYE, professor of mathematics at Strasburg, has retired from active service.

DR. HENRY M. HURD, superintendent of the Johns Hopkins Hospital, has been appointed a member of the Maryland state lunacy commission, vice Dr. Charles F. Bevan, retired.

PROFESSOR G. W. WILSON, of Upper Iowa University, Fayette, Iowa, has held during July and August a research scholarship at the New York Botanical Garden.

A PRIZE founded in honor of the late J. P. Moebius, the neurologist, will be conferred for the first time next year.

M. ANTOINE HENRI BECQUEREL, the eminent French physicist, has died at the age of fifty-six years.

KANSAS City has begun work upon its new Zoological Gardens, which it is said will be completed in the course of the next five years at a cost of about $500,000.

MRS. REID, widow of the late Thomas Reid, who was president of the Bermuda Natural History Society and mayor of Hamilton, has given $2,500 to the Bermuda Aquarium and Biological Station.

PRESS dispatches state that Count Zeppelin has announced that he intends to found an institute for the investigation of the problems of air navigation in the interest of German industry, defence and science. The contributions made by the public, he says, are now far beyond the sum necessary to replace the destroyed airship and beyond the sum he intends to accept toward the recuperation of his private fortune which was spent in airship experiments. All of the surplus now on hand and all further contributions will be added to the endowment of the institute. The Bank of Stuttgart, which is receiving the subscriptions, has $500,000 deposited to Count Zeppelin's credit, and about $250,000 has been subscribed but not yet paid.

A CONGRESS on thalassotherapy, or treatment of disease by sea air, sea bathing, etc., will be held next September at Abbazia, near Fiume, on the southern coast of Austria.

AT a meeting consisting of representatives of temperance organizations interested in the International Anti-alcohol Congress, which has been held during the past twenty years in various continental towns, it was agreed to invite the congress to meet next year in London for the first time. That invitation having been accepted, arrangements are now being made for the twelfth congress to be held during the week beginning July 18, 1909. The congress, which is to last a week, will probably meet at the Imperial Institute, and the delegates will be present from nearly every country in the world.

Dr. W. D. Matthew, one of the members of the American Museum Expedition to Nebraska, has recently returned from the field. The investigations of the party have been confined mainly to the Miocene beds of Sioux County. Much interesting material has been collected from the Lower Miocene in the vicinity of Agate; and farther to the south, Dr. Matthew and Mr. Harold Cook discovered two new fossil-bearing levels from which were obtained collections especially rich in fossil horses. Several incomplete skeletons of the Middle Miocene horse have been secured, together with abundant fragmentary material from a higher level which may prove to represent a new and large fauna that hitherto has been very little known.

The expedition to James Bay and vicinity by Mr. Alanson Skinner, for the American Museum of Natural History, has obtained not only ethnological material from the Cree Indians, but much new information regarding their religious and social customs. The Cree are essentially hunters, and the complete set of specimens brought back by Mr. Skinner will add greatly to the ethnological interest of the collections already installed in the museum halls. Mr. Skinner's attempt to study the Naskapi (a little-known tribe) was fruitless, as the Indians no longer frequent the east coast of Hudson Bay, but remain in the country bordering the Atlantic. The members of the expedition covered more than a thousand miles in an eighteen-foot canoe, and narrowly escaped starvation while returning through the forests of northern Canada.

According to the Paris correspondent of the London *Times*, the *Pourquoi Pas*, conveying the Charcot mission on the second voyage of discovery of its commander, Dr. François Charcot, to the Antarctic regions, left the port of Havre on August 16. Some 30,000 persons bade it God-speed from the quays, and a little company of distinguished guests were present at this dramatic leave-taking. Among them were M. Doumer, whose intervention secured from the French parliament a subsidy of $160,000 for the expedition. Dr. Charcot expects to be absent about two years. One of his objects in returning to the regions of the South Pole is to bring back samples of the fossils to which Dr. Nordenskjöld has already drawn attention. He intends to transport them to one of the open ports of the Antarctic continent, either Port Lockroy or Port Charcot, and then to go on to Loubet Land to begin his exploration of the regions to the south. He takes with him provisions for twenty persons for more than two years. The *Pourquoi Pas* will reach the southern ice at the beginning of the austral summer towards December 15, at about 800 kilometers south of Cape Horn. Dr. Charcot's staff will then have their work cut out for them. They include M. Bougrain, who will make the astronomical observations; M. Rouch, specialist in meteorology and oceanography; M. Godefroy, who will study the hydrography of the coast and the tides; M. Gourdon, geologist, and Dr. Jacques Liouville, marine zoologist and botanist. The commander himself is a good bacteriologist.

The measures devised by the governor of Uganda, Sir Henry Hesketh Bell, for combating the spread of sleeping sickness are, according to Reuter's Agency, meeting with a considerable measure of success. During 1907 there were no new cases among Europeans, and the deaths among natives during the twelve months numbered less than 4,000. The whole of the population has been removed from the shores of the Victoria Nyanza, and it is hoped that the disease-carrying fly in that belt, if not reinfected, will gradually cease to be a source of danger. Several thousands of the sufferers from sleeping sickness are being maintained in segregation camps, but the treatment by atoxyl is not proving of much avail. Consistent and vigorous action will be necessary for some years to come if sleeping sickness is to be stamped out of the country.

The United States not only produced 96.6 per cent. of all the salt consumed within its borders in 1907, but exported nearly 62,000,000 pounds, valued at more than a quarter of a million of dollars, according to W. C. Phalen, whose report on the salt and bromide industry of this country for the last calendar year has just been published by the U. S. Geological Survey. The salt production of the United States in 1907 amounted to 29,704,128 barrels of 280 pounds, valued at $7,439,551—an increase of 1,531,748 barrels in quantity and of $781,201 in value over the output in 1906. The average net value of the product in 1907 was $1.79 cents per short ton, as against $1.69 per ton, in 1906, an increase for 1907 of 10 cents per ton. In both quantity and value of output the United States stands at the head of the salt-producing countries of the world. In quantity the United Kingdom, the German Empire, and France rank next, in the order given, although the value of both the German and the French output exceeds that of the United Kingdom.

A total output far in excess of that of any previous year or any other country, an unparalleled accumulation of stocks, and high prices for oil of all grades characterized the petroleum industry of the United States in 1907, according to David T. Day, of the United States Geological Survey. The total production of petroleum in this country in 1907 amounted to 166,095,335 barrels, an increase of 39,601,399 barrels over the production of 1906, the increase being greater than the total product of petroleum in any year up to 1889. The total value increased from $92,444,735 in 1906 to $120,106,749 in 1907. The average price decreased slightly, from $0.731 per barrel in 1906 to $0.723 in 1907.

The London *Times* states that long before the flight of his fourth airship Count Zeppelin had been laying his plans for the construction of his fifth balloon. Ten or twelve weeks ago he entrusted Messrs. C. G. Spencer and Co., the well-known manufacturers and aeronauts of Highbury, with the task of making the balloon fabric. The work is in full progress in the works at Highbury. In the factory a number of girls are engaged in preparing the goldbeaters' skin from which the Zeppelin balloon No. 5 is to be made. The envelope will be composed of six layers of the skin, and by a process known only to the firm the skins are so joined together that no seams are visible, and the finished fabric combines extreme lightness with an extraordinary degree of toughness. Mr. Spencer said that the cells, or gas holders, of No. 5 balloon were being built like a very large drum, and were divided into 15 sections, each being self-contained. The holding capacity of these would be 40,000 cubic feet, so that the whole balloon —600,000 feet—would be considerably larger than that of No. 4. There would be sufficient room in the building for the inflation of each section separately. The sections would then be packed carefully and sent to Germany to be fitted into the rigid framework of Count Zeppelin's airship. Mr. Spencer said that this goldbeaters' skin is the strongest material for its weight that could be found. Hitherto Count Zeppelin had relied, he said, upon an indiarubber-covered fabric, but though this is cheaper it is three or four times heavier. It is estimated that the skins of about 600,000 cattle will be required before the work is finished. The firm expects to finish the fabric in about a fortnight.

According to a report recently issued, the total number of visits recorded as having been made by the public to the Natural History Museum (London) during the year 1907 was 497,437, as compared with 472,557 in 1906—an increase of 24,880. The number of visits on Sunday afternoons was 66,367, as against 61,151 in the previous year. The average daily attendance for all open days was 1,370.3; for week-days only, 1,386; and for Sunday afternoons, 1,276.3. The total number of gifts received during the year by the several departments of the museum was 2,105, as compared with 2,057 in 1906, among the donors being the Egyptian government (an important series of fishes from the Nile); the Prince of

Wales (the skeleton of an Indian elephant from Mysore); the Hon. W. Rothschild (a mounted specimen of a bull of the Alaskan elk); and Mr. Boyd Alexander, in the name of the Alexander-Gosling expedition (the skin and skull of a male Okapi, and portions of the skin of two other individuals of the same species, obtained by him during his recent journey from Nigeria to the Nile).

As a result of a recent conference between representatives of the War Department and the Forest Service, looking toward the practise of forestry on timberlands on military reservations, the Forest Service has received requests from Fort Mead, South Dakota, and Fort Leavenworth, Kansas, for an examination of the forests at those posts. The service will suggest a plan of management in each of these instances, as well as for other posts from which similar requests are received. Military reservations which have been examined and reported upon in the past are those at West Point, New York; Fort Wingate, New Mexico; the Rock Island Arsenal, Illinois, and the Picatinny Arsenal, New Jersey. The forest at West Point, for which the Forest Service made a working plan in 1903, is supplying the post with part of the needed cordwood, lumber, hurdle poles, tan bark and other forest products. Similar plans are in preparation for the forests of Rock Island and Picatinny Arsenals.

The results of the French scientific mission to the Congo for the study of the sleeping sickness, recounted in the *Dépêche Coloniale Illustrée,* are abstracted in the London *Times,* according to which that mission, under the charge of Dr. Gustave Martin, did not get seriously to work before June of last year. It has had to struggle against the inertia and often the ill-will of the natives. In the region of the Upper Ubangi and the basin of the Gribingi and the Shari they found only isolated cases. On the other hand, in the immense country of the Middle Congo, the Sanga, and the Ubangi up to the sea there are no points where the plague has not exercised its ravages, devastating entire villages. The members of the mission have personally visited the caravan routes from Brazzaville to Loango up to Buanza, Madingu, and the mountainous region between the copper zone of Minduli and the former political post of Manganga, the Upper Alima, the Lower Sanga, part of the valley of the Congo, and the Upper Ubangi as far as Fort de Possel and Bessu. As a general result of their observations it is evident, says the present report, that no diagnosis of the sleeping sickness is certain without the revelation of the presence in the organism of the trypanosome. The best microscopic method of discovering the presence of the microbe is a problem which has absorbed the attention of the mission. By the mere microscopic examination of the blood 258 natives were found harboring the microbe and twenty Europeans were discovered to be infected. The director of the laboratory department of the Pasteur Institute, M. Mesnil, says, indeed, in his report on the preliminary studies of the French mission, that minute examination of the blood of all Europeans who have spent some time in the tsetse zones is an operation that ought not to be neglected. No vaccine nor serum avails to cure the sleeping sickness. The future belongs to chemical therapeutics, and the atoxyl treatment is the only one which, according to this authority, gives generally good results. This remedy was first employed by Mr. Thomas in 1905 at the Liverpool School of Tropical Medicine, although the action of arsenical compounds in animal trypanosomiases had already been recognized by numerous investigators. At the same time certain inconveniences, already noted at Liverpool, in the use of atoxyl alone are confirmed by the French mission. The French mission, aided by the government and the geographical societies, proposes a certain number of practical preventive measures. A sum of 250,000f. is now being solicited to continue the work already begun and to place France on an equality with the other powers in the struggle against this terrible plague.

Nature quotes from the *Comptes rendus* of the Paris Academy of Sciences for June 29 the report of the committee appointed to consider the distribution of the Bonaparte fund for 1908. The committee has considered 107 applications for assistance from this research fund. Some of these, it is mentioned, do not comply with the conditions laid down by the founder, Prince Roland Bonaparte, and others are for work entirely outside the field of the Academy of Sciences. The committee excludes also demands for assistance in researches in medicine, surgery and general biology, since the funds of the *Caisse des Recherches scientifiques* are exclusively reserved for biological studies. Ten grants are recommended as follows: (1) 2,000 francs to L. Blaringhem for a continuation of his important studies on the variation of species and the experimental methods for the creation of new species of plants; (2) 2,000 francs to Dr. Billard to enable him to pursue his studies on the hydroids; (3) 2,000 francs to Dr. Estanave to furnish him with a means of continuing his researches on direct vision projection in relief, with special reference to radiography; (4) 2,500 francs to MM. Fabry and Buisson for a continuation of their work on the establishment of a system of standard wave-lengths. The grant is to be applied to the purchase of a plane grating, a metal concave mirror of large diameter, and two plane mirrors required for a study of the differences between the lines of the solar spectrum and those of the electric arc; (5) 5,000 francs to M. Gonnessiat for the purchase of astronomical intruments for the observatory of Algiers; (6) 2,000 francs to Dr. Loisel for the continuation of his actinometric observations at the Observatory of Juvisy; (7) 2,000 francs to M. Dongier for the establishment of apparatus for the simultaneous study of the rainfall and atmospheric potential; (8) 2,500 francs to M. Perot for the spectroscopic study of the light from the sun by interferential methods; (9) 2,000 francs to M. Matignon for the determination of specific heats at high temperatures; (10) 3,000 francs to P. Colin for the publication of a map of South Imerina. These recommendations were adopted by the academy.

A COMMISSION, appointed by the crown to investigate the condition of Ireland's forests and to suggest measures for bettering it, has just made public its report. The commission became convinced that there was imperative need for afforestation on a large scale, that the time had come when the "let alone" doctrine applied to the woods could no longer be endured. The commission outlines and vigorously urges the adoption of a large scheme for the state to plant about 700,000 acres with forest trees. This, with the 300,000 acres of existing forest, would give Ireland 1,000,000 acres of forest land, an area which the commission considers essential for the agricultural and industrial requirements of the country. About 20,000 acres of this would be purchased by the state in mountainous and rough regions and managed as state forest, while 500,000 acres, chiefly in small blocks, would be planted by the state, but managed by private owners or by county councils. The facts that under the Land Purchase Acts much woodland formerly held in large blocks is being sold in small parcels and lumbered, and that there is now opportunity for the government to acquire woods and land suitable for forests, make it specially urgent for the state to take immediate action. To show that such a scheme of land acquisition and planting is not impracticable, the Commission cites the case of Denmark, an agricultural country half the size of Ireland, which, since 1881, has increased her forests by 175,000 acres. Another case is that of little Belgium, which, in spite of her dense agricultural and industrial population and already large forests, has added 70,000 acres to her forests in the last twenty-five years. Though Ireland is particularly suited in soil and climate for the growth of forests, and some of her area is much better adapted for forests than agricultural crops, yet only 306,000 acres, or one and one half per cent. of her total area is forested.

UNIVERSITY AND EDUCATIONAL NEWS

AN anonymous gift of $100,000 has been made to the Vienna Academy of Sciences for the establishment of a "Radium Institute" in connection with the new physical laboratories of the University of Vienna.

It is announced that hereafter women who are subjects of the German empire will be admitted to the universities on the same footing as men. Women of other countries will require the permission of the minister of public instruction for matriculation.

The governors of University College, Bristol, have approved the draft charter for establishing a University of Bristol.

According to the daily papers, the salaries paid to instructors and professors at the University of Chicago will be increased by about twenty-five per cent. An official statement of the changes in the salaries will doubtless be made shortly.

Jay William Hudson, Ph.D. (Harvard), has been appointed assistant professor of philosophy in the University of Missouri.

Alfred Edward Taylor, M.A., Frothingham professor of philosophy in McGill University, has been appointed professor of moral philosophy in the University of St. Andrews, in succession to Professor Bosanquet.

Dr. Henry Alexander Miers, F.R.S., fellow of Magdalen College, Oxford, and Waynflete professor of mineralogy in Oxford University, has been appointed principal of the University of London, from October 1, upon the resignation of Sir Arthur W. Rücker.

At the University of Manchester Dr. J. E. Petavel, F.R.S., has been elected professor of engineering; Mr. T. G. B. Osbern, lecturer in economic botany; Mr. C. H. Lander, lecturer in engineering drawing; and Dr. F. H. J. A. Lamb, senior demonstrator in physiology.

THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS

The college announces the following new appointments for the college year beginning September 16, 1908:

F. D. Crawshaw, B.S. in electrical engineering, Worcester Polytechnic Institute, '96, who has served as head of the manual training department of the Central High School, Minneapolis, Minn.; as first assistant, manual arts department, Bradley Polytechnic Institute, and as principal of the Franklin School, Peoria, Ill., to be assistant dean of the College of Engineering.

Frank B. Sanborn, B.S. Dartmouth, '87, C.E. Dartmouth, '89, M.S. Harvard, '98; for nine years past professor in charge of the department of civil engineering, Tufts College; has been granted leave of absence for one year by that institution and during this time will act as assistant professor of civil engineering with the University of Illinois, doing work not otherwise provided for during the prospective temporary absence on leave of Professor I. O. Baker.

Shelby S. Roberts, B.S. Rose Polytechnic Institute, '98, C.E. Rose, '07; for the past ten years engaged in railway work, chiefly with the St. Louis, Peoria & Northern Railway, the Louisville & Nashville, and the Illinois Central, has been appointed assistant professor of railway civil engineering. Mr. Roberts will give his entire attention to instructional and research work with reference to railway track construction and maintenance and with reference to railway signaling.

William F. Schulz, a graduate of the Baltimore Polytechnic Institute in 1890, an honor man at Johns Hopkins University, '93, bachelor of science in electrical engineering, University of Illinois, '00, Ph.D. Johns Hopkins University, '08. For five years assistant and instructor in physics at the University of Illinois, has been appointed assistant professor of physics.

Kenneth G. Smith, A.B. University of Chicago, '96, B.S. in mechanical engineering, University of Illinois, '05; for three years with the Kerr Turbine Company, has been appointed to have charge of the engineering experiment station extension work, with the rank of assistant professor of mechanical engineering.

A. St. J. Williamson, University of Illinois, B.S. in mechanical engineering, '98, M.E. '02, and for the past seven years engaged in railway work, chiefly with the Mexican Central Railway, has been appointed instructor in railway mechanical engineering.

C. F. Kelley, A.B. Harvard University, '06, a student with De Camp and other noted artists, has been appointed instructor in architecture.

C. C. Albright, B.S. Purdue University, '03, C.E. '08, and for the past five years engaged in railway work, has been appointed instructor in civil engineering.

A. R. Lord, B.S. in civil engineering, University of Maine, '07, and for the past year instructor in civil engineering of the same institution, has been appointed instructor in general engineering drawing.

F. W. Doolittle, a graduate of Lenox College, A.B. Princeton, a graduate in civil engineering, University of Colorado, '07, has been appointed instructor in theoretical and applied mechanics.

J. G. Kemp, A.B. University of Illinois, '06, and for the past two years assistant in physics at Purdue University, has been appointed assistant in physics.

E. C. Converse, A.B. University of Illinois, '04, and for the past four years a teacher in the public high schools, has been appointed assistant in physics on part time.

A. M. Elam, B.S. in mechanical and electrical engineering, State University of Kentucky, '08, has been appointed assistant in general engineering drawing.

Lewis McDonald, B.A. and B.S. in civil engineering, University of Illinois, '08, has been appointed assistant in civil engineering.

The facts set forth by the preceding statement emphasize the organic growth of the school of railway engineering and administration which was established two years ago by the University of Illinois. This school stands midway between the college of engineering and the department of economics. Its director is the dean of the college of engineering. Its organization within the college of engineering at present consists of an associate professor of railway engineering, in general charge, and especially concerned with the problems of railway equipment; an assistant professor of civil engineering, especially concerned with problems of the track; an instructor in railway mechanical engineering, especially concerned with locomotive performance and train resistance; and an associate in railway engineering, especially concerned with the specialized problems of electrical traction. Its organization within the department of economics consists of a professor of railway administration and an instructor in railway accounting.

DISCUSSION AND CORRESPONDENCE

WILD JAMAICA COTTON

To the Editor of Science: With reference to the interesting letters of Messrs. Colville, Britton and Cook in Science of April 24, I venture to write to mention that I have grown several samples of cotton seed from Jamaica, kindly sent by the Agricultural Department. One of the varieties grown appears to be identical with the one under reference except in the case of the flowers, which in my specimen were all yellow or pale yellow. The identity of the two varieties can easily be proved or disapproved owing to the fact that the bracteoles of my plants have only two to four teeth, while most varieties with which it could possibly be confounded have many more. It is quite distinct from *G. punctatum* Sch. & Thon. as are also many plants stated by Watt to belong to this species, *e. g.*, "the Hindi weed of Egypt"; it is, however, apparently identical with the specimen figured by him as *G. punctatum* var. *Jamaica*.

With reference to the main point raised in correspondence viz.: the explanation of a mixture of naked and fuzzy seeds. The seeds of my cotton were all naked, but seeds giving rise on sowing to exactly similar plants, and all bearing either grayish or brown, or green fuzz, were received from Trinidad, Nicaragua and neighboring regions. This supports the statement made by Mr. Cook, that the variation in the fuzz does not necessarily imply hybridization. Further evidence on this point is that these varieties come true to seed.

I have grown other varieties, however, which gave a mixed product similar to that in question. Owing to poor germination consequent on poor monsoons, I failed (while in India) to obtain very definitive information as to the numerical ratio in which this character in such cases passes from generation to generation, but in one case, at least (that of a cotton from Bagdad), it was found that both naked and fuzzy seeds picked from the same plant gave rise to plants bearing both kinds of seeds. Now, Mr. Balls[1] and myself[2] have independently proved that fuzziness of the seed is dominant when crossing occurs between a naked and fuzzy seeded variety. If, therefore, the mixed character of the seed is due to its having been borne by hybrid plants, we should expect segregation of the characters and, on sowing, the naked character (recessive) having once appeared should come true to seed. As stated above, this did not, in the case noted, occur and the mixed character of the offspring is therefore apparently not due to the hybrid character of the parent.

So far as experiment has yet gone the nakedness or fuzziness of the seed appears to be subject to fluctuations that are unusually large even in this genus of large fluctuations. I have grown many varieties of cotton that differ only in this characteristic and come perfectly true to seed in respect of it and have further found that the fuzziness of a variety is decreased by growth under certain conditions.[3]

F. Fletcher

School of Agriculture,
Giza, Egypt

QUOTATIONS

AS TO UNIVERSITY ADMINISTRATION

The Popular Science Monthly has some sharp things to say editorially in its July issue in regard to the administration of American universities, with special reference to recent events at Syracuse, Cincinnati and in Oklahoma. There is not a little justice in the contention that whereas "elsewhere throughout the world the university is a republic of scholars administered by them," in this country it is "a business corporation." The complaint is not new, and it is being made more and more frequently of late. The editor goes on to say:

"The ultimate control is lodged in a board of absentee trustees, whose chief duty is the election of a president. The qualifications most regarded in the president are the ability to get money for the institution and a good presence at public functions; but he is expected to "run" the university. The professors and instructors are employed "at the pleasure of the trustees," and so long as the president maintains his position, this means at his pleasure. Advances in salary or position, appropriations for apparatus, etc., are subject to the same pleasure. In larger institutions the department-store system naturally grows up. Deans and heads of departments are responsible to the president, and their subordinates are responsible to them."

It is fair to say that the American ideal of efficiency is responsible for a system which has its virtues, and is unfortunate mainly because it comes into conflict with another and even higher American ideal, the ideal of democracy. In a great business organized under keen competitive conditions there is as little room for democracy as in the army. All other considerations must yield to that special efficiency which belongs to strong autocratic control.

But if there is any place where this system does not belong, it is the university. Here there is no mad scramble for wealth, no competitor to crush, no secret tactics to follow. Culture should be made not "to hum," but to blossom sweetly. More important than great gifts or new buildings or business-like management is the maintenance of academic freedom and of the dignity and self-respect of the faculty. The professor is, or ought to be, more than a mere employe, hired for a certain "job." And the president is, or ought to be, both more and less than a mere superintendent, to hire and discharge and make a good showing with his yearly reports. No single thing has done more harm to higher education in America during the past quarter-century than the steady aggrandizement of the presidential office and the modeling of university administration upon the methods and ideals of the factory and the department store.

That it does not in all cases work badly is due simply to the fact that the men are better

[1] "Year-book of the Khedivial Agricultural Society," Cairo, 1906.

[2] "Mendelian Heredity in Cotton," *Journal of Agricultural Science*, Vol. II., Part III.

[3] "The Cotton Plant," *Nature*, Vol. 77, No. 1994.

than the system. As *The Popular Science Monthly* says: "In a great university, such as Harvard, courtesy and consideration do not fail. In the smaller colleges, there is the spirit of the family. So long as the best men are found at our colleges and universities, it may not matter greatly under what system of academic government they live. But there is real danger that the existing system may prove repulsive to men of the highest intelligence and character, and that mediocrity and time-serving may be developed, where we need the most vigorous ability and independence." It was the older American idea that the president of a college was simply primus inter pares. To-day there is as wide a gulf between him and his faculty as between a superintendent of city schools and the grade teachers, and however the change may better business management, it does not attract strong men to the profession of teaching, nor does it foster a vigorous intellectual life in the universities. And occasionally a gross and tyrannical abuse of authority reminds the world how far America is behind Germany in the freedom of its university life.—*Springfield Republican.*

SCIENTIFIC BOOKS

The Labyrinth of Animals. By Albert A. Gray. Vol. II. London, J. A. Churchill. 1908.

The first volume of Dr. Gray's extensive stereo-photographic studies of the vertebrate labyrinth ha been reviewed in Science.

The second volume is fully up to the standard of the first volume, and is a storehouse of interesting and valuable information. The author, in a prefatory note to Vol. II., states that he is indebted to the Carnegie Trust for their liberal generosity in assisting him in the publication of this volume. We think the volume well worthy the support.

As in the first volume there is a series of stereoscopic photographs, giving magnified views of the labyrinths of the various animals studied. Brief descriptions and summaries accompany these photographs.

The volume begins with the continuation of the study of the rodent labyrinth. The labyrinth of the capybara is interesting, in that it presents the most extreme example of the sharp-pointed type of cochlea yet described.

The labyrinth of the insectivora is next considered. "This organ shows evidence of more ancient characteristics than that of any other order of mammals with the exceptions of the monotremata, sirenia, cetacea and a few of the polyprotodont marsupials."

In the labyrinth of the cetacea and sirenia, the cochlea is of a "very primitive type." The appearance of the labyrinth lends little support to the view that the sirenia and cetacea are closely related to the ungulates or to the edentata. The ankylosis of the cervical vertebræ, which is so marked a feature in the anatomy of the cetacea, and the consequent limited movement of the head upon the trunk, are associated with marked modifications in the vestibules and canals. The semicircular canal portion of the labyrinth is very small as compared with the cochlear portion.

The marsupialian labyrinth is next considered. "While there is no doubt that the marsupials left the main stem of mammalian descent at a much earlier period than most of the orders, yet, so far as the labyrinth is concerned, they have developed along parallel lines to such an extent that the organ must be considered almost as far advanced as in some of these orders."

The only example of the monotreme labyrinth studied by Dr. Gray is that of the duck-billed platypus. "In appearance it may be said to stand midway between the labyrinth of the reptiles and that of the eutherian mammals."

The study of the labyrinth of mammals is concluded by a brief study of the venous system of the labyrinth.

The labyrinth of birds is next taken up. The comparative anatomy of the avian labyrinth has been less studied than that of other divisions of the vertebrates. Thus Gray's contributions to the subject are of special value. The labyrinth of birds bears resemblances to that of the alligator on the one hand and that of the monotremes on the other.

In general, in birds the vestibule is very small, while in reptiles it is the largest part of the labyrinth. In some respects the canals in the avian labyrinth show greater resemblance to those in the mammalian labyrinth than to those in the majority of reptiles.

The book is concluded by a brief description of the labyrinths of reptiles and amphibia. Dr. Gray points out that the typical reptilian labyrinth of the present time is by no means so similar to that of birds, as many anatomists seem to think. The labyrinth of the alligator is very different from the typical reptilian organ. In reptiles the cochlea is relatively small, and is drawn out in the form of a cone, except in the teguixin and the alligator, where it has more of a tube shape. The vestibule is the bulkiest portion of the labyrinth, and contains a well-developed otolith apparatus. The canals are distinguished from those of birds, mammals and amphibians by their angularity and comparative straightness of outline. The horizontal canal, however, has a curved outline as in other divisions of the vertebrates. The canals are not set in planes at right angles to one another, but are frequently in planes which are parallel to one another, or at angles of forty-five degrees. This is of importance in view of theories which have been advanced as to the functions of the canals.

The description of the labyrinth of the amphibians is limited to two examples, both belonging to the anura. The author states that since the organ varies considerably in different species a much larger amount of material would be required to give an even fairly complete description of the labyrinth of the amphibians. The descriptions given of the labyrinths of the giant toad and the tigrine frog are interesting for the sake of comparison with those of higher forms.

As in the preceding volume, very valuable tables of measurements of the various labyrinths studied are given.

Dr. Gray is to be congratulated upon the important contribution which he has made to this valuable field of comparative anatomy.

C. R. B.

A Text-Book of Physiological Chemistry. By Olof Hammarsten. Translation from the Sixth German Edition, by John A. Mandel. Fifth Edition. New York, John Wiley and Sons. 1908. Pp. 845.

Professor Hammarsten's "Physiological Chemistry" continues, in its successive editions, to rank as the most successful and reliable of the current text-books, if it is not also the most popular among them. One gains a good impression of the rapid advances which chemical physiology has experienced in recent years by comparing the first German edition of 1890—a book of 400 pages—with the present translation of its latest successor. Familiar defects of text-books on progressive "laboratory sciences" have consisted in the failure to keep abreast of the advances in knowledge and in the tendency to present the subject—physiology in particular—in a cut-and-dried, dogmatic fashion. One can only admire the industry of Professor Hammarsten in maintaining a thoroughly up-to-date record. In contrast with several of the American and German books in the same field, his volume shows both range and perspective in a degree which is attributable to the author's long experience and broad scholarship. But in addition to all this, the treatment is peculiarly *suggestive,* so that the reading of any chapter will bring to even the younger student some appreciation of the present evolutionary stage of physiological chemistry and of the problems which present themselves on all sides. A review of scientific evidence may not furnish an ideal compendium for "preparing for examinations." It is, however, eminently superior to a dogmatic text in affording an appreciation of the way in which physiology develops.

The successive editions of Hammarsten's book seem to the reviewer to embody a gradually improved critique in the elimination of accumulated data of uncertain value. Furthermore, it is encouraging to find in a foreign compilation some adequate recognition for the work of American biochemical investigators.

Hammarsten's text-book can not be said to present the novelty of viewpoint which is peculiar to parts of books such as those by Bunge and Abderhalden. The element of propaganda is nowhere present; but as an orderly arranged storehouse of contributions to the literature it remains unsurpassed. Many of us have learned to depend upon Hammarsten's "Physiological Chemistry" as a reliable help of almost cyclopædic comprehensiveness. Both the author, on the eve of his retirement from active teaching, and the translator have rendered a further useful and creditable service.

Lafayette B. Mendel

Yale University

Devonic Fishes of the New York Formations. By Charles R. Eastman. New York State Museum, Memoir 10. Albany, New York State Education Department. 1907. Pp. 1–235, plates 1–15.

This is unquestionably the most important contribution to the study of American fossil fishes since the publication of Newberry's classic monograph nearly two decades ago.[1] It embodies the results of years of painstaking research; is carefully elaborated, beautifully illustrated and, like everything else from Dr. Eastman's pen, clearly and interestingly written.

It is, of course, out of the question to attempt here a discussion of the many novel facts and interpretations in which the memoir abounds. We may only touch here and there upon some point of special importance.

One of the valuable features of the memoir consists in the large number of new forms and new localities that are put on record. The most noteworthy among these, perhaps, is that of the discovery in America of the genus *Asterolepis.* This is represented by only a single armor plate, unfortunately, but the figures and description leave no doubt that the specimen is an *Asterolepis.* It comes from a lower Devonic horizon (Chapman sandstone of Maine)—a circumstance of high importance; for inasmuch as all the European species[2] of *Asterolepis* have come from the Upper Devonic, the present specimen carries the history of the genus farther back in time than hitherto known. It proves, too, that the organisms of the antiarchan style of structure attained high specialization as early as the Lower Devonic, when they were already represented by three genera, *Asterolepis, Pterichthys* and *Microbrachius,* thus making almost positive the indication that the ancestors of the Antiarcha may one day be discovered as far back as the Upper or Middle Siluric.

There are also described a new species of *Ptyctodus,* one of *Machæracanthus,* one of *Cladodus:* the last, represented by a tooth from the Middle Devonic of Ohio which is declared to represent the oldest cladodont shark yet known (p. 62). Judging by its size one must infer that the cladodonts of that early day had already taken on goodly proportions.

Among arthrodiran "fishes" an interesting small dinichthyid is described, *Dinichthys dolichocephalus;* a new *Glyptaspis,* and a new genus *Protitanichthys.* In connection with this new genus, the type of which (a cranial shield) I have had the opportunity of examining, thanks to the kindness of Dr. Eastman, I regret that I can not put myself in accord with the interpretation given by the author. Dr. Eastman regards this form as a primitive *Titanichthys*—chiefly because the head shield has a pineal element that is broader than long. But this fact, in the reviewer's opinion, is rather inadequate proof that the species is a Titan. *Titanichthys* is not the only Arthrodire with an abbreviated pineal, Dr. A. S. Woodward having long since shown the presence of such a pineal in *Phlyctænaspis.*[3] And, moreover, a careful study of the type specimen shows the pineal to be really elongated as in typical coccosteids. What Dr. Eastman figures as the posterior suture of the abbreviated pineal, I am convinced, is

[1] "The Paleozoic Fishes of North America," Monograph U. S. Geol. Survey, XVI., 1889.

[2] With the reservation indicated by Eastman (p. 40, foot-note), in favor of the obscure fragments described by Pander from the Siluric of the Baltic provinces.

[3] *Geological Magazine,* Vol. IX., 1892, pl. i, fig. 8.

but a transverse flexure across the middle of that plate proper. But even apart from the question of the shape of the pineal element, the genus *Protitanichthys* is obviously founded on doubtful grounds. As Dr. Eastman himself points out (pp. 144, 145), it is extremely probable that this cranial shield belongs to a true *Coccosteus*, perhaps to *C. occidentalis* or to the so-called *Liognathus spatulatus*, both of which are known only from single elements found in the same formation (Delaware limestone, Delaware, Ohio). In view of these considerations it appears to me that the name *Protitanichthys* itself is objectionable. The prefix *Pro* in generic names ought to be rigidly restricted to such cases only where the evidence for ancestral relationship amounts to practical certainty, as, for instance, in the phylogenetic series of the horses or the camels.

In regard to *Acantholepis*, also, we are forced to dissent from Dr. Eastman's interpretation. Newberry and others have shown that the objects so named are dermal defenses of some indeterminable Arthrodire or Ostracophore. Now Dr. Eastman rejects this interpretation and advances the view, upon very slender evidence, that they are "dermal defenses of Chimæroids, probably dorsal finspines" (p. 78). He speaks of these spines as having exserted and inserted moieties, though admitting (p. 79) that the inserted part has never been observed.

A few minor slips have crept into the text—a circumstance not surprising when one considers the mass of detail dealt with. Thus it is stated that no dinichthyid is known to have symphyseal denticles (p. 126), when in 1906 the reviewer published two figures of a mandible belonging to the Newberry collection which clearly displays some ten such denticles.[4]

On one or two points we could wish that the figures had been fuller. For instance, a description is given of what Dr. Eastman interprets as the parasphenoid of *Macropetalichthys*. When one considers that the structure so named by our author has never been adequately described; that among those having intimate first-hand acquaintance with the specimens some go the length of denying that any structure homologizable with a parasphenoid at all exists in *Macropetalichthys*, or indeed in any arthrognath; one wishes that this debatable element had been carefully illustrated, so that whoever wished might judge whether this be a parasphenoid or not. One also could wish that the dentition of that primitive form *Dinichthys halmodeus* had been figured so that we could have arrived at a clear concept of the peculiarities of these interesting structures.

And lastly, this review were inadequate indeed, did we not touch upon Dr. Eastman's views on the relationships of the *Arthrodira*—a group upon which he has bestowed considerable time and effort during the past few years and which occupies no less than a quarter (68 pages) of the present memoir. Indeed, his view of the affinity of the Arthrodira is the veritable *Leitmotif* which runs through his entire discussion of the group.

This theory may be briefly stated as follows: a Paleozoic dipnoan gave off two lateral branches of lung fishes. One of these flourished through several geological periods, giving rise to *Dipterus, Ctenodus, Uronemus* and the like, finally becoming extinct; the second branch, constituted the stock of the Arthrodires, evolved a galaxy of forms, only to become extinguished at the close of the Devonic. The central stock of primitive ceratodonts, on the other hand, continued essentially unmodified through all later geological periods and is represented at the present day by the existing lung-fishes.

Hence Dr. Eastman upholds two distinct theses: (1) that a ceratodont, not a dipterine, exemplifies most nearly the primitive dipnoan; and, (2) that the Arthrodira are specialized offshoots of this primitive ceratodont.

The first of these theses, although contravening the widely accepted view elaborated by Dollo and others, our author does not treat at any length in this memoir and we need not, therefore, go into it.[5] As for the second, the

[4] *Mem. Amer. Mus. Nat. Hist.*, IX., 1906, p. 118, fig. 11, and p. 149, fig. 25 *C*.

[5] For a critique of Dr. Eastman's views on this

reviewer has already in part expressed his opinion[6] and Dr. Eastman's renewed arguments have not led him to alter his point of view.

The central argument against Dr. Eastman's theory of the dipnoan affinity of the Arthrodira seems to the reviewer to be that he lays too much stress on a single character—the resemblance of the crushing dentition of the ceratodonts to that of *Mylostoma* among arthrodires. This resemblance he interprets as an homology and makes it one of the cardinal arguments for relationship. But why may not this partial resemblance in dentition be a case of parallelism, of adaptation to similar food, in two widely different groups?—especially so in view of the wide differences between arthrodires and dipnoans in other regards, and because of the frequent occurrence among fishes of adaptations to a similar hard diet. It seems to the reviewer that a close examination of Dr. Eastman's argument for the homology of the ceratodont and arthrodiran dentitions, especially the exposition on pages 150–151, will hardly carry conviction to the mind of the critical reader.

But the establishment of homology between ceratodont and arthrodiran dentitions is the crucial point in Dr. Eastman's theory. Reject this central argument as not proved or, if you please, as *sub judice,* and little evidence remains, at least in the reviewer's opinion, to support the thesis of a genetic affinity between arthrodires and dipnoans. Some of the adduced evidence must, in fact, be ruled out of court as not material to the present case, for instance the question of the shape of the caudal fin[7] or of the homology of certain skeletal elements.

Furthermore, as Professor Dean has recently urged, there are certain absolutely irreconcilable differences between arthrodires and dipnoans; for instance, the presence in all arthrodires of a complicated dorsal and ventral body-armor constructed on one plan and with complicated neck joints, and its absence in all dipnoans.

And again, the characters linking the arthrodires with the Ostracophores to which writers have again and again called attention within the past half century, are surely not dipnoan.

These are only some of the broader criticisms against Dr. Eastman's views on the affinity of the arthrodires. Did space permit, we might profitably examine certain of the subsidiary hypotheses and conclusions and point out minor difficulties and discrepancies which weigh against Dr. Eastman's main thesis. But enough has been said, we believe, to indicate some of the chief grounds for dissenting from our author's view that the Arthrodira are specialized dipnoans.

L. Hussakof

American Museum of Natural History

subject see a review by Professor Bashford Dean in Science, July 12, 1907, p. 48.

[6] *Mem. Amer. Mus. Nat. Hist.*, IX., 1906, pp. 126–128.

[7] For, granted even that *Coccosteus* had a diphycercal tail, and that fact does not alter the balance of evidence, since a diphycercal tail is not an exclusively dipnoan character.

Variations and Genetic Relationships of the Garter Snakes. By Alexander G. Ruthven. United States National Museum, Bulletin 61, pp. 201. 1908.

In these days of minute analysis on the part of systematic zoologists, an acute and exact study of variation with a synthetic purpose comes as rest to the weary.

The courage displayed by Dr. Ruthven in giving reasons for his scheme of genetic relationships in this impracticable group can be best valued by other herpetologists who have ventured on the same task and have been carefully secretive as to how they did it. As one of these I may be privileged to both praise and criticize this excellent paper.

Nothing but good can be said of the method adopted by the author in carefully estimating the value of the characters commonly held to be specific in snakes, and of the painstaking care with which it has been followed to the end. It is an ingenious bit of demonstration, and one easily verifiable, which shows that reductions in the number of rows of dorsal scales as girth of body decreases in the individual snake, are brought about always by the dropping of certain definite rows, and are not promiscuous, and this observation leads on to the almost equally certain conclusion that specific variation in the scale rows follows the same sequence as in the case of individuals, and is correlated with girth of body. Outside of such sequence variation so rarely occurs that it is negligible. So also with the labial scuta, certain of which are present, absent or fused, in dependence upon head-length.

These results are of much interest and value, and will become more so with increasing knowledge of the processes which make up the so-called "laws of growth." But—and here criticism must take a hand—however surely the chapter on variation establishes these and other novel facts, the reviewer is not able to see that the proposition laid down by Dr. Ruthven as a guide to his phylogenetic lines of parallel development necessarily follows from them. The proposition in brief is that *Thamnophis* started out with the maximum number of dorsal rows known in the genus, and that the forms resulting from geographical extension are for the most part consequent on dwarfing, due to unfavorable environment—the whole course of species formation in the group being one of reduction, and the maximum of size being assumed to be *T. megalops*, of the Mexican plateau, with an occasional twenty-three rows. This is a necessary step to the author's final conclusion as to the original home of *Thamnophis*, but it is by no means certain that *megalops* in the average is really larger than *sirtalis* or *parietalis* of the north, and examples of the questionable form known as *biscutata*, from Oregon, are now and then found which also have twenty-three rows.

Dwarfing has undoubtedly been a factor in the formation of some species, as notably *butleri* and *leptocephalus*, but the evidence is not complete that it has been general. Indeed the fundamental postulate of the theory has more strain put upon it than it can bear, for in the light of what is known as to the relative abundance of garter snakes in different portions of their range, and of their habits, it is not easy to admit that all conditions encountered by them beyond the Sonoran habitat of *megalops*, must be regarded as unfavorable.

If variability in dorsal scales is related to size, and has become definitely limited as a physiological function of certain rows, it is altogether possible, and to the reviewer it seems probable, that the process of differentiation into species has been much more complex than the scheme so ingeniously developed by Dr. Ruthven, and that loss by dwarfing, and gain, perhaps by reversion, have played their respective parts over and again as species have adapted themselves during their migrations to unfavorable or favorable environments.

This leads to the one of Dr. Ruthven's conclusions which is most open to question, in that his four lines of descent in *Thamnophis* are traced back to northern Mexico as the center of origin of the genus.

As presented here there is incompleteness in the theory, for it requires the existing forms of garter snake to be left there, just as they are, in a sort of cul de sac, from which there is no further phyletic outlet. There is no guide possible, even to speculation, as to a common ancestral form, or as to the source from which the genus was derived.

Zoological geographers will be slow to believe that a group so largely dependent upon water is likely to have originated in an arid region, concerning which there is no reason to suppose that in geologically recent times it has been less dry than now. This general consideration is of little moment in Dr. Ruthven's opinion, but certain other probabilities remain, to be less easily dismissed.

From structure and life history there seems good reason to believe that *Thamnophis* came off from *Tropidonotus*, an almost cosmopolitan genus, and one in all certainty much older. Now *Tropidonotus* is distinctly not an inhabitant of the Sonoran region, and makes no approach to it nearer than the low gulf coast of Mexico, and as an intruder up the valley of the Rio Grande. There must be significance in the absence of posterior vertebral hypapophyses in all the genera of colubrine snakes which with fair certainty may be assigned to a Sonoran origin. Nor is there one haviug keeled scales, except *Pityophis,* which appears to have inherited them from *Coluber,* and exhibits them now in weakness and instability indicating that they are being got rid of. I have shown elsewhere that hypapophyses and keeled scales are probably useful in swimming, to aquatic species. In both of these respects *Thamnophis* would be an anomaly among indigenous Sonoran genera, and its possession of both structures appears to be an argument of much weight on the side of its Austroriparian origin.

In matters of detailed taxonomy little need be said, especially when one admits the sway of the personal equation among specific characters. The author does present objections of some importance to the phylogenetic schemes devised by Professor Cope and the present reviewer, but it is to be remembered that the last of these, at least, was put forward as no more than a tentative hypothesis—a *ballon d'essai* as it were—and its author has no present inclination to make defense of all its details. But it must be said that parts of Dr. Ruthven's grouping are equally inadmissible. For instance, he combines with a long known Washington and Oregon form, *leptocephalus* (*ordinoides* in his nomenclature), garter snakes from the coast region of central California, usually recognized as *elegans,* which he excludes altogether from that portion of its range. This is not a happy conclusion, in view of the fact already recorded by me (*Proc. Academy of Nat. Sciences of Phila.,* 1903, p. 290), that I removed from the oviducts of a female from Santa Cruz Co., California, which would be, and indeed is assigned by Dr. Ruthven to *leptocephalus* (*ordinoides*), thirteen young, fully developed, twelve of which in color and scutellation are typical *elegans,* as defined by Baird and Girard. The snake to which Ruthven applies the name *elegans* is a species of the mountains and high plains properly known as *vagrans.*

Again, certain specimens of *elegans* from Santa Cruz Co. and neighboring portions of California, occur that are distinguishable with difficulty from *parietalis,* which Dr. Ruthven places on a quite different line of descent.

But I cheerfully turn away from fault-finding. The paper is admirably conceived, carefully executed, is original and fearless throughout, and systematic zoology would make large measure of gain if there were hope that it might serve as a finger-post to better methods in the study of variation. Here it deserves all praise.

ARTHUR ERWIN BROWN
THE ZOOLOGICAL GARDENS,
PHILADELPHIA

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for July contains the following articles "A New Mendelian Ratio and Several Types of Latency," by George H. Shull; "The Leg Tendons of Insects," by C. W. Woodworth, in which the author notes that the fact that the leg tendons are cuticular invaginations, and therefore subject to replacement at each molt, has not, so far as he is aware, been published. A case of "Abnormal Incisors of *Marmota monax*" is described by Charles A. Shull, and "A Note on the Coloration of *Plethodon cinereus*" is given by Hugh D. Reed, who describes two unusually red individuals. Marian E. Hubbard gives the results of "Some Experiments on the Order of Succession of the Somites of the Chick," which show that not more than two somites can arise in front of the one first formed. Hervey W. Shimer discusses "Dwarf Faunas," concluding that the chief agency in their production is an abnormal habitat. This might come about by change in a normal habitat or by the extension of an animal's range into an unfavorable location. In "Notes and Literature" Charles A. Kofoid gives a clear and interesting résumé of "The Life History of the Eel."

The Zoological Society Bulletin for July notes the birth of a mountain goat in the Park, the first born in captivity. The parents were two of a herd of five secured by Director Hornaday in 1905, and born in May of that year. There is an account of the present status of the park showing that it ranks first in number of individuals represented in the collections, there being 4,034 animals living in the park. Under the head of "Interesting Animal Surgery" is noted an operation for cataract performed on the Indian rhinoceros, "Mogul." A Census of American Bison gives a total of only 2,047 on January 1, of which 969 were in captivity in the United States and 41 in Canada: these figures are now different owing to the sale to Canada of the Pablo herd. As a supplement to the bulletin F. A. Lucas has an article on "The Passing of the Whale," noting that the number of whales are being rapidly lessened and that unless protective measures are taken one or two species are in danger of actual extermination.

Bird-Lore for July–August contains articles on "The Fish Hawks of Gardiner's Island," by Frank M. Chapman; "The Return of the Snowy Heron," by Herbert R. Sass; "A Little Blue Heron Rookery," by M. Harry Moore, and the fifth paper on "The Migration of Flycatchers," by W. W. Cooke. The Educational Leaflet is by Mabel Osgood Wright and devoted to the tree swallow. The report on The Audubon Societies notes steady progress, but as the result of continuous work, and the vast numbers of birds sold for "plumes" shows the necessity of further hard work.

THE LIQUEFACTION OF HELIUM[1]

In his communication to the Amsterdam Academy concerning the liquefaction of helium Professor Onnes describes in considerable detail the steps that led up to that achievement, the complicated apparatus employed, and the difficulties that had to be surmounted. The narrative conveys a vivid impression of the obstacles that have to be overcome in order to lower temperature a very few degrees in the neighborhood of the zero of absolute temperature. In spite of the most elaborate and comprehensive preparation and ample supplies of liquid hydrogen, not only was the whole apparatus, with its subsidiary arrangements, tested to its utmost capacity, but the physical energies of the professor and his assistants were well-nigh exhausted by the prolonged struggle.

The constants of helium, while showing some important points of difference, are found to agree very remarkably with the predictions made by Dewar on theoretical grounds in his presidential address to the British Association in 1902. After a correction of two tenths of a degree the boiling point of the liquid is found to be 4.5 degrees Centigrade. By exhaustion to below one centimeter, and probably below seven millimeters of pressure, the professor considers that the temperature was reduced to about 3 degrees without, however, affecting the mobility of the liquid.

The density of the liquid helium is 0.15, or about double that of liquid hydrogen; and the proportion between the density of the vapor and that of the liquid is as 1 to 11. The critical pressure is in the neighborhood of two or three atmospheres, which is relatively low in comparison with the figures for other gases.

Professor Onnes deduces a critical temperature not much higher than 5 degrees Centigrade. But with regard to this and all the other figures he says that more careful measurements and calculations must be made before any certain and final conclusion can be reached. At temperatures so near to the absolute zero there is always room for doubt in the application of laws deduced from the behavior of bodies in more normal conditions, and for the present we must apparently be content to accept the values of the helium constants as provisional.

[1] From the London *Times*.

SPECIAL ARTICLES

A NEW GROUP OF PERMIAN AMPHIBIANS

More than thirty years ago the late Professor Cope described from the reputed Permian, of Illinois, three small vertebræ which he considered reptilian and which he made the type of the genus and species *Lysorophus tricarinatus*. Six years ago Professor Case recognized in certain material—a considerable series of connected and more or less intertwined vertebræ—which he had collected from the Permian of Texas, the same genus, and, possibly, the same species. He reached the conclusion that the animal was legless and serpentiform in shape. In the absence of the skull, he referred the form, as Cope had done, to the Reptilia. Two years later F. Broili thought that he recognized in some imperfect skull material of the same species a pair of flat bones below the palatal region, which he believed to be gular plates. As such plates are characteristic of fishes and unknown in reptiles, with which he also classed the genus, he reached the rather startling conclusion that the reptiles were, in part at least, derived directly from the fishes—a conclusion, it is needless to say, which was received with doubt and incredulity by naturalists. Because of this extraordinary character he proposed for the form the family name Paterosauridæ.

Recently, in the examination of the Texas Permian material in the Chicago University collection, I was so fortunate to find a skull of *Lysorophus* in connection with vertebræ, which, upon preparation proves to be wonderfully perfect and complete. The so-called "gular plates" of Broili are merely and clearly four pairs of epibranchials, all nearly of the same size, the first pair only with a stout pair of ceratobranchials connected with them. Upon the whole the branchial apparatus resembles not a little that of *Necturus* or *Proteus;* and indeed there are certain other resemblances to these salamanders in the skull that can not be overlooked—the small, pointed snout, the very small size and anterior position of the orbits and nares, especially. The temporal region is unossified; the basioccipital is ossified and there are two occipital condyles. There is no pineal eye; and there is a pair of large plates, apparently proatlantal, back of the small, unpaired supraoccipital.

Lysorophus was a slender, well-ribbed, serpentiform, legless, probably blind, mud-burrowing amphibian, with long, one-headed ribs attached neurocentrally, and with notochordal vertebræ, strangely resembling, though genetically very distinct from, the modern Cæcilia. In skull structure it is not unlike modern amphibians, but will doubtless require the erection of a new group for its reception, a group equivalent to the modern Cæcilia. In length the creature may have reached a foot or fifteen inches, though the skull measures but a trifle more than half an inch.

S. W. Williston
University of Chicago

COMBINATIONS OF ALTERNATIVE AND BLENDING INHERITANCE

Whether blending and alternative inheritance are fundamentally the same thing or not, they are usually sharply to be distinguished in their end results. Mendelian work has been almost wholly concerned with alternative inheritance. However, usually each member of the Mendelian pair exhibits fluctuating variation. Tallness of peas is dominant in a Mendelian sense over dwarfness, but each sort varies as to height. When either condition is pure (homozygous) only blending inheritance is concerned. When the two conditions are crossed we have to consider a combination of both alternative and blending inheritance.

When the ranges of variation of the two conditions do not overlap no confusion would occur. However, when they do, although Mendelian segregation and purity of germ may be as perfect as ever, confusion would arise. In the beetle *Crioceris asparagi* there are three pigmentless areas on each elytron. These areas may be distinct or they may be united in various degrees. Usually it is the anterior and middle area which unite. They may be well united, or only faintly so, or not united at all but extra large, or they may not be united and small. It seems[1] that the condition of areas-distinct-and-small is a Mendelian dominant over areas-united. However, the recessive character is subject to the fluctuation just mentioned and the inheritance of these fluctuations is a problem of blending inheritance as contrasted with the problem of areas-distinct *vs.* areas-united.

I have been carrying on a study of the inheritance of abnormal venation in *Drosophila ampelophila* for about forty generations of the fly. As was pointed out in a preliminary report of the work before the Boston meeting

[1] Lutz, *Psyche*, June, 1908.

of the International Zoological Congress, we have here the difficulty in applying Mendelism that the range of variation of the recessive character (extra veins) includes, in its somatic manifestation, the lominant characteristic, so that when the recessive character is not well developed we get, even in strains supposedly "pure" with respect to the recessive character, flies that somatically lack the extra veins. However, the degree of development of these extra veins is inherited and the study of such inheritance is a typical one of blending inheritance. Since the degree of development of the abnormality is inherited there must be a correlation between the potency of the "determiners" in the germs and the soma from which these germs came, also between them and the soma they produce. Flies having slight abnormalities produce germs tending to have the abnormality-producing factor weak. When such flies are mated with flies which lack the factor the zygote is so weak with respect to the factor that few, if any, of the offspring are abnormal. However, if flies, producing germs strong with respect to the factor, are mated with flies lacking it, abnormals will be produced. In other words, we have imperfect dominance. This theory of imperfect dominance possesses the advantage, from the Mendelian's view-point, that one does not have to give up a fundamental principle of Mendelism—segregation or purity of the germ. An explanation of certain cases of latency, such as the carrying of pigment possibilities in white animals where albinism is recessive, is also suggested. For example, the spotted condition of guinea-pigs varies in a negative direction until pigment is to be found only in the eyes or in a very small part of the skin,[2] hence presumably beyond this point, when, although it is germinally present it is not somatically evident.

In other words, when the ranges of variation of Mendelian pairs overlap, the Mendelian phenomena will be masked, owing to the inability of the experimenter to properly classify his material. Nevertheless, the fundamental principle of Mendelism—segregation—may still be operative. For example, Castle[3] concluded that the inheritance of polydactylism was *neither* alternative nor blending. May it not be *both* alternative and blending? The distinction seems theoretically important.

FRANK E. LUTZ

[2] Castle, 1905, Carnegie Pub., No. 23.

[3] 1906, Carnegie Pub., No. 49.

DISTRIBUTION OF DIABASE IN MASSACHUSETTS

No diabase is found west of the Triassic. In the Triassic and east to a line N. 10° E. through the Brookfields is a "Hunne diabase" with two pyroxenes—an augite and a white diopside and feldspars in two generations.

Next east a series of large dykes runs N. 20° E. through Spencer nearly across the state, of a micrographic Hunne diabase, *i. e.*, a rock closely like the above, but containing often abundantly quartz and orthoclase intergrown.

The two types repeat the relations of the western bedded diabase and the Palisade diabase in New Jersey, as recently brought out by Mr. T. Volney Lewis, at the winter meeting of the New York Academy of Sciences. Next east in Massachusetts a band of olivine diabase runs north from Blackstone half across the state.

All the remaining eastern part of the state east of a line drawn about N. 10° W. from the northeast corner of Rhode Island is occupied by a normal diabase, with augite and feldspar in one generation, no olivine or micrographic structure, rich in iron, often showing long rows of octahedra; much weathered and running to coarser grain, and in part of pretriassic age.

Again, in addition to the nepheline rocks around Salem, an interrupted band runs N. 10° W. from Woonsocket, near the northeast corner of Rhode Island, across Massachusetts and into New Hampshire, and the olivine diabase mentioned seems to be in relation with the same. These rough notes are presented as a preface to a request that any one having slides of diabase from Massachusetts would kindly send to the writer information as to whether the same contains olivine, diopside, micrographic or porphyritic structure.

The writer would also value information about any nepheline rocks in Massachusetts.

B. K. EMERSON

AMHERST, MASS.

A SIMPLE ATMOMETER

FOR determining the differences between the evaporating power of the air in different localities, as in the case of studies dealing with the relation of meteorological conditions to plant growth, the atmometer here described has proved very satisfactory. This instrument utilizes a porous clay bougie for

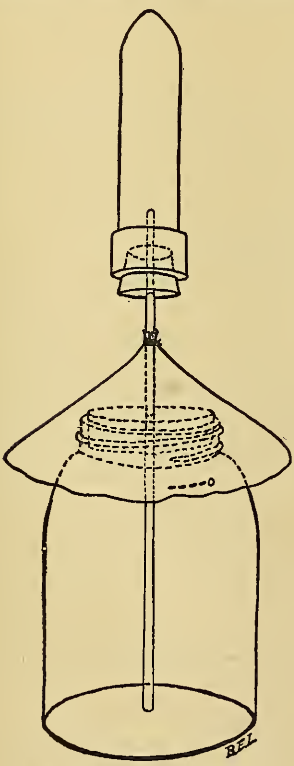

FIG. 1. Porous Cup Atmometer

the evaporating surface, after the manner of an atmometer devised by Babinet and described in 1848.[1] It is a modification of a form independently devised by the author for physiological purposes, and described in Publication No. 50 of the Carnegie Institution, 1906.

The bougie is about 13 cm. long and 2.5 cm. in diameter, closed and rounded at one end and reinforced at the other by a thickened rim. The wall, of unglazed porcelain similar to that used for filter tubes, is about 4 mm. in thickness. The open end is closed by a perforated rubber stopper bearing a glass tube about 30 cm. in length, which extends through a cork stopper nearly to the bottom of a glass jar of the "Mason" pattern. Any bottle will serve as well, and a graduated flask serves better, but the "Mason" jar was adopted because of the ease with which it may be obtained almost anywhere in the United States. To allow access of air to the jar, the cork stopper should fit the latter somewhat imperfectly, or should have a slight groove cut in its margin. Above the jar the tube passes through a conical cap of cloth which is rendered water-proof by means of shellac. This serves to shed rain water and to prevent its direct entrance to the jar. An external file-mark on the jar, near the shoulder (*O* in the figure), serves as a fixed water-level. A pint, quart or half-gallon jar is used, according to the evaporation rate and the time period during which the instrument is to operate without refilling.

In setting up this instrument, the jar is partially filled with distilled water, the bougie (which has been soaked in distilled water to remove air) is filled and its stopper inserted with the glass tube, the tube is filled, and its free end quickly thrust to the bottom of the jar. In the last operation air must not enter the tube. The jar is next filled to the file-mark, the cork stopper placed in position, and the instrument is ready for operation. When the apparatus is thus arranged, the water films closing the pores at the outer surface of the bougie possess a tensile strength adequate

[1] Babinet, J., *Compt. Rend.*, 27: 529–30, 1848.

to prevent penetration of air through the walls, and the bougie remains filled with water, although it is above the water-level in the jar. Evaporation proceeds from the surface of the bougie, water being drawn into the pores to replace what has been lost. The water thus removed from the cavity of the bougie is in turn replaced from the reservoir, and evaporation may continue as long as the tube reaches the water in the latter.

After the lapse of a time period the cork stopper is loosened, slightly raised, and slipped sidewise as far as the tube will permit, its lower surface resting on the edge of the jar. The latter is then refilled to the standard level from a graduated vessel, and the amount of water required to refill is the amount which has been evaporated during the preceding period.

Only pure water is to be used in this instrument, for otherwise a rapid clogging of the pores of the bougie ensues. Water from an ordinary still is satisfactory. To prevent the growth of microorganisms in and on the bougie, which might clog the pores, formaldehyde may be added to the water, to make a 3–5 per cent. solution. This does not interfere appreciably with the operation of the instrument. The bougies, as received from the factory, are, of course, not strictly uniform in porosity, and it is necessary to standardize them by comparing their evaporation rates, under uniform conditions, with that from a standard bougie. The latter is not used excepting for standardizing, and is kept protected from dust and moisture when not in use. A coefficient of correction is obtained by standardizing, which is applied to the readings obtained in actual operation. If properly used the bougies will operate for at least four months without appreciable alteration in their coefficients of correction. It is well, however, to restandardize them at the end of a season's work.

When exposed in the open, rain may fall upon the surface of the bougie, and as long as this surface is wet the water movement in the instrument is reversed, and water actually enters the jar, at a rate determined by the porosity of the bougie and by the height of the water-level in the jar at the time. This error, is, however, very small excepting for long periods of rainy weather. A correction coefficient may be obtained and applied, but the application must depend upon a record of the duration of precipitation periods. Of course the error here mentioned might be avoided by placing a small screen above the instrument, but such a screen would alter the evaporation rate to some extent, even though it were made of glass, and, since the influx of heat from the sun in different localities varies to a marked degree, a screen is not desirable.

This atmometer may be read daily, weekly or monthly, in fact at any convenient intervals, the only condition being that the water-supply in the reservoir must be adequate for the chosen period. The tube may be lengthened to several times the given length without affecting the accuracy of the readings, so that a large reservoir may be used for very long periods. The rate of water loss from the bougie may be reduced by partially coating the surface of the latter with shellac, or a smaller bougie may be used.

This form of instrument has few of the objectionable features possessed by the common open vessel atmometer. It does not attract birds and other small animals and is not subject to errors on account of their visits. It is especially adapted to studies of the effect of wind on evaporation, for high winds do not produce any error, as they so often do in open vessels, by the blowing of liquid water from the surface and by producing variation in the effectual surface itself. It may be standardized so as to give results in terms of depth of evaporation, as usually given, by comparing it with whatever form of open vessel the observer may choose as standard for this purpose. It is self-recording and self-integrating, as far as data for a mean rate are concerned, and, finally, is so inexpensive that several instruments may be exposed at a single locality, thus decreasing the chance of error.

Burton Edward Livingston
Munich, Germany

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 11, 1908

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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., or during the present summer to Wood's Hole, Mass.

SOME PROBLEMS OF THE INDUSTRIAL CHEMIST[1]

THIS address or talk is the outcome of a conversation with Professor Dennis a couple of months ago. After a rather prolonged discussion of many phases of industrial chemistry of mutual interest to both of us, he very kindly suggested that you as students and workers in chemistry might be glad to hear some of these same problems discussed in the same way. I am particularly happy to undertake this task because for six years I was a part of the university here and looked at chemical problems from what I may collectively call the university point of view, while for the last nearly four years I have been engaged in looking at these problems mainly from their commercial side. Due to a combination of circumstances, it was necessary for me to assume responsibility in manufacturing chemicals along lines I had never anticipated, and to come into intimate contact with every phase of the history of these chemicals, including their sale. A further combination of circumstances has put me into intimate touch with many industries not primarily chemical, but, being users of chemicals, they have troubles and call for assistance.

When you leave the university you will, as I have, of course, many times be forced to assume the responsibility of making decisions and giving some kind of a sensible judgment based on inaccurate knowledge

[1] Address given before the Cornell Section of the American Chemical Society, February 27, 1908.

or insufficient data. Many times you will fervently wish that you had become more thoroughly familiar with the characteristics of this or that chemical, or with standard practise in machine design, factory construction, the iron and steel industry, boiler construction, engines and a thousand and one things that could not possibly all be crowded into a college course of reasonable length. I have had under my direction or in my employ or associated with me quite a large number of engineers, chemical engineers, engineering chemists, industrial chemists, industrial engineers, draftsmen, chemical experts, manufacturing chemists and just plain chemists, besides one or two of those chemists who would have graduated in June only their eyes gave out about the first of February. These men have been graduates of European universities, including Berlin, Luxembourg and Upsala; American universities, including Cornell, Harvard, Princeton, Syracuse, Lafayette, Vermont and Massachusetts Institute of Technology and the Rensselaer Polytechnic; others of the men, among them some of the most efficient in chemical manufacture, have had no university training whatever, but have entered chemical works as boys and obtained their training there.

I have endeavored to note the merits and deficiencies of all these men as well as my own shortcomings, or lack of preparation, and want to give you to-night, first, a few of the lines along which I think you would do well to work in your chemical preparation, and, second, sketch a few of the industries which show a good future for the chemist and a few of the problems that confront him there.

The selection of the subjects to be considered will be a purely arbitrary one. It will not at all be based on their comparative importance or extent, but will be determined solely by whether I happen to have first-hand knowledge regarding them.

This decision and restriction require no little firmness of mind. It shuts me out of nearly the whole field of modern chemical research and discovery. It would be such a delight to expatiate on radium and its emanations and allies, or the possible degradation of copper into lithium, or the fulfillment of our long hope of fixing atmospheric nitrogen, or the marvelous developments in electric furnace work and manufacture of alloys, or the changes taking place in the iron and steel industry, the explosives industry and the cement industry, or any other branch of chemical industry which has been undergoing revolutionary changes, regarding which I may have a smattering of information. But it is amazing how small and how prosaic one's information is, when it is restricted to those matters of which he has definite first-hand information.

Taking up now the deficiencies in knowledge or training which the young graduate chemist shows when he meets his first employer, the most striking one to my mind is his ignorance of the comparative *commercial* importance of chemicals; the comparative extent of their manufacture and sale. When you study chemistry as a science solely this question of commercial importance does not and should not arise. Indium should receive as much attention as aluminum or lead. The mere fact that one is bought and sold while the other isn't has no bearing whatever on their relation to the science of chemistry. And further, I do not want to be understood as indicating that chemistry should be taught in any other way than as a science. The business of the student during his four years here is to learn the fundamental principles underlying the various branches of chemistry, acquire a certain familiarity with its representative elements and compounds, and study it as an art in so far as the various analytical and other methods used are applicable through *all* or most branches of chemical industry. To my mind it is no part of the duty of a university to turn out trained soap makers, acid makers, paint makers, etc., but it is her duty to turn out men whose knowledge of chemicals and the principles of chemistry is broad enough so that they can enter any of these industries and make themselves valuable.

The moment a man enters *any* branch of chemical industry then aluminum and lead and iron, we will say, become much more important than indium. This is a situation that will face *every* chemist; it follows that his training in the science and art should be supplemented by some knowledge of commercial chemistry before he leaves the university. Such materials as sulphuric, nitric, hydrochloric and hydrofluoric acid; ammonia, soda ash, sal soda, glaubers salt, epsom salt, copperas, blue vitriol, caustic soda, caustic potash, and the like, concern such a great variety of industries that the chemist is sure to come in contact with most of them in a commercial way. His employers and associates, often not themselves chemists, will have a certain fund of information regarding such materials; any lack of it on the part of the chemist at once produces the impression that he is only a "theoretical" chemist, which is the polite expression used in the trade to damn a man as absolutely useless.

The young chemist should know, for instance, the percentages and gravities at which ordinary acids and alkalies are sold, and his disgust for the Beaumé and Fahrenheit scales should not prevent his being familiar enough with both so that any figures given in either will convey distinct impressions to his mind. He should know in what packages and quantities these common chemicals are shipped and the basis on which settlement is made.

For instance, he should know that sulphuric acid is shipped in three different kinds of packages, tank cars, drums and carboys; that it is shipped in three different strengths of approximately 65, 78, 93 per cent. strength, besides some shipped as 98 per cent. and as fuming acid or 100 per cent. acid containing free sulphur trioxide. These strengths are known in commerce as 50°, 60° and 66°, 98 per cent. and fuming. In the same way he should know the character of package, commercial appearance and strength of nitric acid, mixed acid, hydrochloric acid, hydrofluoric acid, aqua ammonia, carbonate of soda and caustic soda. He should know the distinction between nitric acid and aqua fortis, the basis on which soda ash and caustic soda are sold, respectively, one being on the 48 per cent. strength and the other on the 60 per cent. of Na_2O. He should know that bisulphate of soda is sold by the carload, while bisulphate of potash is more likely to be sold by the pound. Glaubers, epsom, copperas, blue vitriol, magnesium oxide, magnesium chloride, zinc chloride, chlorides of tin, calcium chloride, barium peroxide, all of these substances should be familiar to him, and in each case he should know the kind of package and strength, and the approximate cost of the commercial product. In this connection, I think it would be wise in any museum of industrial chemistry to have two sections to which the attention of students is especially called. One section devoted to chemicals which can be produced according to good processes in large quantities, but which are still hunting for profitable uses, and another section devoted to waste products and by-products of all descriptions which it is desirable to convert into marketable goods. The student should also be thoroughly familiar with the physical appearance and properties of these common products as they exist in commerce, so that he may recognize it at a glance if a mistake in the kind or quality of material has been made, before this mistake has cost his firm a considerable sum of money. Such mistakes will occur so long as purely human agencies handle chemicals. One of the most ludicrous ones that has recently come to my attention was a case where a consignment of soft soap was delivered on an order for thick silicate of soda.

Of course, it may be urged that the chemist can acquire all this information after he has left the university, and this is readily granted. But the acquiring of the knowledge outside is usually tedious and difficult and only accomplished after the chemist has been repeatedly subjected to mistakes and embarrassment due to his ignorance. Then, too, many of us believe that chemistry is a profession, and if so it is as essential for the chemist to be familiar with the present situation and relative importance of the materials with which he has to deal, as it is for the physician or lawyer in his profession.

If the functions of the chemist, the engineer, the business man and the manager could be sharply divided in chemical manufacture so that the chemist would not be asked any questions excepting those which fall entirely within the field of pure chemistry, the demands on his training and information, of course, would be much smaller and the reward of his labors would be correspondingly decreased.

The next place where the young chemist is usually most ignorant and most in need of assistance to my mind is in his knowledge or lack of knowledge of materials of construction and their comparative ability to resist the action of common chemicals. In his university work beakers and flasks and test-tubes and porcelain and platinum dishes, and rubber and glass tubing have always been available and have usually been adequate in size and quality for all his purposes. As soon as he enters chemical industry other materials must be sought more durable than glass and less costly than platinum. What accurate information does he possess regarding the comparative merits of cast iron, wrought iron and steel, for example, in resisting the action of caustic soda solutions, of sulphuric, hydrochloric or nitric acids, chlorine, sulphur dioxide or sodium carbonate solutions. Where are copper and brass and lead necessary or permissible. Where can he use Portland cement or Pecora cement, or silicate of soda or fire clay or ordinary mortar in making tight joints or linings.

To illustrate take the metal copper. It is most valuable in making stills and condensers for wood alcohol, acetone, acetic acid, turpentine, etc., and its alloy brass is extensively used in valves. Yet its use often leads to serious difficulties.

For example, I have seen iron drums to be used for shipping aqua ammonia in which the inside seams had been brazed, and bottling machines for use in bottling ammonia solutions containing brass parts exposed to the liquor. In both cases the final products, of course, were beautifully colored but unsuitable for the market. Similarly I have seen both copper and brass work placed in position where they would be continuously exposed to acetylene containing its ordinary impurities, ammonia, phosphine, etc.

In all these cases there were chemists in charge. They probably knew in a general way something about the action of ammonia and acetylene on copper and copper alloys, but their information was not indexed in their brains under the head of materials of construction.

Take again the case of sulphuric acid,

which is probably manufactured in larger quantities and goes into more industries than any other chemical. As we noted above, it is sold in about five strengths of 65, 78, 93, 98 per cent. strength, respectively, and fuming acid in addition. All these grades of acid must be made, concentrated and shipped, and the first and most important question to be decided is the kind of material to use at each separate stage of the process.

You are all no doubt perfectly familiar with the general features of the process of manufacturing sulphuric acid by the chamber and the contact methods, using either brimstone or pyrites. At the risk of wearying you, I am going to take some time to sketch through these processes, keeping in mind continuously the extreme importance of a knowledge of the action of chemicals on materials used in the construction of apparatus. When sulphur or pyrites is used as the raw material a large amount of cast iron enters into the construction of the burners and very often they are made entirely of cast iron, this in spite of the fact that one of the first freshman experiments proves that when sulphur is burned in the presence of iron, the products unite to form a sulphide of iron. When brimstone is burned in cast-iron burners this same action takes place to a certain extent, but the coating of sulphide of iron formed protects the rest of the iron from injury.

When sulphur is burned in the form either of brimstone or of pyrites the greater part, of course, forms SO_2, but about 6 per cent. burns to SO_3. Either of these two gases may be moved continuously and without danger in cast-iron pipes regardless, within reasonable limits, of how hot they become. On the other hand, a certain amount of moisture, depending on the day and the location of the plant, passes in with the air used for combustion (unless especial precautions have been taken to dry it all) and appears in the SO_2 gases. If these gases are allowed to cool the moisture combines with SO_3 in the gas to form dilute H_2SO_4, which destroys cast iron very rapidly. At the point where the gases are cooled in the contact process, or enter the glover tower in the chamber process, the iron must be abandoned, and all the cast-iron pipes must be arranged to drain forward and not backward. This same feature comes up in making nitric, muriatic acetic and hydrofluoric acids, all of which attack iron rapidly, and still all are made in iron retorts or furnaces. The necessary precaution, of course, is that no part of the retort or furnace should be allowed to cool enough to permit any condensation to form liquid products. If the retort is not properly insulated at any place a hole eats through with amazing rapidity.

Returning to the sulphur dioxide gases, then, we must change from cast iron to lead as soon as the temperature goes low enough to permit condensation. This material is not attacked by weak sulphuric acid. We, of course, could not use lead all the way back to the furnaces, as the excessive heat would melt it. In the chamber system the gases must now continue in lead throughout. In the contact system the sulphuric acid is filtered out after cooling and the gases continue their course in cast iron and steel to the very end without danger.

In concentrating H_2SO_4 still more interesting details arise regarding the materials that may be used. Many have been suggested, and among others glass and porcelain have been used with more or less success. But a factory is no place for glass and porcelain apparatus if any other materials can be found. The four materials now in fairly common use are lead, cast iron, volvic lava and platinum. Lead may be used so long as the acid does not exceed 80 per cent. in strength and so long as direct heat is not applied. Platinum is satisfactory while the acid is between 80 per cent. and 94 per cent. strength, but the installation is very expensive and the loss of platinum is very large if an attempt is made to concentrate above 94 per cent. Cast iron is very satisfactory between 88 per cent. and 98 per cent. Below 80 per-cent. its life is too short to be considered. Cast iron is always attacked in any case, but it is usually cheaper to use cast-iron pans for six months or so and then replace them than it is to make more expensive installations. Fortunately only a small proportion of the iron dissolved by the acid from the pans remains in solution in the acid; nearly all of it is in the form of a sulphate of iron almost insoluble in either water or sulphuric acid, so it readily settles out, leaving a clear acid.

Where it is desired to produce 98 per cent. acid by concentration, a common custom is to evaporate in lead pans by waste heat to 78 per cent., then in platinum stills by direct heat to 93 per cent., then in cast-iron stills to 98 per cent. What evaporates from the lead pans is mainly water and is disregarded. The evaporation from the platinum stills forms a 35 per cent. acid, which can, of course, be condensed in lead. That from the cast-iron stills is over 90 per cent. and must be condensed in platinum. If the acid to be evaporated contains much sediment, as is liable to be the case when it is made from pyrites, or if the platinum stills are allowed to become dry and burn, they may be nearly ruined in a single night by a careless workman. The only material to use in mending the leaks which frequently occur in the platinum stills is gold. This seems rather startling when we consider that the acid itself is sold in quantity for less than a cent a pound, while the brimstone from which it is made costs more than a cent a pound.

Another common and satisfactory arrangement where it is only desired to concentrate up to 93 per cent. strength, is to evaporate in lead pans by waste heat up to 80 per cent. and feed this 80 per cent. acid directly into a large cast-iron still of such capacity that the whole body of acid in it always averages over 90 per cent. This prolongs the life of the iron often to two or three years, instead of its usual life of three to six months.

The distillate from such an iron still can, of course, be condensed in lead, but the upper part of the still itself would soon be eaten out by the weak distillate unless it were lined with acid brick or repressed red brick set in Portland cement neat, or mixed with silica or fine asbestos. Portland cement will stand the action of hot weak sulphuric acid for a very considerable time. A still of this type, if properly cared for, usually meets its end from cracking rather than from eating through. This is due to the caking of the peculiar sulphate of iron, which I mentioned above, on the bottom of the still to such an extent that the heat cracks the iron. When such an accident occurs there is, of course, a delay in operation, which is always expensive, aside from the cost of the new still and possibly a loss of several tons of acid.

Concentration in apparatus made of volvic or volcanic lava rock by driving hot furnace gases directly over and through the sulphuric acid is very satisfactory. The cost of installation is large, but not so large as that of platinum. The lava rock used comes from a mountain near Clermont-Ferrand in central France and so far no satisfactory substitute for it has been found in this country, although a number have been tried, among them some of the hard red sandstones of New York. In the volvic lava concentrating apparatus the stones are liable to crack from heat if stilling is pushed too hard, and, of course, the lead and porcelain parts of the apparatus give out repeatedly.

In making sulphuric acid by the chamber process, the chambers of course are entirely made of lead; but as nitric acid and nitrogen oxides are mixed with the sulphur dioxide gases the strength of sulphuric acid in the chambers can never be allowed to fall below 45°; otherwise it will dissolve nitric acid in sufficient quantity to attack the lead very rapidly. If, on the other hand, the strength in any chamber is allowed to go above 55° nitrogen oxides are dissolved which also attack lead. Between 45° and 55° strength, however, almost no nitric acid or nitrogen oxides are dissolved and the chambers are safe. The action of nitric acid on lead chambers is very insidious and its affects are difficult to detect until a hole finally comes through the lead, probably simultaneous with the descent of several tons of acid.

I might go on to discuss acid eggs, pumps, sprays, piping, tower filling and tanks of a sulphuric-acid plant. In every one of these a careful consideration of the strength and temperature of acid is necessary before we can determine what materials are best or are even to be considered in its construction. I might go on to other industries and discuss why, for instance, in C.P. acids we are reduced to the use of glass, porcelain or platinum, while for C.P. ammonia iron is perfectly permissible, and for pure acetic to be used for vinegar none of these will do (except possibly glass), but we must use silver. Go through every branch of chemical industry, undertake to transport any chemical reaction from a laboratory to a works, and the very first problem that confronts you is what material to use in making your apparatus. The thing I want to impress on you is that you can not make a chemical, you can not make a thing in a chemical works without something to make it in, and the choice of that something is exceedingly important and worthy of serious consideration.

The next line upon which I would recommend the young chemist to be better equipped than chemists usually are, is in his knowledge of power accessories and transmission machinery. I do not mean that he should have any extensive knowledge along these lines, but he should certainly know the principles of a steam engine, how to start and stop it and when it is running properly. He should know the principles of boiler construction and boiler setting and how to care for a boiler; what amounts of fuel can be burned on a given grate surface, what evaporation may be expected from this fuel, and what power it will furnish, and what temperature and analysis of flue gases may be considered economical operation. He should know about steam pumps, their valve arrangement and how to compute their capacity under various pressures. He should know centrifugal pumps and under what circumstances they may be used; blowers plus pressure blowers and exhausts, mechanical stirring apparatus, shafting and pulleys and how to place them. By all this I do not mean that he should be an expert in factory design, or even a millwright or pipe fitter, or engineer or stoker, although he would certainly be much better equipped if he did have all these accomplishments. Yet all these things I have mentioned are the very tools of his trade, they are his beakers, and bunsen burners, and suction pumps, and stirring rods and steam-baths. If the young chemist gets on at all in manufacturing or using chemicals he must use all these appliances, and men working under his direction must manipulate them all, so it seems to me the part of wisdom for him to assimilate all the information along these lines that comes his way.

At the same time the chemist should know his limitations. He is not an engineer and does not pretend to be; he simply reaches out for that small portion of the field of engineering where machinery comes in contact with his chemicals. In this limited field he may acquire and pretend to special information, but beyond it he would do well not to go. Let him rather call his brother engineer into consultation when he gets beyond his depth, so that the brother engineer may in return more readily call the chemist in consultation, to the mutual advantage of both.

The next place where I think the average chemist's stock of information could be profitably enlarged is in his knowledge of what industries use the common chemicals and how they use them. You will notice throughout that I use the term common chemicals. I realize perfectly that if a young man undertook to inform himself fully and broadly regarding all chemicals, along the various lines I have indicated from the beginning of this address, he would die of old age before graduation. Throughout all I have said I refer only or mainly to the three or four dozen chemicals which are largely used and widely distributed. Chemicals are manufactured for one purpose and only one—to make money. Chemicals are used for one purpose and only one—to make more money, and the sooner a chemist learns how and why this and that chemical is used the more valuable he becomes to himself or his employer.

Two mottoes that might well adorn the walls of any chemical works, judging from the view-point of the owners, are: First, "This is not a charitable institution"; second, "If you can't make good get out."

A student in an institution like your university here is furnished with every opportunity and every facility for either practise or investigation work, and no expense is considered too great if it leads to a discovery of some new fact, new law or new relationship of chemicals. The student at the same time is surrounded by a group of thoroughly trained investigators ready and willing to give him information or direct him where to obtain it.

When the chemist is in actual practise, however, he is usually discouraged in spending either time or money in any work which does not show very strong probability of bringing fairly immediate returns. He is in a position of one who is expected to give information, not to receive it, and the answer to the questions asked him is not always found in the back of the book.

Going back to the details of uses of common chemicals, the chemist will be required to have more or less familiarity with a great number of industries such as rubber, glass, leather, tanning, silk, cotton, ice-making, cement, etc., in order to know what kind of chemicals these industries use and what grades of chemicals they require.

To résumé the chief points to which I think young chemists do not pay sufficient attention and do seem to me of extreme necessity in their work are, first, a knowledge of the commercial importance of chemicals and the availability of these chemicals. Second, a knowledge of the action of common chemicals on materials ordinarily used in the construction of apparatus. Third, a knowledge of power accessories and transmission machinery. Fourth, a knowledge of the industries in which common chemicals are used and how they are used; and last, a knowledge of the impurities existing in the common chemicals as they appear on the market.

J. E. Teeple

50 Church Street,
New York City

THE SCIENTIFIC WORK OF THE SAN DIEGO MARINE BIOLOGICAL STATION DURING THE YEAR 1908

THIS year puts the Marine Biological Station of San Diego farther forward on the road to its ideals than has any single year of its previous existence. This results primarily from the circumstances that this year a new boat, the *Alexander Agassiz*, ample for the operations at sea, has gone into commission, and that more funds than hitherto have been available for running expenses.

"A comprehensive biological survey of the waters off the coast of southern California" has been announced from the outset as the station's scientific program. Such an expression of aims is surely somewhat vague; it might be looked upon as somewhat visionary or grandiose, and at least impracticable if any definite meaning be attached to the word comprehensive. Since it is now affirmed that real progress is being made toward realizing the aims, it ought to be possible to show wherein these aims are not wholly vague, are not in spirit grandiose, and are within limits of practicability.

On the theoretical side all, or at any rate much, does indeed hinge on the meaning of "comprehensive" as used in the preamble. It expresses an attitude or standpoint relative to biological research generally, rather than a determination to study every creature exhaustively regardless of rhyme or reason, that may happen to enter or may have a permanent home in these waters. What that attitude is may be stated thus: *To know, to understand organic beings is the object of biology. No phenomenon essential to the life-career of any organism can be pronounced as fully explained so long as any other phenomenon likewise essential to that same life-career is entirely unknown or entirely ignored.* Such is the conceptual matrix in which is set every plan made, every dollar expended, every day's work done, every page printed, at least so far as the scientific director is concerned, in connection with the San Diego Station.

Even allowing the conception to be right, does not the proposal to embody it in an institution of research mean certain failure from the simple fact that it runs counter to the principle of specialization, the principle which has been the king-pin of progress in all recent science? On the face of the matter it looks that way. In truth, though, violence to the principle is neither intended nor done. Quite to the contrary, specialization even more refined and intense than ever, is compelled at some points. The only unusual thing is that the program calls for specialization *in more directions* than is customary for one and the same institution; and that it gives this specialization *organic coordination* in greater measure than biological research has usually had.[1]

[1] On no account would I have the statement of aims of the San Diego Station seem to be oblivious of the similar work being prosecuted in various other parts of the world, especially in European seas. Our obligations to the International Council for the Investigation of the North European Seas, to the Prince of Monaco's extensive oceanographic enterprises, and to the Port Erin Station must be specially acknowledged.

Perhaps no better evidence can be adduced of our sensibility of dependence upon these agencies than by mentioning that Professor C. A. Kofoid, assistant director of the San Diego Station, who is spending his sabbatical year in Europe, is being paid a portion of his expenses by the station to enable him to see as much as possible of what these great enterprises are doing. It is our purpose to adopt the methods and apparatus used by the International Commission as far as may be.

The uniqueness of our program, if it has any, lies in the circumstance that being primarily biological rather than oceanographic, and being in its inception independent of any specified industrial motive, it can concentrate everything on whatever biological problems seem most inviting, most urgent or most accessible at any given time.

To make these generalities concrete, take the group of closely related, really inseparable problems comprised under the term distribution. I set for myself the task of finding what species of salpa occur in the area of the Pacific marked off for study. After some years of collecting I find a total of say eight species. By the time my studies have been extensive enough to make me nearly certain that no others are to be found, I have become keenly aware that some of these eight are much more abundant than others. Moreover, by watching the tow-net hauls as they come in from day to day and from week to week, and by running back over my records for some years, I make out, approximately at least, the order of abundance of the different species for the area. *S. fusiformis-runcinata* clearly heads the list, *S. democratica-mucronata* comes next, then probably, though not quite certainly, *Cyclosalpa affinis,* and so on. Again, my observations having reached over so long a period and over so much material, I could not fail to recognize certain rules according to which some at least of the species, *i. e.,* the more abundant ones, are distributed through the year and through the different depths of water. Intimations are found too of rules prevailing in the reproductive activity of the commoner species for both the sexual and the asexual phases of the life cycle. It seems that the different species reach their maximum abundance at different times of the year; that one species probably occurs at greater depths than another ever does; that the climax of abundance is brief for one species while more extended for another, and so on.

Were I willing to stop with commonplaces of zoology such as these, nothing would be required for my pursuits beyond efficient means of collecting (which in this case happen to involve considerable expenditure), some diligence in getting together, examining and recording material, and a little acumen in seeing and question-asking. But surely the knowledge thus gained is far from *full knowledge* of these particular animals. How comes it that *S. fusiformis-runcinata* is the most abundant species in these waters, while *S. cylindrica* turns up as hardly more than a straggler? Why, as has been the case this summer at least, does *S. democratica-mucronata* swarm in early June when *fusiformis-runcinata* is comparatively rare, while the latter species comes on by the millions in late July, the former being at this time a real rarity in the net hauls.

Must I look to environment or the constitution of the creatures, or to both for answers? The very fact that I ask the questions almost compels me to look to both. If I knew for a *certainty* that the full answer lay in either direction alone, I should quite surely know the answer *itself,* so should be under no necessity of asking the questions. Well then, if my questions are serious and I have gumption enough to seek the answers where obviously they must be sought, it will be necessary to go at the constitution of the animals more searchingly than before, and also at the environment. In other words, I have run with full force into the problem of *organic adaptation.* There is no doubt in my mind that much, if not the whole, of the species problem, so overshadowing in the biology of the last hundred or more years, has been befogged by the generality of idea and want of methodological accuracy with which this very subject of adaptation has been treated. Pinned down to something really tangible and definite, does not the question formulate itself in this way: *In how far can the differentials between two kinds of organism be correlated with differentials in the environments which they respectively oc-*

cupy? Whether this formulary covers the whole case or not, it certainly reaches a good deal of it.

Immediately we see the problem take this form and resolve to tackle it on this basis we notice it to be in unison with at least two of the master principles underlying the soundest of progress in all physical science, viz., the principles of refined *quantitative treatment* and of *relativity*. I can make no real headway toward correlating kind-differentials among organisms with environmental-differentials without some measure of quantitative accuracy as to these differentials on both sides. If, for example, I find that *S. fusiformis-runcinata* flourishes equally well from the surface down to 350 fathoms while *S. democratica-mucronata* is never found deeper than say 50 fathoms, and if I am bent on finding out what there is, if anything, in the difference between the two animals that corresponds to the difference between 50 and 350 fathoms, I must bring these two sets of differences into an equation practically. This means that in order to give such a form of expression the real force of the mathematical equation, *i. e.*, to know that a known variable on one side must have a corresponding variable on the other, much, as a rule very much, quantitatively accurate data on each side will be necessary. And this means that a vast amount of observing, of comparing, and of measuring the animals themselves must be done. Thus much belongs to my province as a special student of these animals. For the physical data on the other side I am metaphorically as well as literally "all at sea." Do the kinds of organisms undergo their changes, reproductive, distributional, etc., which differ relatively to each other, within practically the same water, or is there different water corresponding to these changes? This calls first of all for knowledge of currents, which knowledge it is the business of a hydrographer to furnish. My own unaided attempts to get it would surely be wanting in reliability and furthermore would be made at the expense of time and energy that ought to be more profitably applied to tasks for which I am fitted.

Again, facts relative to the temperature, density and chemical composition of the water must surely enter into the environmental side of the equation. Who but a professional physicist and a professional chemist is fit to supply the data? The food of these species must be determined and at least some facts pertaining thereto must enter into the reckoning. No one but a specialist, perhaps several of them, on the groups of minute organisms which happen to constitute the dietary of salpa can furnish these data.

The long and short of all this is that it is impossible for me to handle the problems of species, distribution and adaptation of salpa with any large measure of success unless I can have the cooperation, not haphazard and incidental, but designed and sure, of specialists in several branches of science.

The object of this brief paper is to show something of what the present year means in the way of executing such a program at the San Diego Station.

The *Alexander Agassiz* is now ready to do any sort of at-sea work that the present main section of the program (planktology) calls for within the bounds of the area set off for investigation, *i. e.*, the area comprising the continental shelf from Point Conception southward to—Panama if necessary. The area in which most of our operations lie is about 15,000 square miles in extent and has a maximum depth of a little more than 1,000 fathoms.

I mention only one important point the craft has made during the summer concerning water-movements. By anchoring on Cortez Bank about 95 miles off the coast, she has proved the existence of a northeast drift at this point for at least a portion of the year which is independent of tidal action. Published charts of the East Pacific and reports of navigators are conflicting as to such a drift. The prevailing view is, it seems, that it does not occur. The fundamental importance of reliable information on the question for problems of distribution of marine organisms in this locality hardly needs pointing out. How constant and extensive this drift is remains for future determination.

Thanks to the ingenuity of Professor C. A. Kofoid as a designer and to the skill of Messrs. Hensley and Baker, of San Diego, as mechanicians, a closing net is now in operation on the *Agassiz* that can be opened, towed and then closed at the same level, and at any depth in which the vessel can trawl. As a consequence I now have an abundance of *S. fusiformis-runcinata* that I know with certainty came from within a few feet of 350 fathoms, and likewise from various other intermediate depths. The mental comfort there is in the possession of information on this point about which there are no haunting doubts, is great and grows larger as one perceives the larger problems that hinge upon the trustworthiness of the data.

I may mention incidentally that the expenditures involved in this work at sea is not great relatively. What I mean by relatively is that the expense is small as compared with what such work costs when it is done in *coastal areas* by a vessel built and equipped for truly *oceanic areas and depths*. To illustrate: During March, 1904, through the good auspices of President D. S. Jordan it was my pleasure to have scientific direction of the United States Bureau of Fisheries Steamer *Albatross* for explorations on the coast of southern California. Excepting for about half a dozen trawl hauls made just beyond the edge of the continental shelf in 2,000 fathoms and over, the work of that period was in the same area and of the same general character as that now being done by the *Agassiz*. In almost all respects the advantages are surely with the *Agassiz*. The smaller vessel can be handled much more rapidly and surely, and can, of course, work in much shoaler waters, and has various other minor advantages that need not now be dwelt upon. Were the *Albatross* and the *Agassiz* both at the Station's command and both operable at the same expense I am quite sure we should use the *Albatross within our area* only on rare occasions. When work in specially rough waters became urgent we should want the larger vessel. It is only when depths beyond the continental shelf are to be explored that the large ship is needed, is in fact indispensable. Yet the *Agassiz* with her equipment represents an initial expenditure of less than $15,000 with a cost of operating amounting to about $22 per day (when a mooring can be made overnight), while the *Albatross* represents an initial expenditure of not less than $150,000 and a daily cost for operating of not less than $300.

This year, for the first time, a physicist has joined the staff as a regular member. Such equipment is supplied as is requisite for the investigations so far comprehended in the program. Mr. F. W. McEwen, an instructor in physics at the Leland Stanford Junior University, is the man in the place. About 400 density determinations have been made during June and July, reaching through depths to 400 fathoms. Naturally many more temperatures have been taken. The particular satisfaction in having a physical laboratory operating in conjunction with the biological work lies in the fact that whenever a special biological question comes along requiring information from the physical side, the physicist can be appealed to *then and there*. That enables one to know what data either different or more of the same or relevant sort are to be sought. This is an advantage quite apart from that of having on hand a general stock, so to speak, of information about the water such as the systematic work of the physicist puts into the records.

As yet the station funds have not made possible a chemist and a chemical laboratory, but the addition of these in the not distant future is anticipated.

I may conclude by mentioning two other extensions of undertaking that stand to the credit of the present year. Miss Myrtle Johnson, of the station staff and a university student, has carried well forward a mensuration-mathematical study of growth and development of the zooids of the salpa chain. In this work Dr. J. Lipke, of the department of mathematics of the University of California, and Dr. Raymond Pearl, of Orono, Maine, have as a courtesy, rendered service without which the value of whatever results may be reached would be uncertain. Mr. S. E. Bailey, of the staff, has proven during the summer the practicability of determining with accuracy reaching to the fourth decimal place the weight of *Fundulus* eggs and embryos at various stages of development. The biological importance of investigations of this sort can not, I believe, be overestimated. This is no place to set forth the grounds of such belief although I may call attention to their obvious adjacency to such work as Minot in particular, has been doing recently on the weight of different animals at different periods of life.

Although the object of this communication is to indicate those aspects of the year's work that constitute a forward step in carrying out the general program of the Station, mention should be made of the fact that tasks under way for several years have by no means been neglected. Dr. Torrey made good progress in the description of the pelagic coelenterata; Mr. E. L. Michael, resident naturalist of the Station, has nearly completed a paper on the classification of the Chaetognaths of the region, and the director did something on the systematic treatment of the littoral ascidian fauna. Mr. Maurice Nichols, of the department of botany of the University of California, devoted much labor to the description of the corallanes. The usual work was continued of preserving and recording all collections brought in, preparatory to making them available for the various specialists who will report on them.

WM. E. RITTER

LA JOLLA, CAL.,
July 25, 1908

THE NATIONAL EDUCATION ASSOCIATION, IN CONVENTION ASSEMBLED AT CLEVELAND, O., JULY 1, 1908, DECLARATION

THE National Education Association, now holding its forty-sixth annual convention in Cleveland, and representing teachers and friends of education in every state in this union, makes the following declaration of principles and aims:

1. Fully realizing that trained and skilled labor is a primary essential to the industrial and commercial welfare of the country, we cordially endorse the establishment by municipal boards of education of trade schools, industrial schools, and evening continuation schools; and further recommend that the instruction in these schools be practical and efficient, and have the advice and the approval of the trade interested, to the end that graduates of these schools may at once become advanced apprentices or journeymen.

2. We recommend the subordination of highly diversified and overburdened courses of study in the grades to a thorough drill in essential subjects; and the sacrifice of quantity to an improvement in the quality of instruction. The complaints of business men

that pupils from the schools are inaccurate in results and careless of details is a criticism that should be removed. The principles of sound and accurate training are as fixed as natural laws and should be insistently followed. Ill-considered experiments and indiscriminate methodizing should be abandoned, and attention devoted to the persevering and continuous drill necessary for accurate and efficient training; and we hold that no course of study in any public school should be so advanced or so rigid as to prevent instruction to any student, who may need it, in the essential and practical parts of the common English branches.

3. We assert that the individuality of the pupil should be carefully considered, to the end that he may be instructed in the light of his limitations and capacity; and we commend to all local authorities the necessity of greater care in the arrangement of courses of study, that they may be adapted to the pupils to be instructed, rather than that pupils should be adapted to fixed courses of study and an inflexible system of grading.

4. The public high schools should not be chiefly fitting schools for higher institutions, but should be adapted to the general needs, both intellectual and industrial, of their students and communities, and we suggest that the higher institutions may wisely adapt their courses to this condition. We also suggest to school boards and superintendents the importance of securing for their high schools teachers who have not only abundant scholarship but also successful experience in teaching or efficient and practical training in pedagogy.

5. There is concededly a grave moral depression in our business and social atmosphere. The revelations of the financial and legislative world for the past two years denote a too general acquiescence in questionable practices and standards. We earnestly recommend to boards of education, principals and teachers the continuous training of pupils in morals, and in business and professional ethics, to the end that the coming generation of men of affairs may have a well-developed abhorrence of unfair dealing and discrimination. The establishment of the honor system in schools, the ostracism of the dishonest or unfair pupil, the daily exemplification in the routine life of the school of the advantage of honest and truthful methods, are commended to the especial attention of teachers as a partial means to this end.

6. The Bureau of Education at Washington should be preserved in its integrity and the dignity of its position maintained and increased. It should receive at the hands of Congress such recognition and such appropriations as will enable it not only to employ all expert assistants necessary, but also to publish in convenient and usable form the results of investigations; thus making that department of our government such a source of information and advice as will be most helpful to the people in conducting their campaigns of education. We are of the opinion that the importance of the subject under its control, and the dignity of this country require that this Bureau be maintained as an independent department of the government.

7. The National Education Association notes with approval that the qualifications demanded of teachers in the public schools are increasing annually, and particularly that in many localities special preparation is demanded of teachers. The idea that any one with a fair education can teach school is gradually giving away to the correct notion that teachers must make special preparation for the vocation of teaching. The higher standards demanded of teachers must lead logically to higher salaries for teachers, and constant efforts should be made by all persons interested in education to secure for teachers adequate compensation for their work.

8. It is the duty of the state to provide for the education of every child within its borders, and to see that all children obtain the rudiments of an education. The constitutional provision that all tax-payers must contribute to the support of the public schools logically carries with it the implied provision that no person should be permitted to defeat

the purposes of the public school law by forcing their children, at an early age, to become bread winners. To this end the child labor and truancy laws should be so harmonized that the education of the child, not its labor, shall be made the chief concern.

9. The National Education Association indorses the increasing use of school buildings for free vacation schools and for free evening schools and lecture courses for adults, and for children who have been obliged to leave the day school prematurely. We also approve of the use of school grounds for play grounds and the use of school gymnasiums and bath rooms for the benefit of the children in the crowded districts during summer.

10. Local taxation, supplemented by state taxation, presents the best means for the support of the public schools, and for securing that deep interest in them which is necessary to their greatest efficiency. State aid should be granted only as supplementary to local taxation, and not as a substitute for it.

11. The National Education Association observes with great satisfaction the tendency of cities and towns to replace large school committees or boards which have exercised executive functions through subcommittees, by small boards which determine general policies, but intrust all executive functions to salaried experts.

12. We cannot too often repeat that close, intelligent, judicious supervision is necessary for all grades of schools.

13. The rapid establishment of rural high schools and the consolidation of rural district schools are most gratifying evidences of the progress of education. We believe that this movement should be encouraged until the children of rural communities enjoy the benefits of public education to an extent approximating as nearly as practicable the education furnished in urban communities.

14. The National Education Association wishes to record its approval of the increasing appreciation among educators of the fact that the building of character is the real aim of the schools and the ultimate reason for the expenditure of millions for their maintenance. There are in the minds of the children and youth of to-day a tendency toward a disregard for constituted authority, a lack of respect for age and superior wisdom, a weak appreciation of the demands of duty, a disposition to follow pleasure and interest rather than obligation and order. This condition demands the earliest thought and action of our leaders of opinion and places important obligations upon school boards, superintendents and teachers.

15. It is apparent that familiarity with the English Bible as a masterpiece of literature is rapidly decreasing among the pupils in our schools. This is the direct result of a conception which regards the Bible as a theological book merely, and thereby leads to its exclusion from the schools of some states as a subject of reading and study. We hope for such a change of public sentiment in this regard as will permit and encourage the reading and study of the English Bible, as a literary work of the highest and purest type, side by side with poetry and prose which it has inspired and in large part formed.

16. The National Education Association wishes to congratulate the secondary schools and colleges of the country that are making an effort to remove the taint of professionalism, and other abuses, that have crept into students' sports. This taint can be removed only by leading students, alumni and school faculties to recognize that inter-school games should be played for sportsmanship and not merely for victory.

17. It is important that school buildings and school grounds should be planned and decorated so as to serve as effective agencies for educating, not only the children, but the people as a whole, in matters of taste. The school is becoming more and more a community center, and its larger opportunities impose new obligations. School buildings should be attractive as well as healthful, and the adjoining grounds should be laid out and planned with appropriateness and beauty.

18. The highest ethical standards of conduct and of speech should be insisted on among teachers. It is not becoming that commercialism or self-seeking should shape

their actions, or that intemperance should mark their utterances. A code of professional conduct clearly understood and rigorously enforced by public opinion is being slowly developed, and must one day control all teachers worthy of the name.

19. In teaching, as in every other kind of work, the best service is secured by finding the individual best fitted to the particular place as indicated by training, experience, and meritorious service; the National Education Association therefore heartily approves a merit system of promoting teachers and filling vacancies. We assert, furthermore, that the grounds upon which a teacher may apply for a position are preparatory training, experience, and meritorious service—in a word, professional fitness, alone; and that the use of other personal and political arguments to secure appointment is deplorable in the teacher and a serious menace to a high professional standard.

The foregoing principles and aims have been fully considered by the Committee and unanimously recommended to the Active Members of the National Education Association for adoption.

Respectfully submitted,

Committee on Resolutions:

Howard J. Rogers, *Chairman*, of New York.

Orville T. Bright, of Illinois.

Charles E. Chadsey, of Colorado.

Edgar H. Mark, of Kentucky.

George M. Philips, of Pennsylvania.

David B. Johnson, of South Carolina.

Adopted by unanimous vote of Active Members in session, July 1, 1908.

Irwin Shepard,
Secretary

CONGRESS ON TUBERCULOSIS

The *Journal* of the American Medical Association announces that the following physicians and scientific men expect to attend the approaching congress at Washington:

Belgium: J. F. Heymans, Ghent.

Denmark: Holger Rodam and Johannes Fibiger, Copenhagen.

Germany: G. Hormann, Munich; Mme. Lydia Rabinowitsch-Kempner, F. Meyer, G. Kirchner, Robert Koch, Gotthold Pannwitz and F. Helm, Berlin; F. Köhler, Werden a. d. Ruhr; Dumpf, Ebesteinburg b. Baden-Baden; W. Schwabe and Uhlmann, Leipzig; W. von Leube, Würzburg.

Great Britain: W. R. Smith, G. A. Heron, C. Theodore Williams, H. Horton-Smith and A. Latham, London; Sheridan Delépine, Manchester; Sims Woodhead, Cambridge; Nathan Raw, Liverpool; N. D. Bardswell, King Edward Sanatorium, Midhurst; R. W. Philip, Edinburgh; William Osler, Oxford.

France: Charles Baradat, Cannes; F. Barbary, Nice; A. Calmette, Lille; Dupeux, Bordeaux; A. J. Magnin and L. Landouzy, Paris; R. Hervé, Lamotte-Beuvron; A. Leune, Versailles, Arloing, Lyons; P. Gallot, Mentone.

Italy: Umberto Gabbi, Messina; Massalongo, Verona; Eduardo Maragliano, Genoa.

Greece: Bastile Patrikios, Athens.

Holland: C. F. J. Blocker, Voorburg; R. de Josselin de Jong, Rotterdam.

Norway: F. Harbitz, Christiania; Herm. Gade, Hagekiken pr. Bergen.

Austria: Reisinger, Komitau i Böhmen; Lang, H. von Schroetter, Bartel, C. von Pirquet and H. Riedl, Vienna; A. Taussig, J. Dvorack and T. Altschul, Prague.

Roumania: J. Mitulescu, Bucharest.

Russia: S. von Unterberger, N. Th. von Tschigaieff and A. A. Wladimiroff, St. Petersburg.

Sweden: Karl Petren, Upsala; K. O. Medin, Stockholm.

Switzerland: Spengler, Davos-Platz; Th. Exchaquet, Leysin; Egger, Basle.

Spain: Jose Chabas, Valencia; A. Martinez-Vargas, Barcelona.

Hungary: H. Preisz, Budapest.

COLLECTIONS OF MINERALS FROM ONTARIO

A prize of $100 is offered by Mr. J. B. Tyrrell, mining engineer of Toronto, for the best collection of minerals collected in the province of Ontario during the year 1908 by any one not employed as a collector by a public institution or dealer in minerals. The collection must contain at least thirty mineral species, and it is suggested that where convenient the size of the specimens should be 2 x 3 inches. Each specimen must be labeled with the exact locality from which it was obtained, and the date on which it was collected. No specimen will be considered unless it is so labeled. A typewritten list of the specimens, with names of minerals and localities, in triplicate, together with a declaration stating that they were personally collected by the signer of such declaration in the province of Ontario in 1908 at the localities stated, with the post-office address of the collector, must accompany each collection. The collections must be addressed: "Examiners, Tyrell Prize, Government Assay Office, Belleville, Ont.," and must be sent, *prepaid,* to the Government Assay Office, Belleville, Ontario, on or before December 1, 1908, where they will be opened and examined jointly by Professor Nicol, of the School of Mining, Kingston, and Dr. Walker, of Toronto University. If requested the collections will be returned, charges collect, as soon as possible after the prize is awarded.

LECTURES ON HYGIENE AT CORNELL UNIVERSITY

It is proposed to give next year at Cornell University a course of public lectures on hygiene and public health. These lectures are to be given in cooperation with the state department of health. A committee of the university faculty has adopted a provisional scheme for the first term under which the following course of lectures has been arranged:

October 8—Introductory lecture by President Schurman.

October 13 and 15—"Public Health Administration," E. H. Porter, M.D., State Health Commissioner.

October 20—"Epidemiology," Arthur Newsholme, M.D., health officer, Brighton, England.

October 22—To be announced; foreign visitor.

October 27—"The Relation of the State to the Health of the Rural Community," R. A. Pearson, State Commissioner of Agriculture.

October 29—To be announced; Dr. W. L. Russell.

November 3 and 5—"Social Problems in their Relation to the Public Health," Professor J. W. Jenks.

November 10 and 12—"The Public Health Law," A. H. Seymour, Secretary of the State Department of Health.

November 17, 19 and 24—"The Various Aspects of Vital Statistics," Professor Walter F. Willcox.

December 1—"Public Morality," John B. Huber, M.D., lecturer on tuberculosis, State Department of Health.

December 3—"The Influence of the Action of the Laws of Heredity upon Public Health," Professor S. H. Gage.

December 8—"Voluntary Organization in Public Health Work," Homer Folks, member of the tuberculosis advisory board, State Department of Health.

December 10, 15 and 17—"Bacteriology and Comparative Epidemiology," Professor V. A. Moore.

January 5—"Recent Results of Research upon Causation and Transmission of Malignant Diseases," Professor James Ewing.

January 7—"The Relation of Psychology to Preventive Medicine," Professor E. B. Titchener.

January 12 and 14—"Immunity and Epidemiology," Herbert P. Pease, M.D., director of the hygienic laboratory, State Department of Health.

SCIENTIFIC NOTES AND NEWS

PROFESSOR RUFUS I. COLE, of the Johns Hopkins University, has accepted the directorship of the Research Hospital of the Rockefeller Institute of New York City. He had previously declined the chair of medicine at the University of Michigan.

PROFESSOR HUGO VON SEELIGER, of Munich, has declined a call to the directorship of the Astrophysical Observatory at Potsdam.

DR. HOMER D. HOUSE has been appointed associate director in the Biltmore Forest School.

DR. RAYMOND H. POND, has been appointed biologist of the Metropolitan Sewerage Commission of New York.

The Oklahoma Geological Commission, consisting of the governor, the state superintendent of public instruction and the president of the state university, met for organization on July 25. Governor Haskell was elected president of the commission, Superintendent Cameron, secretary, and President Evans, executive officer. Dr. Chas. N. Gould, professor of geology at the State University of Oklahoma, was elected director of the survey and instructed to begin at once the preparation of reports dealing with the geologic structure and mineral resources of the state.

Dr. Harvey W. Wiley, chief of the Bureau of Chemistry, Department of Agriculture, has been appointed honorary president of the First International Congress for the Repression of Adulteration of Alimentary and Pharmaceutical Products, which will meet in Geneva, Switzerland, beginning September 8.

Professor Freiherr Adolf v. la Valette St. George, professor of anatomy, at Bonn, has celebrated the fiftieth anniversary of his doctorate.

Dr. Antonio Lagorio is taking treatment at the Chicago Pasteur Institute, of which he has charge, on account of infection from a wound from the bone of a rabbit which had been inoculated with rabies.

We learn from the *Journal* of the American Medical Association that the professional silver jubilee of Professor Julius Dollinger, of Budapest, was celebrated recently by his friends, and the last issue of the *Orvosi Hetilap* was expanded into a *Festschrift* in his honor. His present and former pupils contributed a number of interesting articles on various phases of surgery and orthopedics, Dr. Dollinger having been docent in the latter specialty before he was appointed to the chair of general surgery. The recent systematic organization of cancer research in Hungary is also his work.

The silver medal of the Zoological Society of London has been awarded to Sir William Ingram for his gifts of birds of paradise to the society's collection.

At the suggestion of the director of the Aeronautical Observatory at Lindenberg, Prussia, Professor Arthur Berson and Dr. Hermann Elias, of the observatory staff, have been sent to East Africa to make meteorological observations in the upper air by means of balloons and kites, on the days that have been assigned for international cooperation in these investigations.

According to a press despatch, Lieutenants Colin, Jeance and Mercier, of the French navy, have obtained excellent results with a wireless telephone of their invention. Communication has been maintained between Paris and a wireless station at Raz de Seine, Department of Finistère, a distance of about 300 miles.

A monument to the memory of Richard Freiherr von Krafft-Ebing will be unveiled in the court of the University of Vienna on October 6.

Mr. Harry Day Everett, superintendent in the Philippine Forest Service, was murdered by natives in the island of Negros in the early summer. He had been a student of forestry at Cornell and Michigan and was twenty-eight years of age.

Dr. Jacob Farnum Holt, professor of anatomy, physiology and hygiene at Philadelphia High School, died on August 31.

Mr. Frank B. Kleinhaus, mechanical engineer at Pittsburgh and scientific author, was killed through a collision of an electric car with his carriage on September 2. He was thirty-nine years of age.

The death is announced of Dr. Charles Taylor, master of St. John's College, Cambridge, known for his work on geometrical conics and as a theologian.

Dr. Hermann Settegast, professor of agriculture at Berlin, has died at the age of ninety years.

The department of superintendence of the National Education Association will meet at Chicago, on February 23, 24 and 25, 1909.

The use of the metric system of weights and measures will be compulsory in the Philippine Islands after January 1, 1909.

Nature states that some interesting experiments on coal-dust explosions have been started under the direction of Mr. W. E. Garforth, at the Altofts Colliery, Yorkshire. An experimental explosion was witnessed on August 14 by Mr. E. Reumaux (Lens), Dr. J. A. Holmes (United States Geological Survey), Captain Desborough, H.M., inspector of explosives, and a number of experts from France and the United States. The cost of the experiments is borne from a special fund of £10,000 contributed by colliery proprietors.

THE president of the British local government board has authorized, as we learn from the *Journal* of the American Medical Association, the following researches in connection with the annual parliamentary grant in aid of scientific investigations, concerning disease: (1) A further inquiry by Dr. H. M. Gordon into the character and differential tints for the microbes in the throats of patients suffering from scarlet fever. (2) An investigation of protracted and recurrent infection in diphtheria by Dr. Theodore Thomson and Dr. C. J. Thomas. (3) An investigation of protracted and recurrent infection in typhoid fever by Dr. Theodore Thomson, in conjunction with Dr. Hedingham. (4) Investigations by Dr. V. G. Savage into the presence of paratyphoid bacilli in men, the differentiation of streptococci in goats and the bacteriologic measurement of pollutions in milk. (5) A statement of the results of bacteriologic examination of over 7,000 samples of milk from different parts of the country by Professor Delépine. (6) An investigation of the rôle played by flies as carriers of disease, by Dr. Copeman and Professor Nuttall. (7) An inquiry into the condition of flock bedding by Dr. Farrar. The bacteriology and biology of bedding will be undertaken by Professor Nuttall. (8) A statistical inquiry into the social incidence of disease will also be begun.

Petermann's Mitteilungen, as quoted in the *Bulletin* of the American Geographical Society, gives further particulars concerning the expedition which the Swedish government has despatched to Spitzbergen in charge of this well-known geologist. The purpose is geographical and geological research. It is expected to make a more exact survey of the coasts of Ice Fiord and to map the glaciers tributary to it. Excursions inland will be made to ascertain what changes the glaciers have undergone since they were last studied. Many photographs of the glaciers will be taken. The party includes the geologists, C. Wiman, B. Högbom and S. de Geer, the brother of the leader; the zoologist, N. von Hofsten; the photographer, O. Halldin, and the cartographer, E. Jansson. The expedition was taken to Spitzbergen by the gunboat *Svensksund*, whose officers were instructed to make soundings and engage in other hydrographic work.

MR. HARLAN I. SMITH has returned from an archeological reconnoissance of northeastern Wyoming, made in continuation of the work which he started last year for the American Museum of Natural History. The work already accomplished is only the beginning of an investigation into the archeology of a vast region, including the Great Plains, the Barren Lands and the Plateaus of America—a region larger than the entire remaining portion of the continent and regarding which there is practically no archeological knowledge or available specimens from which to secure such knowledge. Among the general problems which are awaiting elucidation may be mentioned the following: (1) When the region came to be first inhabited; (2) what the material culture of the people was; (3) whether people were living in the region before the introduction of the horse, and, if so, how the coming of this valuable animal affected their culture; (4) whether there was more than one culture in the region, and, in this event, where the boundaries of these culture areas may be found. While, on the whole, the results of the two archeological trips to Wyoming would suggest that that particular region was not inhabited until after the advent of the horse, yet such a conclusion can not be definitely reached without an accumulation of such negative archeological evidence, or without making sure that mythological, ethnological or historical evidence may not lead to a contrary result.

An additional construction appropriation of $25,000 for the New York Botanical Garden, voted on June 26, and approved on August 4, will be expended in the continuation of construction of driveways and paths,, principally on the eastern side of the grounds, in the completion of the grading operations necessary at the museum building, in the extension of the system of water-supply and drainage, and for minor works. All the earth and rock to be excavated at the museum building is required for filling and for telford foundation of roads and paths, so that the same money will effect two pieces of work, as has been the case in nearly all the grading operations hitherto accomplished, a result made possible by following the original plan of development approved by the Board of Managers in December, 1896. It is now planned to complete the driveway system and to build at least an additional mile of paths.

According to *Charities* reports from Alaska through a special charge to the Grand Jury sitting at Juneau show that tuberculosis, trachoma, and other diseases are spreading to such an extent among the Indians that their very existence is threatened. From the data furnished it would appear that within a few decades, if the mortality of the race continues as in the recent past, there will be no longer any native inhabitants. The statistics taken from a typical settlement of the natives, show a greater mortality than that of any other primitive race which has come in contact with Anglo-Saxon civilization. An appended report by Army Surgeon Paul Churchill Hutton states that he doubts if any country in the world can show such a percentage of tuberculous natives, and the mortality from this disease is really terrible. He proposes that Alaska be divided into sanitary districts and that sixteen sanitary officers be appointed. He also suggests that an intelligent Indian inspector be appointed for each town having 200 or more inhabitants, and that each Indian inspector study under the regular inspector and disseminate his knowledge among his own people.

The work accomplished by the Reichsanstalt last year, according to an abstract of the annual report in *Nature,* includes the following: In accordance with a commission received by the institution, tests were started on the exact measurement of very small pressures (of the order of between 10^{-6} and 10^{-3} mm.), the pressures being determined from the deflection of a metallic membrane of 25 cm. diameter by means of the Fizeau interference method. The absolute velocity of sound in dry air (free from carbonic acid) has been investigated and found to be 33,192±5 cm. per second. Dr. Scheel has tested some further materials for expansion between $-191°$ and $+16°$ C. with the Fizeau dilatometer described in the previous year's report, and has obtained results varying from 2,120 microns per meter for palladium to -41 microns per meter for quartz glass. Scheel and Schmidt have obtained a much lower value for the refractive index of helium than that found previously by Lord Rayleigh and by Ramsay and Travers, the figures of the former being 1.0000340. Some useful work has been done in regard to the specific heat of nitrogen, CO_2 and water-vapor, up to 1,400° C., and experiments to determine the saturation-pressure of water-vapor above 100° C. have been commenced. In the Electrical Standards Department the variations in manganin resistances have been found to be very slight and the "humidity effect" only just perceptible. Resistance coils are now being wound on metallic spools with longitudinal slots to render them somewhat flexible; in this way it is hoped to make any effect due to humidity practically negligible. Measurements of the wave-length of electric oscillations can be made with an accuracy within 1 part in 1,000 for long waves (above 1,000 meters), and for shorter wave-lengths the accuracy is within 1 per cent. Other experiments have been made with undamped electric oscillations produced after the Poulsen method by means of an arc burning in oxygen. A research of importance to opticians was carried out in regard to the secular variation of the planeness of surfaces of optical glasses, results being given in the report. In addition to the researches mentioned, a number of routine tests were carried out in the various departments of the Reichsanstalt, some of these yielding interesting results from a commercial standpoint.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Senator William F. Villas the University of Wisconsin will ultimately receive his entire estate, valued at between two and three million dollars. By the provisions of the will, Mrs. Villas receives the income during her lifetime, and after her death her daughter receives $30,000 a year. After the property is given to the university, part of the income will be reserved until the principal becomes $30,000,000. The will provides for the erection of a Henry Villas Theater, and for the establishment of ten professorships, each with a salary of not less than $8,000, nor more than $10,000 a year.

By the will of Frederick Cooper Hewitt, Yale University receives $500,000; the New York Post-graduate School and Hospital $2,000,000, and the Metropolitan Museum of Art $1,500,000 and the residue of the estate.

The General Education Board has offered Richmond College, at Richmond, Va., $150,000, on condition that an additional $350,000 be subscribed.

Norwich University, at Northfield, Vt., receives an unrestricted endowment of $100,000 by the will of Colonel C. S. Barrett, of Cleveland, O.

Mr. W. J. Horne, lecturer in physics at the South African College, Cape Town, has been appointed to the inspectorate of the Transvaal Department of Public Education as organizer for technical education.

DISCUSSION AND CORRESPONDENCE

THE AMERICAN SOCIETY OF NATURALISTS

To the Editor of Science: Whether the American Society of Naturalists should be preserved or not depends on whether it has an important work to do and whether its work can be coordinated with that of other societies so that it shall be regularly called upon to perform its proper functions. I, for one, think it has a more important potential part to play than ever before, but whether it shall be permitted to play that part depends upon the cooperation of naturalists in general.

It is argued by those who regard the Society of Naturalists as an anachronism that natural history is no more, that in the differentiation and specialization that accompany the development of science it has broken up into botany, zoology, etc., and that these special sciences are each amply provided for by at least two national societies. It does not, however, follow because we have societies of students of plants, ferns, animals, birds, pigeons, carrier pigeons, insects and butterflies that the Society of Naturalists has become unnecessary. I conceive that even if we had a national society for each *genus* of animals and plants there would still be biologists who would find in a grand meeting of such societies no home. Indeed, the more you multiply societies on the basis of the material studied the more need for a society which shall bring together for mutual conference persons working on the general biological *topics* that are common to plants, animals, insects, butterflies. Our modern societies work directly against such a result. I may be working on heredity in insects and you on heredity in violets, but we hardly speak as we pass by because, forsooth, you are a botanist and I am a zoologist. Consequently we attend different meetings and we fraternize with different colleagues while we read papers of precisely the same theoretic import at the same time in buildings far apart, you to your colleagues who are interested in fossil cycads, in the hourly rate of growth of a gourd, in the development of a moss, or in a bog-society, and I to my colleagues who are awaiting their turn to tell of their discoveries in the circulation of an earthworm, in the properties of a new nerve stain, in the bird fauna of Christmas Island and the distribution of the Characinidæ of Brazil. No wonder we have so little discussions at our meetings with the diversity of interests represented and the scattering of workers on the same topics because they are working on different species.

What is the remedy? Seek an association of workers on *general* biological topics (of interest to more than one of the "sciences") for the presentation and discussion of the results of investigations on such topics. Such an association is already organized. The American Society of Naturalists is dignified by years of service and a membership that includes the most eminent of American biologists. Except in its early years it has been, as it now is, almost exclusively a *biological* society. For some years one of its principal functions has been to arrange for a discussion on some general biological topic. Matters of common interest to biological investigators would seem, therefore, to be its peculiar province. Consequently it can provide the required machinery for bringing together workers on general biological topics.

To meet the need the Society of Naturalists must extend somewhat its work and to do this the cooperation of the other scientific societies is essential. The society has been told for so long that its function is only to provide a discussion, an address and a dinner, that we have come to believe it. But, if it is necessary for the advancement of biological science that the naturalists should expand, recent tradition must not be permitted to stand in the way. Will the societies of anatomy, anthropology, bacteriology, botany, palentology, physiology, psychology and zoology authorize their respective secretaries to constitute, together with the secretary of the Naturalists, a general biological executive committee to select a program for one day of the meeting period, which shall replace that of their individual societies? This day's program might consist entirely of "papers" or in part of "papers" and in part of a symposium. Time should be left for discussion. If the respective societies will do this then, I believe, "general biology" will receive a great impetus in this country.

One more point of great importance and difficulty is the relation of the American Society of Naturalists to the American Association for the Advancement of Science; for if the Society of Naturalists has a rôle then it must not be crushed out, but fitted into a scheme. I suggest that it should seek to affiliate itself with the association on some such terms as these: The Society of Naturalists to be accepted as the Biological Division of the American Association for the Advancement of Science, and to have certain privileges on the council—its president to be first vice-president of the association, or something of the kind—to have general charge of the matters of common interest to Sections F, G, H and K, so that such matters shall be acted on by the executive committee of the Society of Naturalists before being adopted by the council of the American Association for the Advancement of Science. The Naturalists should continue its affiliation with the technical biological societies; thus it could serve as a needed medium between the technical biological societies and the biological sections of the American Association for the Advancement of Science, on the one hand, and the council of the American Association for the Advancement of Science, on the other. The proposed relation may be graphically expressed in the following scheme:

AMER. ASSOC. FOR THE ADV. OF SCIENCE

Sect. A	(American Society of Naturalists)	
Sect. C	Sect. F	Amer. Anthropological Soc.
Sect. B	Sect. G	Amer. Physiological Soc.
Sect. D	Sect. H	Amer. Psychological Assoc.
Sect. E	Sect. K	Amer. Soc. Vertebrate Paleontologists.
Sect. I		
		Amer. Soc. of Zoologists.
		Assoc. of Amer. Anatomists.
		Botanical Soc. of America.
		Soc. of Amer. Bacteriologists.

Occupying the suggested position and managed by a committee of all the secretaries of the sections and independent societies listed above, the Naturalists could fulfill a number of important functions. It could arrange for joint meetings of the independent societies so as to secure a special rate; it could seek to minimize conflicts of programs when a technical society meets with the corresponding section; it could arrange, as suggested above, for a program on general biological topics; it could, in its general meetings, take such action as it might see fit to advance any particular biological interest of common import.

It is not too late for the executive committees of the different technical societies to direct their secretaries to cooperate with the secretary of the Naturalists in arranging a general program for the Baltimore meeting.

Chas. B. Davenport

THE HIGHEST BALLOON ASCENT

To the Editor of Science: I notice that Dr. Chanute in his review of "Airships, Past and Present," Science, July 3, 1908, says, "The greatest authentic height [in a balloon] attained by man has been 35,500 feet." In Hill's Chemistry for students of Medicine, Pharmacy and Dentistry (1903) the following occurs: "A balloon may rise to a great height, because of its great volume of gas ligter than air. The highest ascent was that of Glaisher in 1861, who attained an elevation of over 36,000 feet." This is found in the chapter on medical physics, page 18.

G. T. Overstreet

Louisville, Ky.

[M. Glaisher (September 5, 1862) became unconscious at a height of about 29,000 feet, while still rising at the rate of 1,000 feet per minute. He was again able to make observations after thirteen minutes, at a height of about 26,000 feet and found that he was falling 2,000 feet per minute. From these data and from other corroborative circumstances he estimated that, in the interval, he had reached an altitude of 36,000 to 37,000 feet, but this has not been accepted as authentic. M. Berson's performance (July 31, 1901) is better established. Going up with a provision of compressed oxygen he took an observation at 34,500 feet, while still rising, and then became partly unconscious. He probably rose another 1,000 feet and certainly reached an altitude of 35,500 feet, or possibly of 36,000 feet. He had previously judged that human life was impossible at a height of 36,100 feet and that Glaisher could not have reached it, as "no human being has penetrated to such heights either before or since without taking a supply of oxygen."—Ed.]

SALARIES AT BRYN MAWR COLLEGE

To the Editor of Science: In Science for August 14 appears a letter from Professor David Wilbur Horn, of Bryn Mawr College, criticizing certain financial data concerning that college, which had been reprinted in Science from a recent *Bulletin* of the Carnegie Foundation.

I venture to call attention again to the fact emphasized on the first page of this *Bulletin* that the statistical data published by the foundation were obtained in all cases directly from the authorities of the institutions themselves. In the case of Bryn Mawr, the statistics were furnished by President Thomas and had apparently been prepared with great care, all the items being in her own handwriting.

Henry S. Pritchett

The Carnegie Foundation for the Advancement of Teaching

QUOTATIONS

THE TRIUMPH OF SANITATION AT PANAMA

The redemption of the Panama Canal Zone from preventable diseases receives official confirmation in the report to President Roosevelt of the special commission appointed last April to investigate the work accomplished. The importance of the hygienic problem involved is emphasized by the commission in reviewing the difficulties under which the French labored in their efforts to construct the canal. The report says:

> The terrible scourge of yellow fever against which the French struggled in vain, the filthy and pest-breeding state of the principal Panama towns, the rough labor camps and other pioneer hardships of the first two eras have been eliminated through the brilliant and persistent activity of the department of sanitation, the department of municipal engineering and the building department. To-day we find yellow fever driven from the isthmus, malaria and pneumonia greatly reduced and a high average of health established. Although the government's immediate object on the isthmus is to dig the canal and to provide living quarters for a temporary enterprise, it has, in fact, created comfortable homes and well-organized social communities for its working force.

Modern civilization furnishes no better example than this of the possible victory over pestilence and disease, when the warfare is carried on in the light of modern scientific knowledge. The building of the Panama Canal and the sanitary record of the Japanese in their war with Russia are the two great object lessons of recent years, demonstrating that men can neither work nor fight to the best advantage unless protected from infectious and preventable diseases. The civilized nation which will hereafter put an army in the field or undertake a great engineering problem without first preparing the way by proper and adequate sanitary engineering and equipment will be regarded by the other nations as quite as foolish as a government which would build a vast fleet of modern warships and then arm them with the muzzle loading ordnance of one hundred years ago. An epidemic of typhoid fever in a military camp should be considered a greater disgrace to an army than a defeat in battle, since defeat may come in spite of the greatest exertions and the highest wisdom, while typhoid and yellow fever would be the result of ignorance or disregard of well-known laws of prevention. All nations will profit by the sanitary lesson of the Panama Canal.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

General Chemistry for Colleges. By Alexander Smith. 8vo, pp. 529. New York, The Century Co. 1908.

This book is practically a somewhat abbreviated and simplified edition of the author's "Introduction to General Inorganic Chemistry" which appeared two years ago. The "Introduction" attracted much attention among teachers of chemistry, and received high praise as an excellent and comprehensive presentation of the subject, but it appears that many teachers, while admiring the book as a treatise, considered it too extensive and difficult for beginners, even at the age of college students.

It is evidently on account of these objections to the larger text-book that the shorter work under consideration has been prepared. This is shorter to the extent of more than two hundred pages, and it has been considerably simplified, chiefly by omissions of less fundamental theoretical matter. It is to be observed that the theoretical topics that have been retained have been presented with the same fullness as before, and that the aspect of the new book in its arrangement and illustrations is very similar to that of the old one, although some conspicuous changes have been made in the presentation of some of the theoretical topics, and other minor changes and improvements have been introduced.

It appears to be somewhat doubtful that the present book will appeal to the majority of those who considered the former book too difficult, because the chief changes are those of omission, and they could be made easily while using the larger book.

There is evidently a tendency at the present time to use less childish chemical text-books for older students than was formerly the custom, and this movement is undoubtedly an excellent one, as far as the education of our more capable students is concerned. Therefore, the new book, by a teacher who has shown such ability in text-book production, is to be welcomed, although it may not be considered entirely "easy," and it is to be hoped that we shall soon have a revision of his "Introduction," which, whatever may be thought of it for beginners, is a very useful book for more advanced students.

As a single criticism it may be said that several of the brief statements in regard to metallurgy need revision, even in the later edition. This metallurgical weakness is a very common fault in elementary text-books of chemistry.

H. L. Wells

Thermodynamics of Technical Gas Reactions. Seven Lectures. By Dr. F. Haber, Professor at the Technische Hochschule, Carlsruhe. Translated by Arthur B. Lamb, Ph.D., Director of the Havemeyer Chemical Laboratory, New York University. Pp. 356. London, Longmans, Green and Co. 1908.

Since Gibbs and Helmholtz showed that the mere heat evolved is not a true measure of the driving force of a chemical reaction, chemistry has felt an ever-growing need of accurate determinations of that which is the true measure, the free energy. A knowledge of this quantity permits the theoretical chemist to predict the direction in which a reaction will proceed or the state of equilibrium to which it will arrive, and enables the technical chemist to calculate the possible yield in a given manufacture, or the amount of work obtainable from a given process.

The present volume is by far the most important contribution towards this end which has as yet been made. It is a book written to technical chemists by an acknowledged master of technical chemistry, but it will doubtless find a larger audience among the uncommercial chemists; especially in this country where a broad knowledge of thermodynamics is not yet regarded as indispensable in the training of the chemical engineer.

The first three chapters deal with the theorems of thermodynamics and the development of the general free energy equation. In the fourth and fifth chapters comes the exhaustive discussion of the conditions of equilibrium in such important reactions as the water-gas process, the Deacon process and the formation from the elements of water, carbon dioxide, ammonia and the halogen acids. The sixth chapter critically summarizes all the existing data on the specific heat of gases, which must be known if we are to calculate the free energy at one temperature from that at another. The last chapter treats in detail the experimental methods which have been employed in the study of gaseous equilibria.

After a single perusal of the book the reader may not appreciate the infinite pains, or the critical acumen amounting nearly to inspiration, with which the author has extracted the truth from a great mass of uncertain and frequently contradictory experimental material. His success in this task has been demonstrated several times since the appearance of the German edition by new experimental investigations which have fully corroborated his conclusions.

The English edition, an excellent translation, contains additional matter in the form of three appendices. The first reviews the new and sensational method proposed by Nernst for the calculation of chemical equilibrium from thermal data. The second gives in detail the results of experiments carried on in the laboratories of Nernst and the author on the free energy of formation of carbon dioxide and water, of experiments by Lewis on the electromotive force of the oxyhydrogen cell, and of others by Lewis and Falkenstein on the Deacon process. The third appendix contains a miscellany of short notes dealing chiefly with the reaction velocity in gaseous systems.

To all who are interested in making chemistry an exact science, and who are not unwilling to read a book requiring a little thought and study, this work is heartily commended.

GILBERT N. LEWIS

Handbook of Flower Pollination. By DR. PAUL KNUTH; translated by J. R. AINSWORTH DAVIS. Vol. 2. Oxford, Clarendon Press. 1908.

For many years Hermann Müller's "Fertilization of Flowers by Insects," which had been translated into English, was the standard reference-book on all subjects connected with the relation of flowers to their insect-visitors. It was, however, getting very much out-of-date; so Dr. Paul Knuth, taking it as a basis, undertook the preparation of a new work, intended to include all the information available up to the date of publication. The new "Handbuch der Blütenbiologie" could not be included, like Müller's work, in a single volume, so it was divided into several sections. The first of these consisted of a general introduction; then came an account of the observations made in Europe; and finally, those from other parts of the world were to be given. Knuth did not live to see the last section published, but it was brought to a satisfactory completion in 1905 under the editorship of Dr. Ernst Loew.

There was naturally a demand for an English translation of the "Handbuch," and this arduous task was undertaken by Professor J. R. Ainsworth Davis, of the University College of Wales. The first volume of the translation appeared in 1906; the second has just been published. The first volume differs from the original German, in that it contains the bibliography up to January 1, 1904. The second has been translated without substantial alterations, except that it is much more clearly printed, with fewer abbreviations. No attempt has been made to bring it up to date. The third volume, now in press, will finish the account of the European observations; and the fourth will be prepared next autumn or winter. The last part of Knuth's work, dealing with the "aussereuropäischen" observations, was naturally the most incomplete (pathetically so for many parts of the world!); and hence Professor Ainsworth Davis, in spite of the great increase of work involved, has arranged to incorporate all new information available up to the date of going to press. This will make the final volume almost a new book, and as such it will be invaluable to all students of flower pollination. American students should be careful to forward to Professor Davis any papers they may have written bearing upon the subject, and also any manuscript data they are able to furnish. Those who have the German edition will be able to note the omission of important data, and will have a chance this summer to make many observations which can be incorporated.[1]

The second volume, the immediate subject of this notice, is of great value to American workers. In the first place, most of the European plants described are of American genera, and not a few of the species are circumpolar; in the second, there are many observations on purely American forms, made in European botanical gardens. So closely, indeed, are the European and American data related, that we can not help greatly regretting that they were not combined in a single series. The separation of the European and American sections will doubtless result in many workers procuring only the one or the other, according to their place of residence. This will have the most unfortunate results; for example, American observers may work on particular genera, ignorant of the illuminating results obtained in Europe; or Europeans may take the records from botanical gardens as fairly representative for American genera, overlooking the very different data obtainable where these plants grow wild.

[1] Professor Ainsworth Davis has just been appointed principal of the Royal Agricultural College, Cirencester, and should be addressed there after September 1.

In the present state of the science, it is unavoidable that a work on flower pollination should contain a large amount of undigested information. The precise meaning of the long lists of visitors can not always be determined; and no doubt any author who should try to dispense with these lists, and state the results of research in general terms, would fall into many errors. There are, of course, many important and suggestive generalizations in the book; but every worker will be glad that he is supplied with the actual data at the back of these, data which he can compare minutely with those accumulated by himself.

In a work compiled from so many different sources there will necessarily be some errors. Thus the map on p. 49 does not do justice to the distribution of the humble-bees. *Bombus* extends quite to the north of Greenland (*cf.* Peary) and in Asia reaches the Philippines (*B. mearnsi* Ashmead), Sumatra (*B. senex* Snellen and *B. sumatrensis* Ckll.) and Java (*B. rufipes* Lep.).

T. D. A. Cockerell

SPECIAL ARTICLES

REVISION OF "THE NEW YORK SERIES."

The writer submits the following rearrangement of a part of Clarke and Schuchert's classification of the New York Paleozoic, including changes based chiefly upon the recent work of Hartnagel and others:

Hartnagel's redetermination of the Oneida conglomerate as the equivalent of the topmost or true Medina sandstone, and his separation from the latter of the great thickness of barren shales constituting his "lower Medina" with the suggestion of a disconformity at their top,

	Ulsterian.	Onondaga. Schoharie.
Eodevonic.	Oriskanian.	Esopus (Decewville). Glenerie } Oriskany. Connelly (Port Jervis) } Oriskany. Port Ewen ("Kingston").
	Helderbergian.	Becraft. New Scotland. Kalkberg. Coeymans.
Neontaric.	Cayugan.	Manlius. Rondout. Cobleskill.
Mesontaric.	Salinan.	Bertie. Rosendale. Camillus. Wilbur. Syracuse. Binnewater. Vernon. High Falls. Pittsford. Shawangunk.
Eontaric.	Niagaran.	Guelph (Shelby). Lockport. Rochester (inc. Irondequoit). Clinton { Williamson. Clinton { Wolcott (inc. Furnaceville) Clinton { Sodus. Medina (Oneida).
	Cincinnatian.	Lewiston (Richmond). Lorraine (inc. Oswego). Utica.

opens a way of solution for the vexed Richmond question. These lower shales, for which he has suggested to the writer a revival of the early name LEWISTON SHALE, Hartnagel has again shown to be strictly continuous with the underlying Oswego sandstone, which in turn appears to constitute merely the closing episode of the Lorraine division. The Lewiston shales must therefore be referred to the Cincinnatian (Eopaleozoic), and that they are the true time equivalent of the Richmond beds is indicated (1) by homotaxy, (2) by the finding of the Richmond species, *Rhynchotrema capax* and *Ambonychia radiata*, high up in their supposed Pennsylvania equivalent, the "red Medina" (Juniata), as ascribed to Stevenson in Dana's Manual; (3) by the immediate succession of the Clinton to the Richmond fauna in the continuous deposits of Anticosti and (4) by the survival into the Clinton of such Richmond forms as *Platystrophia lynx* and *Calymmene senaria*. There is thus no room for the interpolation of an "Oswegan" time-division and fauna (if such existed). The Oswego and Lewiston beds as we know them are entirely barren, except for the two Richmond fossils mentioned, while the wholly minor congeries occupying the hundred feet of true Medina (Oneida) and consisting chiefly of *Lingula cuneata* and *Arthrophycus alleghaniensis* contains other forms, such as *Bucania trilobata*, which link it closely with the Clinton fauna, into which it might be merged without violence. In any case the (restricted) Medina falls within the Niagaran, which thus becomes the Eontaric, with the Clinton facies for its initial fauna in America as in Europe.

It should be noted in passing that both Hartnagel and Sarle have shown the fauna of the so-called "upper Clinton" (Irondequoit) limestone to be very nearly that of the Rochester shale, to which it should, therefore, be transferred. A rather similar development of limestone at the base of the Rochester appears to exist in Ohio. The Furnaceville ore bed lies *in* and not *below* the Wolcott limestone.

Having replaced the Niagaran in the Eontaric (compare the old Dana classification —Niagara, Salina, Lower Helderberg), it seems natural to restore the triple time-division of the Ontaric by separating the Salina series from the higher limestones of the Cayugan, to which that name may accordingly be restricted as chiefly applicable. This step is made easy by Hartnagel's unraveling of the Cobleskill limestone and discrimination of the overlying (Rondout) from the underlying (Bertie-Rosendale) "waterlimes." We now have in the marine faunas of the Cobleskill, Rondout and Manlius limestones a very natural group characterized by certain well-marked shells and corals ranging through the three formations. Quite distinct from these is the mass of barachois deposits constituting the group which may be designated by the long-established term Salinan. Hartnagel's determination of the eastern New York expression of these beds on theoretic (stratigraphic) grounds has found a gratifying confirmation through the recent discovery of a Pittsford fauna in the Shawangunk conglomerate, so that we are able to parallel the eastern and western series with certainty.

The Mesontaric thus becomes a unit of remarkable symmetry. It may be likened to a parabola, which, springing from the marine fauna of the Guelph dolomite, ascends through one Eurypterid fauna (the Pittsford-Shawangunk) to a culmination centrally in the barren salt beds (Syracuse) and descends through a second Eurypterid fauna (the Bertie) to a return of marine conditions with *Halysites* and other Niagaran types in the Cobleskill dolomite, itself lithologically not unlike the Guelph.

Unpublished studies by the writer on the Port Ewen fauna have shown its many affinities with that of the overlying Oriskany limestones as known at Glenerie and Becraft's Mountain. Dr. Clarke has, therefore, recommended the transfer of these beds to the Oriskanian, in spite of the preponderance of Helderbergian elements. The oft-mooted pertinence of the Esopus to the Oriskanian also appears to be affirmatively settled, at least for its lower portion, by the writer's finding of Oriskany fossils (*Leptocœlia flabellites*, *Chonostrophia*, etc.) forty feet above its base near Leeds, Greene Co. *Taonurus caudagalli* occurs in the Oriskany limestones at Glenerie.

In the Rondout region the last-mentioned beds, which may now be formally christened as the Glenerie limestone, are underlaid by eighteen or twenty feet of pebble-beds, typically exposed on the hill above South Rondout (Connelly post-office) and in the creek bank opposite, for which the name Connelly conglomerate is proposed. Southwestward, as at Cottekill, this latter appears to give way to shaly limestones exactly resembling those of the underlying Port Ewen, but having a strongly Oriskany fauna, and it is suspected that these are the equivalent of Barrett's *Dalmanites dentatus* zone, herein designated provisionally by the name Port Jervis.

The new name Kalkberg limestone is proposed to cover certain layers heretofore included variously by writers with the beds above or below (New Scotland and Coeymans) and carrying a mixed fauna, highly developed and excellently silicified on Catskill Creek. Here the beds show numerous thin parallel seams of black flint nodules; below these are fourteen feet of typical Coeymans, without flint, and above them are the typically shaly layers of the New Scotland. A similar association has been found at the Indian Ladder and elsewhere. The fauna is one of the most interesting and abundant in the region and combines *Sieberella galeata* with *Bilobites, Nucleospira, Delthyris, Dalmanella, Rhipidomella, Rhynchospira*, etc. The name Kalkberg (lime hill) is the local Dutch designation for the Helderbergian ridge, and is pronounced Collak-barrakh.

George H. Chadwick
St. Lawrence University,
Canton, N. Y.

OBSERVATIONS UPON A YELLOWS DISEASE OF THE FALL DANDELION

The fall dandelion, *Leontodon autumnale* Linn., is becoming one of the worst of the introduced weeds of certain sections of Maine, in meadows, along roadsides and in lawns. This is particularly the case on the lawns of the University of Maine, where the bright yellow flowers are very conspicuous from August till late autumn, in spite of frequent mowing.

Here the plant is affected with a "yellows" disease which the writer has had opportunity to observe for the past two seasons. The diseased plants are very characteristic and conspicuous because the foliage becomes much lighter colored and yellowed and tends to grow upward into a rather compact mass, especially if not cut back by the lawn mower. The plant reacts to the stimulus of the disease by producing an abnormal number of leaves and flower heads, particularly the latter. As a rule the scapes are considerably shortened and the flowers abortive, but plants only slightly affected are occasionally observed to form seeds.

These weeds were very plentiful on the lawns in the fall of 1906 and from 30 per cent. to 50 per cent. of the plants were diseased.

In 1907 there was a decided falling off in number, with respect to diseased as well as healthy plants, the proportion of the former being plainly less than in the preceding season.

On account of the obscure nature of this type of disease, its similarity to aster yellows and kindred troubles, and more particularly on account of the abundance and availability of the material a series of observations and experiments covering a number of years were planned. The outcome of one of these experiments was as follows:

In September, 1906, a number of vigorous, healthy young plants were carefully taken up and transplanted to the corner of a garden. They were placed close together, making a continuous row four or five feet long. Next plants showing early or at least not advanced stages of yellows were selected and transplanted with equal care so as to form a row on either side, parallel with, and about six or eight inches removed from, the row of diseased plants. None of the plants showed any ill effects from the transplanting. In the spring of 1907 nearly all of the diseased plants were dead and the remainder failed to survive the season. All of the healthy plants survived. They have shown no signs of yellows to date and are now strong and vigorous. A portion of the plants will now be removed from the row and placed in the rows where the diseased plants stood.

It is hoped that later work upon this disease of a more fundamental nature may be undertaken with added facilities in the shape of a greenhouse for pathological purposes and complete equipment for histological work.

W. J. Morse

Maine Experiment Station

A PRINCIPLE OF ELEMENTARY LABORATORY TEACHING FOR CULTURE STUDENTS

During recent years, courses for culture students in the biological sciences have been widely introduced into the schools and colleges of this country. The results attained do not measure up to what was hoped for by those who placed them there. Probably no one would be more ready than the better teachers to admit that the average student, to a discouraging degree, comes short of acquiring that information or developing that power of obtaining knowledge for himself which it was planned that he should.

The difficulty is not trivial and it is not imaginary. It is one which should receive serious consideration at the hands of those whose business it is to teach. The present paper is offered as a contribution toward its solution.

One university professor of botany expressed to the writer the opinion that courses in botany are justified by the fact that some who are not adapted to other studies are awakened and develop in scientific work. The writer has known shining examples of such; their proportion, however, is small, and it seems self-evident that the teacher can be content with nothing less than to reach and to bring out the average student who comes into his classes.

The situation can best be stated by taking a concrete illustration. Suppose then, a young teacher with university training, high ideals and a certain individuality. He surrounds himself with his students, places material in their hands and asks them stimulating questions whose answers they can find out. He plans courses which include morphology, physiology and evolutionary relationship of plants. These subjects are sometimes segregated, sometimes (as their arranger thinks) ingeniously interwoven. The teaching proceeds through weeks and months. Looked at as a whole, what is the outcome? Something as follows:

The success of certain of the lessons is immediate and convincing. Perhaps, for example, those upon the morpho-physiology of seeds or upon winter buds, catch the interest of the class, incite independent effort and show every sign of living in the minds of the student. On such days the teacher tastes that fine joy which is said to be his chief reward, mingled it may be with sinful pride and a commiseration for students less fortunate than his own.

But not so much can be said of every lesson. For these the teacher frames for himself many excuses. Perhaps it was an "off day." But as the years pass by and his experience and frankness with himself increase, he is some day to realize that as a matter of fact the hours when actual independent work is being done are few and precious, and that the greater part of the laboratory time is spent in merely performing assigned tasks.

No doubt there are teachers who lift their classes above this level, but no doubt also they are few. And if such is the case, then some hard things remain to be said, viz., that for the majority of students the time given to biological courses must be justified by the information acquired, or else by the disciplinary value of doing required routine work, or else that it is not justified at all.

If conditions are as pictured, the question is pressing—"What is to be done about it?" In looking for a solution my point of departure would be the fact that *certain* of the lessons actually do call out a real interested and independent effort on the part of the student. That ounce of fact is worth tons of theorizing. Then if it is true that the greatest good which can come to the student out of such courses is the development of his own powers of obtaining knowledge, it would not seem far to this principle. *The laboratory course should be composed mainly of those lessons which the instructor can so present as to arouse independent effort on the part of the student.*

Then the question will at once arise "what about the lessons of which this is not true; what about the many and important topics in which the student can at best scarcely do more than to perform faithfully the task assigned?" My answer would be to remove most of them frankly to the domain of lecture and demonstration. A good demonstration, where the student feels the spark of inspiration from the teacher's performance and example, is far better for both teacher and student than a time-serving laboratory exercise. In our haste to emphasize the laboratory method we have swung too far the other way and made too little of what must ever be one of the prime factors of good teaching—the inspiring example of the teacher.

No doubt a certain proportion of laboratory lessons which are mere verification exercises are desirable, but on the whole it still remains true that for culture students *the laboratory hours are too precious to be used in anything but independence begetting work.* In the lecture room is the place to see that the course is rounded out, kept coherent and the ground covered.

It may be permissible to add here a point which in the writer's experience has been worked out as a sort of corollary to the above principle. In blindly attempting to keep the students interested and working on their own initiative, I have found the laboratory work to grow more and more physiological in character.

In studying life histories, for example, I have found my classes to maintain a rather high degree of interest from the algæ up to about the ferns, and then the interest to wane as the homologies with the seed plants are taken up. After some time I perceived that that which held their interest was in the processes rather than in the organs of reproduction; that though they learned something about the homologies of endosperm, prothallus, etc., they did so under some pressure and forgot it with alacrity; and that in their hearts they did not care whether it was so or not. Slowly and with regret I came to the conclusion that in my classes at any rate the "deeper morphology" could not compete with other topics for a place in an elementary course.

Far otherwise was it with subjects which at first I had not had the students really work at all—respiration, photosynthesis, irritability. Here the interest and willingness to work was instantaneous and sustained. When it is considered furthermore that the teacher can give more just and stimulating criticism of the setting up of an experiment than he can of the performance of a dissection; that that which is permanently remembered by the student is after all very little, and that ideas of the life activities of plants are among the most valuable in the subject-matter of botany, the case seems fairly complete for a course dominated by physiology.

In mentioning this seeming corollary I would not have it confounded with the principle which is here advanced. The principle should hold at all events. If a given teacher finds his classes to be most interested and to work hardest in morphology, then morphological problems should claim the laboratory time. The principle is to make any needful sacrifice in order to achieve the main object, to keep the student at his maximum of interest and independent effort.

CHARLES H. SHAW

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES, SECTION OF GEOLOGY AND MINERALOGY

AT the regular monthly meeting of February 3, 1908, the following program was presented:

On Determination of Mineral Constitution through Recasting of Analyses: ALEXIS A. JULIEN.

The results of investigations continued along the line of complex mineral micro-aggregates, brought before the academy at the January meeting, were shown in a series of charts. It appears certain in the case of very complex mineral analyses, after giving due weight to the physical characters and origin of the substances, together with the readiness with which these analyses yield to the process of recasting, that many so-called mineral species are in reality very complex micro-aggregates. One illustration, taken from the complete paper, which is to be issued in the *Annals* of the New York Academy of Sciences, Vol. XVIII., Part II., No. 3, is here given as a suggestive case.

Diabantite, from Farmington Hills, Conn.: Mean of two analyses by G. W. HAWES.

		Per Cent
Silica	SiO_2	33.46
Alumina	Al_2O_3	10.96
Ferric oxide	Fe_2O_3	2.56
Ferrous oxide	FeO	24.72
Manganous oxide	MnO	.39
Lime	CaO	.92
Magnesia	MgO	16.52
Soda	Na_2O	.29
Water	H_2O	9.96
Total		99.78

This is said, by the analyst, to be "a unisilicate of the pyrosclerite group, with the formula,

$$(\tfrac{2}{3}\dot{R}_3 + \tfrac{1}{3}\dddot{Al})\ddot{Si}_3 + 3\dot{H}."$$

Dana states that the figures "correspond to the formula $R_{12}(R_2)_2Si_9O_{36} + 9aq$, which is near to that of pyrosclerite," and also

"*Comp.* $H_{18}(FeMg)_{12}Al_4Si_9O_{45}$, or

$12(FeMg)O\ 2Al_2O_3\ 9SiO_3\ 9H_2O$."

In the recalculation Dr. Julien assumes for the residual pyroxene the same composition as was determined by Hawes for that mineral from an outcrop of diabase in the same region. On this basis the following hypothetical constituents are indicated:

	Per Cent.
Pyroxene (residual)	6.78
Enstatite (residual)	10.45
Prochlorite	54.45
Ekmanite	16.33
Deweylite	8.42
Limonite	2.99
Periclase (magnesia)	0.36

It is apparent by making further comparison that diabantite is not identical with diabantachronyn, and it is not at all likely that any specimens of either mixture are ever identical.

The Annual Meeting of the Geological Society of America, Albuquerque, N. M., December 30–31, 1907: E. O. HOVEY.

An account of the chief points of interest in connection with the meeting was given.

A Revised Cross-section of the Rondout Valley along the Line of the Catskill Aqueduct: CHARLES P. BERKEY.

Explorations of the Board of Water Supply of New York City are now almost completed across the Rondout Valley. There are twelve distinct formations of stratified rock involved, all of which will be cut by the projected pressure tunnel. One unconformity in the series separates the Ordovician Hudson River slates from the overlying conglomerates, shales, sandstones and limestones of Silurian and Devonian age. There are three faults of considerable displacement, together with smaller ones and minor foldings. In the effort to determine the variations of these formations as to thickness, depth from surface, displacements, physical conditions, water content and capacity, the presence of caves or relative solubility, and the position and depth of the buried channels beneath the drift cover, the available figures are so abundant that the cross-section may be considered accurate within a few feet for a considerable proportion of the whole width of the valley, a distance of four miles, and to a depth of 300 to 500 feet. Several drawings illustrating these features in detail, originally prepared for the chief engineer of the Board of Water Supply, were shown by permission, and the successive stages in interpretation of results were pointed out.

Present Trend of Investigation on Underground Waters: James F. Kemp.

Within a few years there has been a marked change of views upon the sources, distribution and extent of underground waters. As recently as 1900, in one of the most important discussions, they were believed to be practically continuous from the groundwater level to the depth of possible cavities and to be almost, if not quite, solely of meteoric origin. Whereas now a very large number of geologists have come to regard the underground water as limited to a comparatively shallow zone; to refer uprising heated waters from deeper zones to magmatic sources in cooling and consolidating bodies of igneous rock; and to attribute some part of the underground waters to the same place of origin. In the interpretation of ore-bodies magmatic waters have been found to be much more reasonable agents of deposition, in many cases, than are the meteoric.

In 1901, on the basis of experience in mines, Professor Kemp made the argument that the groundwater only extended to depths of 1,000 to 2,000 feet. Recently this has had strong corroboration in a paper by M. L. Fuller, of the U. S. Geological Survey (Water Supply and Irrigation Papers, No. 160, pp. 61, 62, 72). Delesse, in 1861, estimated the groundwater as equal to a layer over the globe 7,500 feet deep; Schlichter, in 1902, as equal to one 3,000 to 3,500 feet; Van Hise, in 1904, 226 feet; Chamberlin and Salisbury, in 1904, 800 to 1,600 feet; Fuller, with the completest data of all, to one of only 96 feet. If we assign to the rocks an average of 5 per cent. of cavities, 96 feet of water would just about extend to 2,000 feet, and if 10 per cent. of voids, to 1,000 feet depths, strongly corroborative of the original argument and per cents. used in previous discussions.

From this we are forced to conclude that meteoric sources and underground amounts have been much overestimated.

Chas. P. Berkey,
Secretary of Section

THE TEXAS ACADEMY OF SCIENCE

At the regular meeting of the Texas Academy of Science, held in the Engineering Building of the University of Texas, February 21, 1908, Miss May Jarvis, B.A., tutor in zoology in the university, presented a paper on "Lord Monboddo, a Precursor of the Darwins"; Professor T. U. Taylor, dean of the department of engineering, followed with "Notes on City Surveying," and Dr. William T. Mather, professor of physics, gave a brief sketch of the life and work of Lord Kelvin.

On Friday, March 13, Dr. J. W. McLaughlin, of Austin, a regent of the university and former member of the medical faculty, read a carefully prepared paper entitled "A New Theory of Ferments" which, with the discussion that followed, occupied the entire session.

At the meeting of the academy held April 11, Dr. G. S. Fraps, state chemist, College Station, Texas, discussed "Soil Fertility and Phosphoric Acid."

The program of the meeting for May 8 included "The Law of Fall of Rivers and the Value of the Deduced Curve in River Improvements," by Mr. F. Oppikoffer, U. S. Engineer, Department of Texas, Tarpon, Texas, and a lecture "On Apoidal Stars," by Dr. H. Y. Benedict, professor of applied mathematics in the university.

At the formal meeting, held June 8, papers entitled "Some Figures on the Cost of Freight and Passenger Train Service," by Mr. R. A. Thompson, expert engineer for the Railroad Commission of Texas, and "Fossil Tracks in the Del Rio Clay," by Professor J. A. Udden, of Rock Island, Illinois, were read by title. The ballots having been duly counted the following officers for the year 1908–9 were declared elected:

President—Dr. Eugene P. Schoch, University of Texas, Austin.

Vice-President—Dr. G. S. Fraps, A. and M. College of Texas, College Station.

Treasurer—Mr. R. A. Thompson, C.E., Austin.

Secretary—Dr. Frederic W. Simonds, University of Texas, Austin.

Librarian—Mr. P. L. Windsor, librarian of the university, Austin.

Members of the Council—Hon. A. E. Wilkinson, Austin; Dr. Homer Hill, Austin; Professor O. C. Charlton, Bryan, Texas.

Frederic W. Simonds,
Secretary

Austin, Texas,
July 15, 1908

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 18, 1908

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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., or during the present summer to Wood s Hole, Mass.

THE ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]—I.

Before entering on the subject of my address, I may be allowed to refer to the loss which the British Association has sustained in the death of Lord Kelvin. He joined the association in 1847, and has been for more than fifty years a familiar figure at our meetings. This is not the occasion to speak of his work in the world or of what he was to his friends, but rather of his influence on those who were personally unknown to him. It seems to me characteristic of him that something of his vigor and of his personal charm was felt far beyond the circles of his intimate associates, and many men and women who never exchanged a word with Lord Kelvin, and are in outer darkness as to his researches, will miss his genial presence and feel themselves the poorer to-day. By the death of Sir John Evans the association is deprived of another faithful friend. He presided at Toronto in 1897, and since he joined the association in 1861 had been a regular attendant at our meetings. The absence of his cheerful personality and the loss of his wise counsels will be widely felt.

May I be permitted one other digression before I come to my subject? There has not been a botanical president of the British Association since the Norwich meeting forty years ago, when Sir Joseph Hooker was in the chair, and in "eloquent and felicitous words" (to quote my fath-

[1] Dublin, 1908.

er's letter) spoke in defense of the doctrine of evolution. I am sure that every member of this association will be glad to be reminded that Sir Joseph Hooker is, happily, still working at the subject that his lifelong labors have so greatly advanced, and of which he has long been recognized as the honored chief and leader.

You will perhaps expect me to give a retrospect of the progress of evolution during the fifty years that have elapsed since July 1, 1858, when the doctrine of the origin of species by means of natural selection was made known to the world in the words of Mr. Darwin and Mr. Wallace. This would be a gigantic task, for which I am quite unfitted. It seems to me, moreover, that the first duty of your president is to speak on matters to which his own researches have contributed. My work—such as it is—deals with the movements of plants, and it is with this subject that I shall begin. I want to give you a general idea of how the changes going on in the environment act as stimuli and compel plants to execute certain movements. Then I shall show that what is true of those temporary changes of shape we describe as movements is also true of the permanent alterations known as morphological.

I shall insist that, if the study of movement includes the problem of stimulus and reaction, morphological change must be investigated from the same point of view. In fact, that these two departments of inquiry must be classed together, and this, as we shall see, has some important results—namely, that the dim beginnings of habit or unconscious memory that we find in the movements of plants and animals must find a place in morphology; and inasmuch as a striking instance of correlated morphological changes is to be found in the development of the adult from the ovum, I shall take this ontogenetic series and attempt to show you that here also something equivalent to memory or habit reigns.

Many attempts have been made to connect in this way the phenomena of memory and inheritance, and I shall ask you to listen to one more such attempt, even though I am forced to appear as a champion of what some of you consider a lost cause—the doctrine of the inheritance of acquired characters.

MOVEMENT

In his book on "The Power of Movement in Plants" (1880)[2] my father wrote that "it is impossible not to be struck with the resemblance between the foregoing movements of plants and many of the actions performed unconsciously by the lower animals." In the previous year Sachs[3] had in like manner called attention to the essential resemblance between the irritability of plants and animals. I give these statements first because of their simplicity and directness; but it must not be forgotten that before this Pfeffer[4] had begun to lay down the principles of what is now known as *Reizphysiologie*, or the physiology of stimulus, for which he and his pupils have done so much.

The words of Darwin which I have quoted afford an example of the way in which science returns to the obvious. Here we find revived, in a rational form, the point of view of the child or of the writer of fairy stories. We do not go so far as the child; we know that flowers do not talk or walk; but the fact that plants must be classed with animals as regards their manner of reaction to stimuli has now become almost a commonplace of physiology. And inasmuch as we ourselves are animals, this conception gives us

[2] P. 571.

[3] *Arbeiten*, II., 1879, p. 282.

[4] "Osmotische Untersuchungen," 1877, p. 202.

a certain insight into the reactions of plants which we should not otherwise possess. This is, I allow, a very dangerous tendency, leading to anthropomorphism, one of the seven deadly sins of science. Nevertheless, it is one that must be used unless the great mass of knowledge accumulated by psychologists is to be forbidden ground to the physiologist.

Jennings[5] has admirably expressed the point of view from which we ought to deal with the behavior of the simpler organisms. He points out that we must study their movements in a strictly objective manner: that the same point of view must be applied to man, and that any resemblances between the two sets of phenomena are not only an allowable but a necessary aid to research.

What, then, are the essential characters of stimuli and of the reactions which they call forth in living organisms? Pfeffer has stated this in the most objective way. An organism is a machine which can be set going by touching a spring or trigger of some kind; a machine in which energy can be set free by some kind of releasing mechanism. Here we have a model of at least some of the features of reaction to stimulation.

The energy of the cause is generally out of all proportion to the effect, *i. e.*, a small stimulus produces a big reaction. The specific character of the result depends on the structure of the machine rather than on the character of the stimulus. The trigger of a gun may be pulled in a variety of different ways without affecting the character of the explosion. Just in the same way a plant may be made to curve by altering its angle to the vertical, by lateral illumination, by chemical agency, and so forth; the curvature is of the same nature in all cases, the release-action differs. One of those chains of wooden bricks in which each knocks over the next may be set in action by a touch, by throwing a ball, by an erring dog, in short by anything that upsets the equilibrium of brick No. 1; but the really important part of the game, the way in which the wave of falling bricks passes like a prairie fire round a group of Noah's Ark animals, or by a bridge over its own dead body and returns to the starting-point, etc.—these are the result of the magnificent structure of the thing as a whole, and the upset of brick No. 1 seems a small thing in comparison.

For myself I see no reason why the term *stimulus* should not be used in relation to the action of mechanisms in general; but by a convention which it is well to respect, *stimulation* is confined to the protoplasmic machinery of living organisms.

The want of proportion between the stimulus and the reply, or, as it has been expressed, the unexpectedness of the result of a given stimulus, is a striking feature in the phenomena of reaction. That this should be so need not surprise us. We can, as a rule, only know the stimulus and the response, while the intermediate processes of the mechanism are hidden in the secret life of protoplasm. We might, however, have guessed that big changes would result from small stimuli, since it is clear that the success of an organism in the world must depend partly at least on its being highly sensitive to changes in its surroundings. This is the adaptive side of the fundamental fact that living protoplasm is a highly unstable body. Here I may say one word about the adaptation as treated in the "Origin of Species." It is the present fashion to minimize or deny altogether the importance of natural selection. I do not propose to enter into this subject; I am convinced that the inherent

[5] "The Behavior of the Lower Organisms," 1904, p. 124.

strength of the doctrine will insure its final victory over the present anti-Darwinian stream of criticism. From the Darwinian point of view it would be a remarkable fact if the reactions of organisms to natural stimuli were not adaptive. That they should be so, as they undoubtedly are, is not surprising. But just now I only call attention to the adaptive character of reactions from a descriptive point of view.

Hitherto I have implied the existence of a general character in stimulation without actually naming it; I mean the indirectness of the result. This is the point of view of Dutrochet, who in 1824 said that the environment suggests but does not directly cause the reaction. It is not easy to make clear in a few words the conception of indirectness. Pfeffer[6] employs the word *induction,* and holds that external stimuli act by producing internal change, such changes being the link between stimulus and reaction. It may seem, at first sight, that we do not gain much by this supposition; but since these changes may be more or less enduring, we gain at least the conception of *after effect* as a quality of stimulation. What are known as *spontaneous* actions must be considered as due to internal changes of unknown origin.

It may be said that in speaking of the "indirectness" of the response to stimuli we are merely expressing in other words the conception of release-action; that the explosion of a machine is an indirect reply to the touch on the trigger. This is doubtless true, but we possibly lose something if we attempt to compress the whole problem into the truism that the organism behaves as it does because it has a certain structure. The quality of indirectness is far more characteristic of an organism than of a machine, and to keep it in mind is more illuminating than a slavish adherence to the analogy of a machine. The reaction of an organism depends on its past history; but, it may be answered, this is also true of a machine the action of which depends on how it was made, and in a less degree on the treatment it has received during use. But in living things this last feature in behavior is far more striking, and in the higher organisms past experience is all-important in deciding the response to stimulus. The organism is a plastic machine profoundly affected in structure by its own action, and the unknown process intervening between stimulus and reaction (on which the indirectness of the response depends) must have the fullest value allowed it as a characteristic of living creatures.

For the zoological side of biology a view similar to that of Pfeffer has been clearly stated by Jennings[7] in his admirable studies on the behavior of infusoria, rotifers, etc. He advances strong arguments against the theories of Loeb and others, according to which the stimulus acts directly on the organs of movement; a point of view which was formerly held by botanists, but has since given place to the conception of the stimulation acting on the organism as a whole. Unfortunately for botanists these movements are by the zoologists called *tropisms,* and are thus liable to be confused with the geotropism, heliotropism, etc., of plants: to these movements, which are not considered by botanists to be due to direct action of stimuli, Loeb's assumptions do not seem to be applicable.

Jennings's position is that we must take into consideration what he calls "physiological state, *i. e.*, 'the varying internal physiological conditions of the organism,

[6] "Physiology," English edition, I., p. 11.

[7] H. S. Jennings, "Contributions to the Study of the Behavior of the Lower Organisms," Carnegie Institution, 1904, p. 111.

as distinguished from permanent anatomical conditions.' " Though he does not claim novelty for his view, I am not aware that it has ever been so well stated. External stimuli are supposed to act by altering this physiological state; that is, the organism is temporarily transformed into what, judged by its reactions, is practically a different creature.

This may be illustrated by the behavior of *Stentor*, one of the fixed infusoria.[8] If a fine jet of water is directed against the disc of the creature, it contracts "like a flash" into its tube. In about half a minute it expands again and the cilia resume their activity. Now we cause the current to act again upon the disc. This time the *Stentor* does not contract, which proves that the animal has been in some way changed by the first stimulus. This is a simple example of "physiological state." When the *Stentor* was at rest, before it received the first current of water, it was in state 1, the stimulus changed state 1 into state 2, to which contraction is the reaction. When again stimulated it passed into state 3, which does not produce contraction.

We can not prove that the contraction which occurred when the *Stentor* was first stimulated was due to a change of state. But it is a fair deduction from the result of the whole experiment, for after the original reaction the creature is undoubtedly in a changed state, since it no longer reacts in the same way to a repetition of the original stimulus.

Jennings points out that, as in the case of plants, spontaneous acts are brought about when the physiological state is changed by unknown causes, whereas in other cases we can point to an external agency by which the same result is effected.

[8] Jennings, "Behavior of the Lower Organisms," 1906, p. 170.

MORPHOLOGICAL CHANGES

Let us pass on to the consideration of the permanent or morphological changes and the stimuli by which they are produced, a subject to which, in recent years, many workers have devoted themselves. I need only mention the names of Vöchting, Goebel and Klebs, among botanists, and those of Loeb, Herbst and Driesch among zoologists, to remind you of the type of research to which I refer.

These morphological alterations produced by changes in environment have been brought under the rubric of reaction to stimulation, and must be considered as essentially similar to the class of temporary movements of which I have spoken.

The very first stage in development may be determined by a purely external stimulus. Thus the position of the first cell-wall in the developing spore of *Equisetum* is determined by the direction of incident light.[9] In the same way the direction of light settles the plane of symmetry of *Marchantia* as it develops from the gemma.[10] But the more interesting cases are those where the presence or absence of a stimulus makes an elaborate structural difference in the organism. Thus, as Stahl[11] has shown, beech leaves developed in the deep shade of the middle of the tree are so different in structure from leaves grown in full sunlight that they would unhesitatingly be described as belonging to different species. Another well-known case is the development of the scale-leaves on the rhizome of *Circæa* into the foliage leaves under the action of light.[12]

The power which the experimenter has over the lower plants is shown by Klebs, who kept *Saprolegnia mixta*, a fungus found on dead flies, in uninterrupted veg-

[9] Stahl, *Ber. d. Bot. Ges.*, 1885, p. 334.

[10] Pfeffer, in Sachs's *Arbeiten*, I., p. 92.

[11] *Jenaische Zeitschr.*, 1883, p. 162.

[12] Goebel, in *Bot. Zeitung*, 1880.

etative growth for six years; while by removing a fragment of the plant and cultivating it in other conditions the reproductive organs could at any time be made to appear.[13]

Chlamydomonas media, a unicellular green alga, when grown in a 0.4 per cent. nutrient solution, continues to increase by simple division, but conjugating gametes are formed in a few days if the plant is placed in pure water and kept in bright light.[14] Numberless other cases could be given of the regulation of form in the lower organisms. Thus *Sporodinia* grown on peptone-gelatine produces sporangiferous hypha, but on sugar zygotes are formed. Again, *Protosiphon botryoides,* if grown on damp clay, can most readily be made to produce spores by transference to water either in light or in darkness. But for the same plant cultivated in Knop's solution the end can best be obtained by placing the culture in the dark.[15] Still these instances of the regulation of reproduction are not so interesting from our point of view as some of Klebs's later results.[16] Thus he has shown that the color of the flower of *Campanula trachelium* can be changed from blue to white and back again to blue by varying the conditions under which the plant is cultivated. Again, with *Sempervivum*[17] he has been able to produce striking results —*e. g.*, the formation of apetalous flowers with one instead of two rows of stamens. Diminution in the number of stamens is a common occurrence in his experimental plants, and absolute loss of these organs also occurs. Many other abnormalities were induced, both in the stamens and in other parts of the flowers.

[13] *Willkürliche Entwick.*, p. 27.

[14] Klebs, *Bedingungen*, 1896, p. 430.

[15] *Biol. Centralbl.*, 1904, pp. 451–3.

[16] *Jahrb. f. wiss. Bot.*, XLII., 1906, p. 162.

[17] *Abhandl. Naturforsch. Ges. zu Halle*, XXV., 1906, pp. 31, 34, etc.

There is nothing new in the character of these facts;[18] what has been brought to light (principally by the work of Klebs) is the *degree* to which ontogeny is controllable. We are so much in the habit of thinking of the stable element in ontogeny that the work of Klebs strikes us with something of a shock. Most people would allow that change of form is ultimately referable to changed conditions, but many of us were not prepared to learn the great importance of external stimuli in ontogeny.

Klebs begins by assuming that every species has a definite *specific structure,* which he compares to chemical character. Just as a substance such as sulphur may assume different forms under different treatment, so he assumes that the specific structure of a plant has certain potentialities which may be brought to light by appropriate stimuli. He divides the agencies affecting the structure into external and internal conditions, the external being supposed to act by causing alterations in the internal conditions.

It will be seen that the scheme is broadly the same as that of Pfeffer for the case of the movement and other temporary reactions. The internal conditions of Klebs correspond also to the "physiological state" of Jennings.

From what has gone before, it will be seen that the current conception of stimulus[19] is practically identical, whether we

[18] See the great collection of facts illustrating the "direct and definite action of the external conditions of life" in "Variation of Animals and Plants," II., p. 271.

[19] With regard to the terminology of stimulation, I believe that it would greatly simplify matters if our classification of causal conditions could be based on the relation of the nucleus to the rest of the cell. But our knowledge does not at present allow of more than a tentative statement of such a scheme. It is now widely believed that the nucleus is the bearer of the qualities transmitted from generation to generation, and the regulator of ontogeny. May we not, therefore,

look at the phenomena of movement or those of structure. If this is allowable—and the weight of evidence is strongly in its favor—a conclusion of some interest follows.

If we reconsider what I have called the indirectness of stimulation, we shall see that it has a wider bearing than is at first obvious. The "internal condition" or "physiological state" is a factor in the regulation of the organism's action, and it is a factor which owes its character to external agencies which may no longer exist.

The fact that stimuli are not momentary in effect but leave a trace of themselves on the organism is in fact the physical basis of the phenomena grouped under memory in its widest sense as indicating that action is regulated by past experience. Jennings[20] remarks: "In the higher animals, and especially in man, the essential features in behavior depend very largely on the history of the individual; in other words, upon the present physiological condition of the individual, as determined by the stimuli it has received and the reactions it has performed. But in this respect the higher animals do not differ in principle, but only in degree, from the lower organisms. . . ." I venture to believe that this is true of plants as well as of animals, and that it is further broadly true not only of physiological behavior, but of the changes that are classed as morphological.

Semon in his interesting book, "Die Mneme,"[21] has used the word *Engram* for the trace or record of a stimulus left on the organism. In this sense we may say that the internal conditions of Pfeffer, the physiological states of Jennings and the internal conditions of Klebs are, broadly speaking, *Engrams*. The authors of these theories may perhaps object to this sweeping statement, but I venture to think it is broadly true.

The fact that in some cases we recognize the chemical or physical character of the internal conditions does not by any means prevent our ascribing a *mnemic* memory-like character to them, since they remain causal agencies built up by external conditions which have, or may have, ceased to exist. Memory will be none the less memory when we know something of the chemistry and physics of its neural concomitant.

consider it probable that the nucleus plays in the cell the part of a central nervous system? In plants there is evidence that the ectoplasm is the sensitive region, and, in fact, plays the part of the cell's sense-organ. The change that occurs in the growth of a cell, as a response to stimulus, would on this scheme be a reflex action dependent for its character on the structure of the nucleus. The "indirectness" of stimulation would then depend on the reception by the nucleus of the excitation set up in the ectoplasm, and the secondary excitation reflected from the nucleus, leading to certain changes in the growth of the cell.

If the nucleus be the bearer of the past history of the individual, the scheme here sketched would accord with the adaptive character of normal reactions and would fall into line with what we know of the regulation of actions in the higher organisms. Pfeffer ("Physiology of Plants," Eng. trans., III., p. 10) has briefly discussed the possibility of thus considering the nucleus as a reflex center, and has pointed out difficulties in the way of accepting such a view as universally holding good. Delage ("L'Hérédité," 2d edition, 1903, p. 88) gives a good summary of the evidence which induces him to deny the mastery of the cell by the nucleus. Driesch, however ("Analytische Theorie der organischen Entwicklung," 1894, p. 81), gives reasons for believing that the cytoplasm is the receptive region, while the nucleus is responsible for the reaction, and it is on this that he bases his earlier theory of ontogeny.

[20] P. 124 (1904).

[21] "Die Mneme, als erhaltendes Prinzip im Wechsel des organischen Geschehens," von Richard Semon, 1te Auflage, Leipzig, 1904; 2te Auflage, 1908. It is a pleasure to express my indebtedness to this work, as well as for the suggestions and criticisms which I owe to Professor Simon personally.

HABIT ILLUSTRATED BY MOVEMENT

In order to make my meaning plain as to the existence of a *mnemic* factor in the life of plants, I shall for the moment leave the morphological side of life and give an instance of habitual movement.

Sleeping plants are those in which the leaves assume at night a position markedly different from that shown by day. Thus the leaflets of the scarlet-runner (*Phaseolus*) are more or less horizontal by day and sink down at night. This change of position is known to be produced by the alternation of day and night. But this statement by no means exhausts the interest of the phenomenon. A sensitive photographic plate behaves differently in light and darkness; and so does a radiometer, which spins by day and rests at night.

If a sleeping-plant is placed in a dark room after it has gone to sleep at night, it will be found next morning in the light-position, and will again assume the nocturnal position as evening comes on. We have, in fact, what seems to be a habit built by the alternation of day and night. The plant normally drops its leaves at the stimulus of darkness and raises them at the stimulus of light. But here we see the leaves rising and falling in the absence of the accustomed stimulation. Since this change of position is not due to external conditions it must be the result of the internal conditions which habitually accompany the movement. This is the characteristic *par excellence* of habit—namely, a capacity, acquired by repetition, of reacting to a fraction of the original environment. We may express it in simpler language. When a series of actions is compelled to follow each other by applying a series of stimuli they become organically tied together, or *associated,* and follow each other automatically, even when the whole series of stimuli are not acting. Thus in the formation of habit *post hoc* comes to be equivalent to *propter hoc.* Action B automatically follows action A, because it has repeatedly been compelled to follow it.

This may be compared with Herbert Spencer's[22] description of an imaginary case, that of a simple aquatic animal which contracts its tentacles on their being touched by a fish or a bit of seaweed washed against it. If such a creature is also sensitive to light the circumstances under which contraction takes place will be made up of two stimuli—those of light and of contact—following each other in rapid succession. And, according to the above statement of the essential character of associative habit, it will result that the light-stimulus alone may suffice, and the animal will contract without being touched.

Jennings[23] has shown that the basis of memory by association exists in so low an organism as the infusorian *Stentor.* When the animal is stimulated by a jet of water containing carmine in suspension, a physiological state A is produced, which, however, does not immediately lead to a visible reaction. As the carmine stimulus is continued or repeated, state B is produced, to which the *Stentor* reacts by bending to one side. After several repetitions of the stimulus, state C is produced, to which the animal responds by reversing its ciliary movement, and C finally passes into D, which results in the *Stentor* contracting into its tube. The important thing is that after many repetitions of the above treatment the organism "contracts at once as soon as the carmine comes in contact with it." In other words, states B and C are apparently omitted, and A passes directly into D, *i. e.,* into the state which gives contraction as a reaction. Thus we have in

[22] "Psychology," 2d edition, 1870, Vol. I., p. 435.

[23] "Behavior of the Lower Organisms," 1906, p. 289.

an infusorian a case of short-circuiting precisely like the case which has been quoted from Herbert Spencer as illustrating association. But Jennings's case has the advantage of being based on actual observation. He generalizes the result as the "law of the resolution of physiological states" in the following words: "The resolution of one physiological state into another becomes easier and more rapid after it has taken place a number of times." He goes on to point out that the operation of this law is seen in the higher organisms, "in the phenomena which we commonly call memory, association, habit-formation, and learning."

In spite of this evidence of mnemic power in the simplest of organisms, objections will no doubt be made to the statement that association of engrams can occur in plants.

Pfeffer, whose authority none can question, accounts for the behavior of sleeping plants principally on the more general ground that when any movement occurs in a plant there is a tendency for it to be followed by a reversal—a swing of the physiological pendulum in the other direction. Pfeffer[24] compares it to a released spring which makes several alternate movements before it settles down to equilibrium. But the fact that the return movements occur at the same time-intervals as the stimuli is obviously the striking feature of the case. If the pendulum-like swing always tended to occur naturally in a twelve-hours' rhythm it would be a different matter. But Pfeffer has shown that a rhythm of six hours can equally well be built up. And the experiments of Miss Pertz and myself[25] show that a half-hourly or quarter-hourly rhythm can be produced by alternate geotropic stimulation.

We are indebted to Keeble[26] for an interesting case of apparent habit among the lower animals. *Convoluta roscoffensis,* a minute wormlike creature found on the coast of Brittany, leads a life dependent on the ebb and flow of the sea. When the tide is out the *Convoluta* come to the surface, showing themselves in large green patches. As the rising tide begins to cover them they sink down into safer quarters. The remarkable fact is that when kept in an aquarium, and therefore removed from tidal action, they continue for a short time to perform rhythmic movements in time with the tide.

Let us take a human habit, for instance that of a man who goes a walk every day and turns back at a given mile-post. This becomes habitual, so that he reverses his walk automatically when the limit is reached. It is no explanation of the fact that the stimulus which makes him start from home includes his return—that he has a mental return-ticket. Such explanation does not account for the point at which he turns, which as a matter of fact is the result of association. In the same way a man who goes to sleep will ultimately wake; but the fact that he wakes at four in the morning depends on a habit built up by his being compelled to rise daily at that time. Even those who will deny that anything like association can occur in plants can not deny that in the continuance of the nyctitropic rhythm in constant conditions we have, in plants, something which has general character of habit, *i. e.,* a rhythmic action depending on a rhythmic stimulus that has ceased to exist.

On the other hand, many will object that even the simplest form of association implies a nervous system. With regard to

[24] See Pfeffer, *Abhandl. K. Sächs. Ges.,* Bd. XXX., 1907. It is impossible to do justice to Pfeffer's point of view in the above brief statement.

[25] *Annals of Botany,* 1892 and 1903.

[26] Gamble and Keeble, *Quar. Jour. Micros. Sci.,* XLVII., p. 401.

this objection it must be remembered that plants have two at least of the qualities characteristic of animals—namely, extreme sensitiveness to certain agencies and the power of transmitting stimuli from one part to the other of the plant body. It is true that there is no central nervous system, nothing but a complex system of nuclei; but these have some of the qualities of nerve cells, while intercommunicating protoplasmic threads may play the part of nerves. Spencer[27] bases the power of association on the fact that every discharge conveyed by a nerve "leaves it in a state for conveying a subsequent like discharge with less resistance." Is it not possible that the same thing may be as true of plants as it apparently is of infusoria? We have seen reasons to suppose that the "internal conditions" or "physiological states" in plants are of the nature of engrams, or residual effects of external stimuli, and such engrams may become associated in the same way.

There is likely to be another objection to my assumption that a simple form of associated action occurs in plants—namely, that association implies consciousness. It is impossible to know whether or not plants are conscious; but it is consistent with the doctrine of continuity that in all living things there is something psychic, and if we accept this point of view we must believe that in plants there exists a faint copy of what we know as consciousness in ourselves.[28]

I am told by psychologists that I must define my point of view. I am accused of occupying that unscientific position known as "sitting on the fence." It is said that, like other biologists, I try to pick out what suits my purpose from two opposite schools of thought—the psychological and the physiological.

[27] "Psychology," 2d edition, Vol. I., p. 615.

[28] See James Ward, "Naturalism and Agnosticism," Vol. I., Lecture X.

What I claim is that, as regards reaction to environment, a plant and a man must be placed in the same great class, in spite of the obvious fact that as regards complexity of behavior the difference between them is enormous. I am not a psychologist, and I am not bound to give an opinion as to how far the occurrence of definite actions in response to stimulus is a physiological and how far a psychological problem. I am told that I have no right to assume the neural series of changes to be the cause of the psychological series, though I am allowed to say that neural changes are the universal concomitants of psychological change. This seems to me, in my ignorance, an unsatisfactory position. I find myself obliged to believe that the mnemic quality in all living things (which is proved to exist by direct experiment) must depend on the physical changes in protoplasm, and that it is, therefore, permissible to use these changes as a notation in which the phenomena of habit may be expressed.

(*To be concluded*)

Francis Darwin

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

The accompanying table gives the number of doctorates of philosophy and science conferred this year and during the preceding ten years by forty-two institutions. In the issue of Science for August 30, 1907, will be found the details for the earlier years. The numbers for the eleven years have been as follows: 236, 224, 239, 255, 224, 270, 289, 325, 326, 327, 366. There has thus been a considerable though irregular increase. Unless the number this year is a chance fluctuation, it represents a gain of 12 per cent. above last year and of 50 per cent. above the figures for six or eight years ago.

Columbia and Chicago gave more degrees, 55 and 54, respectively, than have ever before been granted by any institution in one year. There is no noticeable alteration in the standing of the different universities. Wisconsin has maintained the large advance made last year, and Illinois has conferred five degrees, not a large number, but equal to the total of the preceding ten years. Probably the most important educational advance of the next ten years will be the growth of advanced and research work in the great state universities of the central and western states.

Of 3,093 degrees conferred in the eleven years, 1,416, nearly half, have been in the natural and exact sciences. As shown in Table II., there were this year 184 degrees in these sciences, a gain of 41 over last year. Chicago gave 37 of these degrees, twice as many as any other institution, and takes the position at the head

TABLE I

Doctorates Conferred

	Average of 10 Years 1898–1907	1908	Total for 11 Years 1898–1908
Chicago	35.6	54	410
Harvard	33.8	42	380
Columbia	32.2	55	377
Yale	31.8	32	350
Johns Hopkins	30.5	28	333
Pennsylvania	22.5	32	257
Cornell	18.1	22	203
Wisconsin	8.6	17	103
Clark	8.7	11	98
New York	6.7	15	82
Michigan	6.9	4	73
Boston	4.4	11	55
California	3.3	4	37
Princeton	2.6	6	32
Virginia	2.8	4	32
George Washington	2.8	3	31
Minnesota	2.4	3	27
Brown	2.3	2	25
Bryn Mawr	2.1	4	25
Nebraska	2.0	2	22
Catholic	2.0	1	21
Stanford	1.4	2	16
Iowa	1.1	2	13
Georgetown	1.0	0	10
Illinois	.5	5	10
Washington	.7	1	8
Missouri	.4	3	7
Vanderbilt	.6	1	7
Massachusetts Institute	.3	3	6
Colorado	.5	0	5
North Carolina	.5	0	5
Pittsburg	.1	4	5
Washington and Lee	.4	1	5
Northwestern	.4	0	4
Cincinnati	.3	0	3
Indiana	.0	3	3
Kansas	.3	0	3
Lafayette	.3	0	3
Dartmouth	.1	1	2
Lehigh	.2	0	2
Syracuse	.2	0	2
Tulane	.1	0	1
Total	271.5	378	3,093

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years 1898–1907	1908	Total for 11 Years 1898–1908	Per Cent.
Chicago	16.4	37	201	49
Johns Hopkins	16.8	17	185	56
Columbia	13.4	21	155	41
Harvard	14.1	13	154	41
Yale	12.4	16	140	40
Cornell	10.4	15	119	59
Pennsylvania	9.0	18	108	42
Clark	7.7	11	88	90
Wisconsin	2.8	6	34	33
Michigan	2.9	1	29	40
California	2.4	2	26	70
George Washington	1.7	2	19	61
Brown	1.2	2	14	56
Nebraska	1.3	1	14	64
Princeton	1.1	3	14	43
Stanford	1.1	2	13	81
Virginia	1.1	2	13	41
Bryn Mawr	1.0	1	11	44
Minnesota	.7	1	8	30
Washington	.7	1	8	100
Iowa	.7	0	7	54
New York	.6	1	7	9
Massachusetts Institute	.3	3	6	100
Catholic	.5	(b)	5	25
Missouri	.3	2	5	71
Vanderbilt	.3	1	4	57
Washington and Lee	.3	1	4	80
Illinois	.3	0	3	30
Indiana	.0	3	3	100
Kansas	.3	0	3	100
North Carolina	.3	0	3	60
Colorado	.2	0	2	40
Dartmouth	.1	1	2	100
Lehigh	.2	0	2	100
Northwestern	.2	0	2	50
Boston	.1	0	1	2
Cincinnati	.1	0	1	33
Georgetown	.1	0	1	10
Lafayette	.1	0	1	33
Syracuse	.1	0	1	50
Total	123.2	184	1,416	46

of the list hitherto held by Johns Hopkins. Columbia with 21 degrees takes the third place, held last year by Harvard. Pennsylvania, with 18 degrees, much exceeds any previous year, and Yale and Cornell with 16 and 15 degrees, respectively, surpass their records in all but one year. Harvard and Johns Hopkins, on the other hand, show losses. These figures have, however, no considerable significance, as chance fluctuations of this size are likely to occur. The last column shows the percentages of the degrees which were in the sciences, there being considerable differences in the different institutions. Thus at Cornell and Johns Hopkins nearly 60 per cent. of the degrees are in the sciences, whereas, at Harvard, Yale and Columbia the percentage is about forty. At Clark it is ninety; at New York University it is nine and at Boston University two.

TABLE III

	Average of 10 Years 1898–1907	1908	Total for 11 Years 1898–1908
Chemistry	32.0	54	374
Physics	15.5	22	177
Zoology	14.7	25	172
Psychology	13.4	23	157
Mathematics	12.1	23	144
Botany	12.6	11	137
Geology	7.1	5	76
Physiology	4.1	7	48
Astronomy	3.4	1	35
Paleontology	1.6	1	17
Bacteriology	1.4	1	15
Anthropology	1.0	4	14
Agriculture	1.0	2	12
Anatomy	.9	2	11
Engineering	.8	0	8
Mineralogy	.6	0	6
Pathology	.5	2	7
Metallurgy	.3	0	3
Geography	.1	1	2
Meteorology	.1	0	1
Total	123.2	184	1,416

In Table III. the details for the several sciences are given. Chemistry shows a marked increase over any preceding year with as usual about double as many degrees as physics and zoology. Psychology, mathematics and botany follow closely, and there is then a drop to geology, physiology and astronomy. As has been noted in previous reports no strict line can be drawn between the natural and exact sciences, on the one hand, and philosophy, history and the languages, etc., on the other. The scientific method is increasingly applied in these subjects, and this tendency is probably more evident in the doctors' theses than elsewhere. The number of degrees given in these subjects this year was as follows: History, 32; English, 30; philosophy, 25; economics, 17; Germanic languages, 14; Romance languages, 12; Greek, 13; Latin, 12; Oriental languages, 9; political science, 9; education, 6; theology, 7; sociology, 6; law, 1; music, 1.

The institutions which led this year in conferring degrees in the different sciences were as follows: In *chemistry*, Chicago, Johns Hopkins and Pennsylvania, 7 each; in *physics*, Johns Hopkins 7, Yale 6; in *zoology*, Chicago 6, Pennsylvania 5; in *psychology*, Clark 6, Chicago and Columbia 5; in *botany*, Chicago 5; in *mathematics*, Chicago 6, Yale 4; in *geology*, Yale 3.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO

Edith Ethel Barnard: "The Effect of Electrolytes and Non-electrolytes on the Catalysis of Imido Esters."

Katharine Blunt: "A Study in Catalysis: The Formation of Amidines."

Robert Lacey Börger: "On the Determination of Ternary Linear Groups in a Galois Field of Order p^2."

Willey Denis: "On the Behavior of Various Aldehydes, Ketones and Alcohols toward Oxidizing Agents."

June Etta Downey: "Control Processes in

Handwriting; An Experimental Study of Verbal Imagery."

Grace Maxwell Fernald: "The Phenomena of Peripheral Vision as affected by the Brightness of Background and by Dark Adaptation."

Robert Anderson Hall: "A Study in Catalysis: The Formation of Guanidines from Isourea Esters."

Louis Ingold: "Vector Interpretation of Symbolic Parameters."

Nels Johann Lennes: "Curves in Non-metrical Analysis Situs with Applications to the Calculus of Variations and Differential Equations."

Frederick William Owens: "The Introduction of Ideal Elements and Construction of Projective n-space in Terms of a Planar System of Points involving Order and Desargues's Theorem."

Lula Pace: "Fertilization in Cypripedium."

Joseph Peterson: "Ohm's Law in relation to some Secondary Phenomena of Hearing."

Frank Henry Pike: "The Resuscitation of the Respiratory and Other Bulbar Nervous Mechanisms, with special reference to the Question of their Automaticity."

William Horace Ross: "On the Relation between the Radioactivity and the Composition of Thorium and Uranium Minerals."

Louis Agassiz Test: "A Study in Catalysis; The Rearrangement of Ortho-aminophenyl Esters."

Norman Richard Wilson: "Isoperimetrical Problems which are Reducible to Non-isoperimetrical Problems."

George Winchester: "The Effect of Temperature upon the Discharge of Electricity from Metals illuminated by Ultra-violet Light."

Oliver Charles Clifford: "Determination of the Susceptibility of Copper and Tin and their Alloys."

Frederick Valentine Emerson: "The Geographic Interpretation of New York City."

Louis Allen Higley: "The Action of Sodium and of Sodium Alcoholates on Various Esters of Acetic Acid."

Edwin Garvey Kirk: "The Histogenesis of Gastric Glands."

Frank Eugene Lutz: "The Variations and Correlations of the Taxonomic Characters of Gryllus."

Roy Lee Moodie: "Contribution to a Monograph of the North American Extinct Amphibia."

Florence Ella Richardson: "A Study of Sensory Control in the Rat."

Mary Emily Sinclair: "On a Compound Discontinuous Solution connected with the Surface of Revolution of Minimum Area."

Charles Christopher Adams: "The Geographic Variations and Relations of Io."

Mary Blount: "The Early Development of the Pigeon's Egg from Fertilization to the Organization of the Periblast."

Leonas Lancelot Burlingame: "Staminate Cone of Podocarpus."

Wallace Craig: "Expression of the Emotions in the Pigeons."

Reginald Ruggles Gates: "A Study of Reduction in *Œnothera rubrinervis*."

Herbert Marcus Goodman: "Active and Passive Immunity to Diphtheria Toxin."

Leroy Harris Harvey: "The Prairie Grass Formation of Southeastern South Dakota."

John Thomas Patterson: "Gastrulation in the Pigeon's Egg."

Charles Houston Shattuck: "Origin of Heterospery in Marsilia."

Ralph Edward Sheldon: "The Olfactory Tracts and Centers in Fishes."

George Washington Tannreuther: "History of the Germ Cells and Early Embryology of Certain Aphids."

Clarence Stone Yoakum: "An Experimental Study of Mental Fatigue."

COLUMBIA UNIVERSITY

Warner Brown: "Time in English Verse Rhythm."

Frank G. Bruner: "The Hearing of Primitive Peoples."

Gertrude Simmons Burlingham: "A Study of the Larctariæ of the United States."

Elizabeth Buchanan Cowley: "Plane Curves of the Eighth Order having Two Fourfold Points with Distinct Tangents and no other Point Singularities."

Norman Edward Ditman: "Opsonins and Vaccines in Medicine and Surgery."

Claude Russell Fountain: "The Spherical Emission of a Righi Vibrator."

Sven Froeberg: "The Relation between the Magnitude of the Stimulus and the Time of Reaction."

Francis Marion Hamilton: "The Perceptual Factors in Reading."

Eric Higgins: "The Temperature Coefficient of the Weight of a Falling Drop as a Means of Estimating the Molecular Weight and the Critical Temperature of a Liquid."

Homer Doliver House: "North American Species of the Genus *Ipomœa*."

Elmer Ellsworth Jones: "A Comparison of

Mental States in the Horizontal and Vertical Positions of the Body."

Farel Louis Jouard: "3-Amino-o-Phthalic Acid and Certain of its Derivatives."

Robert Harry Lowie: "The Test-theme in North American Mythology."

Daniel Ralph Lucas: "Physiological and Pharmacological Studies of the Ureter (III.)."

Clarence Earl May: "Oxygen Ethers of the Type —N:C·(OR), derived from Certain Nitrogen Heterocycles."

Arnold William Meyer: "The Determination of Diastatic Power by the Saccharification of Soluble Starch."

Leighton B. Morse: "The Selective Reflection of Salts of Carbonic and other Oxygen Acids."

Matthew Steel: "The Influence of Magnesium Sulphate on Nitrogenous Catabolism in Dogs, with Special Reference to the Distribution of Nitrogen among the Constituents of the Urine."

Reston Stevenson: "The Weight of a Falling Drop and the Laws of Tate. The Determination of the Molecular Weights and Critical Temperature of Liquids by the Aid of Drop Weights."

Frederick Seymour Weingarten: "The Influence of Internal Hemorrhage on Chemical Changes in the Organism, with particular reference to Proteid Catabolism."

William Henry Welker: "Some Observations on the Excretion of Nitrogenous Substances in the Urine of Dogs under Conditions of Diminished Oxidation induced by Potassium Cyanide."

UNIVERSITY OF PENNSYLVANIA

William Milton Barr: "A Study of the Spectrum and Bromides of Columbium."

William Blum: (*A*) "Experiments on the Atomic Weight of Cadmium." (*B*) "Derivatives of Complex Inorganic Acids."

James Edmund Bryan: "A Statistical and Clinical Study of the Children in the Elementary Schools in the City of Camden, New Jersey, in the School Year 1905–6, with a view to determining the Extent and Conditions of Retardation."

George Gailey Chambers: "The Groups of Isomorphisms of the Abstract Groups of Order p^2q."

Harold Sellers Colton: "Some Effects of Environment on the Growth of *Lymnæa columella* Say."

Margaret Harris Cook: "Spermatogenesis in Lepidoptera."

Lloyd Cadie Daniels: "Some New Derivatives of Complex Inorganic Acids."

Harrison Hale: "An Electrolytic Method of Analyzing Zinc Ores."

Jacob Daniel Heilman: "A Clinical Study of One Thousand Retarded or Over-age Children in the Public Schools of Camden, New Jersey."

Mary Elizabeth Holmes: "The Use of the Rotating Anode in Electrolytic Separations."

Merkel Henry Jacobs: "The Effects of Desiccation on the Rotifer *Philodina roseola.*"

George Irving Kemmerer: "The Atomic Weight of Palladium."

Jacob Buehrle Krause: "The Modification of the Reaction-time due to Variation of the Preparation."

Herbert Guy Kribs: "The Behavior of Æolosoma."

John Ahlum Schaeffer: "Double Fluorides of Titanium."

Frank Gouldsmith Speck: "Ethnology of the Yuchi Indians."

Charles Vuilleumier: "The Distribution of the Values of Reactions to Sound in Twenty-four Hundred Consecutive Reactions with Each of Four Subjects."

Louise Baird Wallace: "The Spermatogenesis of *Agalena nævia.*"

JOHNS HOPKINS UNIVERSITY

Marshall Perley Cram: "The Fractionation of Crude Petroleum by Capillary Filtration."

Ernest Elisha Gorsline: "A Study of the Claisen Condensation."

John Sharshall Grasty: "The Limestones of Maryland."

Lars Olai Grondahl: "Synchronous Commutation as a Method for Transformation from Alternating to Direct Current."

David Vance Guthrie: "The Ultra-violet Absorption Spectra of Certain Metallic Vapors and their Mixtures."

Felix Edward Walsh Hackett: "The Resonance and Magnetic Rotation Spectra of Sodium Vapor."

Herbert Eugene Ives: "An Experimental Study of the Lippmann Color Photograph."

Carl Alfred Jacobson: "The Conductivity and Ionization of Electrolytes in Aqueous Solutions as conditioned by Temperature, Dilution and Hydrolysis."

Edward G. Mahin: "Conductivity and Viscosity of Dilute Solutions of Lithium Nitrate and Cadmium Iodide, in Binary and Ternary Mixtures of Acetone with Methyl Alcohol, Ethyl Alcohol and Water."

Brainerd Mears: "The Osmotic Pressure of Cane Sugar Solutions at 15° Centigrade."

Harmon Vail Morse: "The Osmotic Pressure of Cane Sugar Solutions at 10°."

Edward Charles F. Phillips: "On the Pentacardioid."

Harvey Clayton Rentschler: "Dispersion of Gases."

William Frederick Schulz: "The Effect of a Magnetic Field upon the Absorption Spectra of Certain Rare Earths."

William Walker Strong: "Ionization in Closed Vessels."

James McIntosh Johnson: "Studies in Catalysis."

Ivey Foreman Lewis: "The Life History of *Griffithsia bornetiana.*"

YALE UNIVERSITY

Stanley Rossiter Benedict: "Experimental Studies on the Metabolism of Magnesium and Calcium."

Earl Gordon Bill: "An Apriori Existence Theorem for Three Dimensions in the Calculus of Variations."

Theodore Harding Boggs: "The Influence exerted by the United Empire Loyalists on the Life and Politics of Nova Scotia and New Brunswick."

Walter Minor Bradley: "The Analysis and Chemical Composition of the Mineral Warwickite."

Samuel Hopkins Clapp: "Researches on Pyrimidine Derivatives."

William Allen Drushel: "The Quantitative Estimation of Potassium."

Frank Nugent Freeman: "The Habit of Handwriting and its Development, an Experimental Study."

Ruth Sawyer Harvey: "Drainage and Glaciation in the Central Housatonic Basin."

Frederick William Heyl: "Researches on Pyrimidines."

Francis Jerome Holder: "Multiple Series."

Francis Baker Laney: "The Gold Hill Mining District of North Carolina" (2 parts, texts and maps).

Ernest Barnes Lytle: "Multiple Integrals over Iterable Fields."

Howard Douglass Newton: "On some New Relations of Titanium in Analysis: The Volumetric Estimation of Titanium, of Iron in Presence of Titanium, and of Iron and Vanadium after Reduction with Titanous Sulphate."

Perry Blaine Perkins: "A Determination of the Molecular Weight of Radium Emanation by comparing its Rate of Diffusion with that of Mercury Vapor."

Freeman Ward: "Geology of the New Haven-Branford Region."

Euphemia Richardson Worthington: "Some Theorems on Surfaces."

CORNELL UNIVERSITY

Joseph Herschel Coffin: "An Analysis of the Action Consciousness based on the Simple Reaction."

Clyde Firman Craig: "On a Class of Hyperfuchsian Functions."

Herbert Grove Dorsey: "Coefficient of Linear Expansion at Low Temperatures."

Claude Wilbur Edgerton: "Studies on the Physiology and Development of some Anthracnoses."

Willard James Fisher: "The Temperature Coefficients of Gas Viscosity."

Percy Hodge: "An Experimental Study of Photo-active Cells with Fluorescent Electrolytes."

Reuben Edson Nyswander: "The Absorption and Reflection of Calcite and Aragonite for Infrared Rays as dependent upon the Plane of Polarization."

Clarence Albert Pierce: "Thermo-phosphorescence."

Carl George Schluederberg: "Actinic Electrolysis."

George Daniel Shafer: "Structure and Development of the Eyes of Certain Spiders."

John William Turrentine: "Contributions to the Chemistry of Hydrazine."

Anna Lavinia Van Benschoten: "The Birational Transformations of Algebraic Curves of Genus Four."

Paul J. White: "An Agricultural Survey of Tompkins County, New York."

Frances Gertrude Wick: "Some Electrical Properties of Silicon."

Albert Hazen Wright: "The Anura of Ithaca."

HARVARD UNIVERSITY

Percy Williams Bridgman: "Mercury Resistance as a Pressure Gauge."

Manton Copeland: "Spermatogenesis in Apis and Vespa."

Harry Louis Frevert: "Investigations in Chemical Thermodynamics."

Eliott Park Frost: "The Psychology and Correlation of Individual Differences."

Frank Irwin: "The Invariants of Linear Differential Expressions."

Grinnell Jones: (I.) "The Atomic Weights of Sulphur and Phosphorus." (II.) "The Compressibilities of certain Salts."

Joseph Abraham Long: "The Maturation of the Egg of the Mouse."

Joseph Howard Mathews: "A Study of Compressibility and its Relation to various other Physical Properties of certain Organic Compounds."

Charles Napoleon Moore: "On the Theory of Convergence Factors and some of its Applications."

Rollin Clarke Mullenix: "The Peripheral Terminations of the Eighth Cranial Nerve in Vertebrates, especially in Fishes."

Arthur Sperry Pearse: "The Reactions of Amphibians to Light."

Conrad Louis Benoni Shuddemagen: (I.) "The Demagnetizing Factors for Cylindrical Iron Rods." (II.) "A Study of Residual Charge in Dielectrics."

John Hunt Wilson: (I.) "A Revision of the Atomic Weight of Lead." (II.) "Energy Changes involved in the Dilution of Amalgams of Thallium, Indium and Tin."

CLARK UNIVERSITY

Ernest William Coffin: "On the Education of Backward Races."

Herbert Burnham Davis: "The Raccoon: A Study in Animal Intelligence."

Charles Wilson Easley: "Partial Vapor Tensions of Binary Mixtures."

Willis Lloyd Gard: "Some Neurological and Psychological Aspects of Shock."

James William Harris: "The Development of the Esthetic Interest in Children."

Newton Miller: "The Biology of the American Toad."

George Ordahl: "Rivalry; its Genetic Development and Pedagogy."

Caroline Amelia Osborne: "The Sleep of Infancy as related to Physical and Mental Growth."

William Louis Prager: "Steric Hindrances in Esterification."

Hermon Lester Slobin: "On Plane Quintic Curves."

Jesse Hayes White: "Relations of the Racial and Individual Social Instincts."

UNIVERSITY OF WISCONSIN

Alfred Newton Cook: "Phenyl Ether and some of its Derivatives."

Robert Wilhelm Hegner: "The Early Development of the Germ Glands of some Chrysomelid Beetles."

Warren DuPré Smith: "Coal Deposits of Batan Island."

Charles Austin Tibbals: "A Study of the Tellurides."

Charles Taylor Vorhies: "Studies on the Trichoptera of Wisconsin."

Henry Charles Wolff: "The Continuous Plane Motion of a Liquid bounded by Two Right Lines."

INDIANA UNIVERSITY

Walter Louis Hahn: "The Habits and Reactions of the Cave Bats."

Dennis Emerson Jackson: "Some Experimental Observations upon the Prolonged Existence of Adrenalin in the Blood."

Mrs. Effa Funk Muhse: "The Cutaneous Glands of the Toad."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

George Alonzo Abbott: "A Physico-chemical Study of Ortho- and Pyro-phosphoric Acids and of their Sodium and Ammonium Salts."

Charles Angus Kraus: "Solutions of Metals in Non-metallic Solvents."

Edward Wight Washburn: "Ionic Hydration and True Transference Numbers."

PRINCETON UNIVERSITY

Fay Cluff Brown: "The Ions emitted from Platinum and their Kinetic Energy."

George MacFeely Conwell: "The 3-space P. G. (3, 2) and its Group."

Lionel Herman Duschak: "Studies of the Silver Coulometer."

BROWN UNIVERSITY

Maurice Louis Dolt: "The Action of Acetic Anhydride on para Methoxy Phenyl Propiolic Acid, and on Methylene Ether of 3-4 Dihydroxy Phenyl Propiolic Acid."

Philip Bardwell Hadley: "The Development and Behavior of the American Lobster."

UNIVERSITY OF CALIFORNIA

Samuel Alfred Barrett: "Pomo Indian Basketry."

James Grant Davidson: "Function of the Electrodes in Conduction through Flames and Gases."

GEORGE WASHINGTON UNIVERSITY

Frank Cummings Cook: "Phosphorus Metabolism Experiments."

Clara Southmayd Ludlow: "The Mosquitoes of the Philippine Islands; the Distribution of Certain Species and their Occurrence in Relation to the Incidence of Disease."

UNIVERSITY OF MISSOURI

Charles Brooks: "The Fruit Spot of Apples; a Morphological and Physiological Study."

Caroline McGill: "The Structure of Smooth Muscle in the Resting and in the Contracted Condition."

LELAND STANFORD JUNIOR UNIVERSITY

William Draper Harkins: "Papers on Smelter Smoke."

Mary Isabel McCracken: "Studies in Heredity."

UNIVERSITY OF VIRGINIA

William Allison Kepner: "The Nutrition of the Ovum of *Scolia dubia*."

John Jennings Luck: "The Structures of the Non-integrable Groups of Seven Parameters."

BRYN MAWR COLLEGE

Helen Elizabeth Schaeffer: "A Study of the Electric Spark in a Magnetic Field."

DARTMOUTH COLLEGE

Leland Griggs: "The Early Development of the Nervous System of Amblystoma."

UNIVERSITY OF MICHIGAN

John Serenus Bordner: "The Longitudinal Traction on the Formation of Mechanical Tissue in Plant Stems."

UNIVERSITY OF MINNESOTA

Henry Anton Erikson: "The Ionization of Gases at High Pressures."

UNIVERSITY OF NEBRASKA

Leroy Dey Swingle: "The Development of a Herpetonionadine Parasite of the Sheep-tick." "The Embryology of *Myosurus minimus*."

NEW YORK UNIVERSITY

Martin A. Rosanoff: "Determination of Chlorides and Bromides in the presence of Cyanides."

VANDERBILT UNIVERSITY

James Harrison Scarborough: "The Computation of the Orbit of Planet."

WASHINGTON UNIVERSITY

Henri Theodore Antoine Hus: "An Ideal Ecological Cross-section of the Mississippi River in the Vicinity of St. Louis, Mo."

WASHINGTON AND LEE UNIVERSITY

Mosby Garland Perrow: "Determination and Comparison of the Atomic Volume Contraction in the Isomorphous Series, $R'M'''(SO_4)_2 \cdot 12H_2O$ and $R_2'M''(SO_4)_2 \cdot 6H_2O$."

SCIENTIFIC NOTES AND NEWS

DR. L. H. BAILEY, of Cornell University, has consented to accept the chairmanship of the commission appointed by President Roosevelt to report upon the social and economic conditions of agricultural life.

OXFORD University will confer the degree of doctor of science on Professor Svante Arrhenius and on Dr. Vernon Harcourt on October 8, on the occasion of the celebration of the jubilee of the University Museum.

ON the occasion of the recent unveiling of the Bunsen monument at Heidelberg, honorary doctorates were conferred on Professor Adolf von Baeyer, and on Professor J. H. van't Hoff.

A COMMITTEE has been formed in England to present a national testimonial to Mr. Francis George Heath in recognition of his labors in arousing public interest in the preservation of open spaces, woods and forests.

THE staff of the Division of Pharmacology of the Hygienic Laboratory, Washington, D. C., has been enlarged by the following appointments: Dr. W. H. Schultz, formerly instructor in physiology and pharmacology, University of Missouri; Dr. Worth Hale, formerly instructor of pharmacology, University of Michigan; Dr. M. G. Motter, formerly professor of physiology at Georgetown University and secretary of the Board of Trustees of the United States Pharmacopœia, and Mr. W. I. Wilbert, formerly of the German Hospital, Philadelphia. The addition to the Hygienic Laboratory, provided for by congress a year ago, is nearing completion; it will enable the laboratory to extend its work considerably.

MR. GEORGE L. FAWCETT, for three years laboratory assistant in the United States Subtropical Laboratory at Miami, Florida, has been transferred to the Porto Rico Experiment Station at Mayaguez, where he is to be plant pathologist. This promotion takes effect on September 15.

Dr. W. H. Willcox, lecturer at St. Mary's Hospital Medical School, London, has been appointed senior scientific analyst to the British Home Office in succession to the late Sir Thomas Stevenson.

Dr. Eric A. Nobbs has been appointed director of agriculture in Rhodesia. He was graduated in agricultural science at the University of Edinburgh in 1899 and for the last six years he has been agricultural assistant to the Cape government.

Dr. Heinrich Moritz has been appointed director of the Observatory of Rio de Janeiro.

Dr. von der Borne has been given charge of the earthquake station at Krietern, near Breslau.

Mr. Robert Newstead, the lecturer in economic entomology and parasitology in the Liverpool School of Tropical Medicine, will go to Jamaica in the first week of November to undertake the investigation of the ticks there responsible for certain diseases in animals, and of disease-bearing insects. He may be accompanied by a medical research investigator, whose duties would be to investigate indigenous diseases of the island.

Dr. Sven Hedin's family, at Stockholm, has received the following telegram from the secretary to the viceroy of India, dated Simla, August 31: "Dr. Sven Hedin is well after a hard and successful journey. He reaches Simla early in September and sends you hearty greetings."

In spite of a heavy sea, the *Pourquoi Pas* left Cherbourg, on August 31, for Madeira. Mme. Charcot and Mme. Waldeck-Rousseau will leave the vessel at Buenos Ayres.

On the occasion of the celebration of the fiftieth anniversary of the foundation of the University Museum, Oxford, a bust will be unveiled of the late Professor Weldon, who held the Linacre chair of comparative anatomy until his death in 1906.

Dr. Ernst Loeb, the botanist, has died at Berlin at the age of sixty-six years.

Dr. Max Rosenmund, professor of topog-

Dr. L. P. Barclay, formerly representing the Bausch and Lomb Optical Company, died on September 1, at the Loomis Sanatorium, Liberty, N. Y.

Dr. Henry Youle Hind died at Windsor, Nova Scotia, in August, at the age of eighty-five years. He was a native of Nottingham, England, but came to Canada in 1847, after receiving his education at Leipzig, Cambridge and in France. He was geologist to the Red River exploring expedition in 1857, and had charge of the Assiniboine and Saskatchewan expedition of the following year. He explored a part of Labrador in 1861, made a preliminary geological survey of New Brunswick in 1864, examined at a later date the gold districts of Nova Scotia, and explored mineral lands in Newfoundland in 1876.

According to the London *Times* active preparations have been in hand for some time past in England and in New Zealand for the despatch of relief food-supplies and equipment for Lieutenant Shackleton and his comrades to McMurdo Sound in the Antarctic regions, where they are wintering preparatory to the sledge journeys to the south, east and west at the beginning of October. The supplies from London were shipped to Lyttelton, New Zealand, by the Royal mail steamer *Paparoa*, on September 3, and from Liverpool by the steamship *Surrey*, where they will be put on board the *Nimrod;* but meats, butter, cheese, woolen goods, etc., will be procured in New Zealand. The *Nimrod* will take food-supplies for thirty-eight men for one year, to provide against the possibility of being frozen in. A number of firms have made the expedition presents of their own commodities. The *Nimrod* will leave Lyttelton for the Antarctic on December 1, and she is at present in dry dock in that port undergoing repairs. The *Nimrod* left Lieutenant Shackelton and his party in the best of health at McMurdo Sound base, 77½ degrees south latitude, on February 22, and she returned to Lyttelton. She successfully landed all the stores at the above base before sailing, viz.: portable house, 33 feet by 19 feet by 8 feet; acetylene gas plant; two years' food-supplies, equipment, ponies, dogs, motor-car, coal, oil, etc., in fact everything neces-

raphy at the Zurich Polytechnic School, has died at the age of fifty-one years.
sary to make their stay there warm and comfortable for the winter. Captain F. P. Evans, R.N.R., by permission of Sir James Mills, chairman of the Union Steamship Company, of New Zealand, will command the *Nimrod* on her voyage to the Antarctic. It is hoped that news from the Antarctic will be received about March or April, 1909.

A TELEPHONE line has been installed to provide means of communication between the Queen Margherita Observatory on the Gniffet Peak, on Monte Rosa, and the observatory lower down the mountain. The carrying out of this line entailed many difficulties; the higher observatory is 14,960 feet above the sea. This building is only open for two months each year in the middle of summer.

UNIVERSITY AND EDUCATIONAL NEWS

THE regents of the West Virginia University, at their meeting in June, voted an increase of 10 per cent. in the salaries of all members of the faculty above the rank of instructor.

THE Board of Education of New York City asks for $33,031,484.65 for the schools in the coming year, an increase of $6,258,521.06 over 1908. The increase of about $5,500,000 for this year is largely due to the proposed increase of teachers' salaries, this alone occasioning an increase in the budget of $3,273,163.52. It is estimated that the increase in the number of pupils for 1909, will be nearly 25,000. To provide a teaching staff for the increased registration in the elementary schools alone will require employment of 9 men principals, 2 women principals, 3 male assistants to principals, 15 assistants to women principals, 102 men teachers, 636 women teachers, and 82 kindergartners, at a total additional expense of $136,315.47.

LEIPZIG UNIVERSITY will celebrate the five hundredth anniversary of its foundation in July of next year.

THE foundations of the new hall of engineering of the University of Nebraska have been completed, and work has begun on the superstructure. The sum appropriated for this building is approximately $100,000, and it is hoped to have it completed by the opening of the fall semester in 1909.

THE newspapers *Reich* and *St. Petersburger Zeitung*, have been fined $1,500 each for publishing articles criticizing the policies of Mr. Schwartz, the new minister of education. He is said to have issued an order that all university professors and instructors belonging to the constitutional democratic party should either renounce their political principles or give up their positions.

IT is reported that ten members of the faculty of the College of Physicians and Surgeons, San Francisco, have resigned.

PROFESSOR ARTHUR DEXTER BUTTERFIELD, for ten years professor of mathematics in the University of Vermont, has accepted a similar position in the Worcester (Mass.) Polytechnic Institute, from which he was graduated in 1892 and in which he was formerly instructor.

DR. GEORGE A. COE, professor of philosophy at the Northwestern University, has been appointed to a chair in the Union Theological Seminary, New York City.

DR. ERNST A. BESSEY, pathologist in the United States Department of Agriculture, for the past three years in charge of the United States Subtropical Laboratory of Miami, Florida, has been elected to the professorship of botany in the University of Louisiana, at Baton Rouge. He will assume his new duties on October 20.

LIEUT.-COLONEL BOURGEOIS, chief of the geodetic section of the French Army Geographical Service, has been appointed to the chair of astronomy and geodesy in the Paris École polytechnique, vacant by the resignation of M. Poincaré.

DISCUSSION AND CORRESPONDENCE

SCHAEBERLE AND GEOLOGICAL CLIMATES

TO THE EDITOR OF SCIENCE: In Professor Schaeberle's last communication to SCIENCE, June 5, p. 894, he makes the statement that "it now rests solely with the scientists to demonstrate, if possible, that some vital flaw exists in my (Schaeberle's) published work (upon the effective surface temperature of the sun and the temperature of space); so long as this can not be done, 'most modern theories' of geological climate must certainly be regarded as 'upset,' *for these theories are based upon an adopted value for the temperature of space which is* (according to my [Schaeberle's] demonstration) *too great by nearly three hundred degrees of the centigrade scale* at the earth's distance from the sun, etc." (italics original).

Statements as sweeping as these in the columns of Science, as pointed out by Lane in answer to an earlier communication, appear to call for some comment for the benefit of those of your readers who are neither geologists nor astronomers. In answer it may be stated that an inspection of recent geological literature in the special mediums of geological publication shows that all articles dealing with actual details of geological climates are based *not upon considerations of the temperature of space,* but upon *detailed studies of the geological record.* It is the effort of modern theory upon ancient climates to meet this evidence and the lines of theory are determined by the definiteness and complexity of the facts to be explained rather than by any assumption in regard to the temperature of space.

A generation ago, when but little was definitely known in regard to geologic climates, theoretical calculations as to what conditions could, should, or would have prevailed at the base of the atmosphere, would have had some weight. At present a study of the stratigraphic record to find what actually were the conditions is much more definite and profitable. The results of such study have been to show an oscillation of widespread climatic conditions from glacial to torrid and from humid to semi-arid, or arid, reaching back to the very beginning of the sedimentary rocks; extreme oscillations of shorter period being superimposed upon others of more general character and æon-long in their duration. At times climates appear to have been widely uniform, a feature whose explanation has been sought in hypotheses of changes in character of lands, in ocean currents, in atmospheric composition, or in solar diameter. But at other times, as in the Permian, climates seem to have been distinctly local, though the geologic, or time, contrasts in climates have been in general more striking than the geographic, or space, variations. Perhaps the heaviest blow which has been struck recently at the older hypothesis of a simple climatic evolution from a primitive, uniform, torrid condition is found in the work of Coleman, who has presented the evidence of a glacial period practically at the beginning of the sedimentary record in North America. The advance of knowledge in regard to geological climates, as in so many other fields, has been away from simplicity toward complexity.

In view of these conclusions by well-qualified geologists Manson's hypothesis of an earth self-heated and protected by a cloud envelope until the Tertiary, which Schaeberle considers that he has demonstrated as a true theory, and which has recently been picturesquely written up by Percival Lowell for the *Century* magazine as the assured dictum of geology, must be regarded as in no measure adequate to explain the facts. If that hypothesis is not to be relegated to the scientific scrap heap it must either be very greatly modified or its supporters must break down the conclusions in regard to geologic climates which have made it unavailable as an explanation. Until this is done it must be regarded as an unsupported speculation.

It would also add definiteness to that hypothesis if its advocates would make it quantitative by stating the amount of thermal energy now actually delivered by the earth's interior to its surface in unit time, basing this calculation upon the thermal conductivity of rock and the temperature gradient. For applying the hypothesis to past times the favorable sub-hypothesis should be postulated of assuming that the earth is simply a cooling body unwarmed by radio-active or other internal activities, since this permits a more rapid delivery of heat in the past. For the purposes of such a calculation also, the surface may be assumed to have remained of practically constant temperature, compared to the earth's interior; since by the terms of the hypothesis the soil has been the seat of living beings during much of the time of cooling.

Furthermore, the rate of outflow of heat is determined solely by the temperature difference on the two sides of a rock layer, and a cloud envelope could only retard such outflow through materially raising the temperature of the surface rock and diminishing the temperature difference on the two sides of the outer zone. This is something which, as shown above, has not taken place, and consequently the delivery of thermal energy from the interior to the surface of a cooling earth may be computed for any fraction of its age. The evolution of life must be restricted to the later portions of the hypothetical cooling process, since, as Lane has pointed out,[1] rocks seem to have been buried in early times to as great a depth as now without metamorphism, save where mashed or injected. To cite a specific instance—the Belt terrane of Montana and Idaho shows formations which were buried to a depth of several miles in pre-Cambrian times, now almost if not quite as unmetamorphic as the Triassic formations of the eastern United States.

The actual thermal energy per unit time now and in past times received from the earth's interior, thus computed, could be compared with that determined by measurement as received in unit time from the sun and without reference to the actual temperatures of either earth or sun. Even in spite of much error in regard to the fundamental constants, unless some surprising error in previous methods is developed, such a calculation would show the earth to contribute but a negligible fraction and would indicate to what an extent a hypothetical cloud envelope and early atmosphere of assumed composition would have to operate as an impermeable blanket to make up for the hypothetical deficiency in solar radiation. Having drawn this thermally opaque envelope about the earth, the Mansonians must next demonstrate how light was able to penetrate to permit the building up of vegetable protoplasm and give employment to the eyes of animals during the Paleozoic and Proterozoic ages.

Joseph Barrell

[1] Science, April 10, 1908, p. 591.

QUOTATIONS

THE PUBLIC HEALTH

Professor William T. Sedgwick's address on "The Call to Public Health" has been printed in a recent number of Science, and the perusal of it can not fail to be instructive and inspiring. The health of the public must necessarily be based upon the health of individuals, yet when one speaks of the public health he has in mind something much broader and much more important than the health of isolated members of the community. The public health means the health question socialized, and this broadening of the base so as to include whole populations has arisen from the conception, made vital by modern science, that the health of the individual immediately concerns his family, his neighbor and his city. There is a community of interests vitally affecting human life which makes the public health of importance to the municipality and the state; and, as Professor Sedgwick easily shows, this is a development that has come very late in modern civilization, and to-day calls for a greater degree of attention than has ever before been given to it.

A certain selfishness, or indifference to others, that has naturally resulted from the old individualism, has until recent years blinded the majority of people to the necessary relation between individual and public health. The main concern of the average man has been to keep himself and his family well; all others he had no interest in. He paid the doctor's bills for professional services in the family circle, and there his responsibility ended. Modern science has shaken this form of indifference by demonstrating the preventability of most contagious and infectious diseases. Epidemics have been studied enough to convince the average man that their spread in a normal, civilized community is nothing less than a wanton massacre of the innocents. And the helplessness of the individual, even when attended by the best of medical practitioners, in contending alone with the general conditions which play havoc with the health of the most favored people, has convinced every one of knowledge and sense that the maintenance of the public health is a public function. As there is a community of interests at the bottom of the health question, so there must be community of effort.—*The Springfield Republican.*

SCIENTIFIC BOOKS

Rocks and Rock Minerals. A Manual of the Elements of Petrology without the Use of the Microscope. By Louis V. Pirsson. New York, John Wiley and Sons; London, Chapman and Hall. 12mo. Pp. 414, 74 figs., 36 plates.

Few if any petrologists are better qualified by reason of notable attainments in the science, as well as by long experience in teaching it, to write a manual of petrology than is Professor Pirsson, of Yale University, and it is with pleasure that we note the appearance of the book before us. Teachers of petrology will in general, we believe, fully agree with the author's opinion, as expressed in his preface, that there has long been a need for a "small, concise and practical treatise" on petrology in which the subject is dealt with entirely from a megascopic standpoint. Mining engineers and others who have to deal with rocks in a practical way have also felt the urgent need of such a book for purposes of reference. In our opinion the present manual meets this need in a highly satisfactory manner, and its publication marks a distinct advance in the treatment of elementary petrology. A general idea of the scope of the book may be obtained from the table of contents which follows:

Part I., Introductory and General Considerations. Chapter I., Scope of Petrology: Historical Methods of Study; Chapter II., Chemical Character of the Earth's Crust and its Component Minerals.

Part II., Rock Minerals. Chapter III., Important Properties of Minerals; Chapter IV., Description of the Rock-making Minerals; Chapter V., Determination of the Rock-making Minerals.

Part III., The Rocks. Chapter VI., General Petrology of Igneous Rocks; Chapter VII., Description of Igneous Rocks; Chapter VIII., Origin and Classification of Stratified Rocks; Chapter IX., Description of Stratified Rocks; Chapter X., Origin, General Characters and Classification of the Metamorphic Rocks; Chapter XI., Description of the Metamorphic Rocks; Chapter XII., The Determination of Rocks; Index.

The arrangement of the material in the various chapters is admirable throughout, while discussions, descriptions and statements in general are accurate, clear, concise, yet sufficiently complete, and are written in a style which is attractive and easy to read. Chapter IV., dealing with the general petrology of the igneous rocks, seems particularly worthy of notice, since it presents such material of a general character, both practical and theoretical, as is really essential for a clear understanding of igneous rocks, in a manner entirely in keeping with the most recent developments of the science, and yet within the comprehension of those not thoroughly trained in physical chemistry, nor in micro-petrology, a task that is not an easy one. An idea of the contents of this chapter may be gathered from the following topics, which are among those discussed therein: The modes of occurrence of igneous rocks; the chemical composition of magmas and their differentiation; the crystallization of silicate solutions (magmas) and the development of texture in igneous rocks; contact metamorphism; the classification of the igneous rocks.

In regard to the classification mentioned above, a system has been developed entirely consistent with megascopic petrology, all distinctions being based upon differences of texture or of mineral composition that can be made out by the careful study of good hand-specimens with the aid of a pocket lens, and a knife, in some few instances supplemented by a simple chemical test. The first division is made on the basis of differences of grain (granularity) into three classes. These are divided according as the rock in question is porphyritic or non-porphyritic. Further division is made, chiefly upon differences of mineral composition, into a few broad groups which are designated by familiar rock names (granite, diorite, etc.) firmly fixed in petrological literature by long usage. The more important varieties falling under these various groups or kinds of rock, but which for microscopical or other reasons have received special names from petrographers, are referred to in appropriate places, so that the significance of such names when encountered can be easily found by reference to the book. Among the names adopted for the rock groups, it may be noted that *dolerite* has been retained, very wisely it seems, to designate those granular, igneous rocks, with predominant ferro-magnesian minerals but in which it is not possible to tell positively just what ferro-magnesian mineral is present. This group will therefore include much that is commonly referred to as diabase. *Felsite* (resp. felsite-porphyry) is used for those nearly or entirely dense rocks, light in color, and generally highly feldspathic in character, while basalt (resp. basalt-porphyry) covers those dense, dark-colored, igneous rocks, for the most part ferro-magnesian in character. It will be noted that both of these terms, felsite and basalt, have been given a broader meaning than is customary in books covering a somewhat similar field. For example, dacites and most andesites fall under the head of felsite. Directions, however, for recognizing such varieties when it is possible to do so macroscopically, are given. The classification is summarized in a convenient table on page 202.

While some teachers will doubtless wish to make some minor additions to the scheme of classification in their class-room work, the scheme as a whole appears so sane, simple and practical that it can not fail to meet with general approval, and it is to be hoped that it will also come shortly into general use. In such an event it would be a strong influence toward uniformity and simplicity of practise among field workers in geology and petrology.

In Chapter VII. we find the descriptions of individual kinds of rock treated under such appropriate headings as: Mineral Composition; General Properties; Chemical Composition (the latter illustrated by a few well-chosen analyses); Occurrence and Alteration. Thus while the descriptions furnish one with data useful for the recognition of the rock in the field or laboratory, they also furnish in a most satisfactory manner what might be termed the Natural History of the rock.

With so excellent a manual available as a basis for petrological study it is to be hoped that it may be substituted for the dry and generally uninteresting lecturing so common in petrological laboratories, as well as for the too numerous laboratory guides and notes of inferior quality, and thus promote a general improvement in petrological teaching.

In conclusion it may be said that the book is conspicuous by reason of its typographical excellence and for the superior quality of the illustrations which admirably illustrate the text.

CHARLES H. WARREN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
BOSTON, MASS.

Die Pendulationstheorie. Von Dr. HEINRICH SIMROTH, Professor an der Universität Leipzig. Octavo, S. 564, Karten 27. Leipzig, Konrad Grethlein's Verlag, 1907. Pr. brosch, M. 12.

Theories of polar pendulation, based on geological or geographical considerations, have been proposed independently in the past few years by two investigators, one[1] an engineer, another[2] a geologist. To Professor Simroth alone among biologists, however, does the idea seem to have appealed as worthy of attention for its possible value in explaining the facts of zoogeography.

[1] Paul Reibisch, "Ein Gestaltungsprinzip der Erde," 27 *Jahresber. Ver. f. Erdk. zu Dresden*, 1901, S. 105–124. II., *ibid.*, 1905, S. 39–53, 2 Karten.

[2] D. Kreichgaur, "Die Aquatorfrage in der Geologie," Steyl, 1902.

The theory of Reibisch (rather than that of Kreichgaur), which the author has chosen as his working hypothesis, was first suggested to its originator as a tentative explanation of certain puzzling geographical facts. In particular is mentioned that the west coast line of South America becomes higher as one proceeds southward from the equator; and that recent coral reefs in the Pacific are partly in the condition of rising and partly in that of sinking. These differences are explained, according to Reibisch, if in addition to the difference between the rotational and equatorial diameters of the earth (40 km.), we assume a slow "pendulation" of the globe on an axis approximately perpendicular to the rotational axis, whose poles lie in the vicinity of Ecuador and Sumatra. In consequence of the greater equatorial diameter it follows that as a body of land in pendulation approaches the equator it will tend to be submerged, and that as it approaches the rotational poles it will correspondingly rise. This effect of the swing on land elevation will be greatest along the "Schwingungskreis," a great circle about the earth marking the greatest amplitude of swing. The Schwingungskreis passes through the two rotational poles, traverses the Pacific across its middle, crosses the Scandinavian Peninsula and the continent of Europe southward, and lops off the northwest quarter of Africa. In conformity with this theory the terrane quadrant embracing the North Atlantic, Europe, North Africa, and all of Asia except the east third is supposed now to be in "equatorial pendulation," that is, is nearing the equatorial position in the swing on the Sumatra-Ecuador pole. The same quadrant is assumed to have had a position farther northward in the glacial period, and to have lain farther southward in the Jurassic and Cretaceous. The "South Pacific" quadrant likewise is assumed to be now gradually approaching the equatorial position (in "equatorial phase"); while the "North Pacific" quadrant, embracing also the eastern third of Asia, and North America with the exception of Greenland and the Labrador region, is receding from the equator (in "polar phase"). The "Atlantic-India South" quadrant, taking in the bulk of the Indian Ocean, the south Atlantic, lower Africa, and South America below Ecuador, now finds itself approaching the polar phase. The region of the swing-poles themselves is necessarily subject to little swing, and is therefore supposed to have endured in the course of geologic ages little or no large climatic change.

In his general introductory discussion, following the exposition of the mechanics of the Reibisch hypothesis, and dealing in a broad way with the significance of pendulation in the origin and distribution of organisms, Professor Simroth enrolls himself with the adherents of the Kant-Laplace theory and takes no account at all of later theories of earth-origin. It is accordingly assumed that life must have arisen at a time of average higher temperature than prevails at present. On the question of the place of origin of the first organisms the Reibisch theory is regarded happily as broad and flexible enough to cover the requirements of any of the various suppositions that have been made. To the Laplacian and pendulationist it need make little difference whether it is held that life arose on land or in the water, at the rotational poles or in the tropics. The hypothesis of a gradually cooling globe, however, favors the supposition of the origin of life at the poles or on the mountains—these being the most cooled situations at any given time after surface solidification. And with further cooling must begin the pro-tropical migration, *for need of warmth,* that in time results in the concentration of a large primitive fauna in the tropics (liberally defined), to form the starting point of the succeeding movements which Professor Simroth finds the pendulation theory so helpful in explaining. If the "Urthiere" are already there, so much the better. If not, it is scarcely less easy than necessary to get them there, or at least started in that direction. For the companion assumption that the "great bulk of the most ancient known forms of life have lived, first or last, in the tropics, where they arose, or whither they had been driven by the advancing cold," is of cardinal importance in any endeavor to explain animal distribution in accordance with a principle of pendulation. Of the truth of such an assumption it is held that the facts of paleontology, as well as our knowledge of the distribution and relationships of living forms, furnish an encouraging amount of corroborative evidence.

With the two hypotheses of pendulation and a concentration of a primitive fauna in the tropics established or granted, we are all but ready to follow the ensuing movements that are conceived to have determined the manner and direction of the dispersals of the past and of to-day. A circumequatorial movement, *away* from the vicinity of the swing poles themselves and toward the Schwingungskreis, is all that remains necessary in order to get these populations of old within the "sphere of influence" of the swing. This lateral movement is conceived as practically a logical necessity, those forms of life inhabiting the hot zone, and especially those portions of it with most equable temperature, *i. e.*, about the swing-poles, being *forced as they increased in numbers to begin an effort to extend their range in a like temperature and so long as no obstacles of the medium or other kind stood in the way*. How inevitable are the consequences of pendulation to a "caught" population, in the view of the author, once the preceding suppositions have been allowed, is evident from the following quotation: "An organism that has arisen under the Schwingungskreis [or has migrated there or near there] will as a consequence of pendulation be mechanically removed from its proper climate unless it moves out to the right and left on its own parallel. . . . Its distribution thus becomes discontinuous. It will inhabit two separated areas [transversally symmetrical points] which lie one to each side of the Schwingungskreis," the eastward or westward migration only coming to a stop when first a point is reached "which most nearly resembles climatically the original habitat." Among the more salient examples of transversally symmetrical points offered by the author are: the alligator, the sole Asiatic species of which lives in the Yang Tse Kiang, while the nearest related form found elsewhere inhabits the lower Mississippi; the shovel-nosed sturgeons, of Turkestan and the Mississippi Valley; *Psephurus* and *Polyodon;* the dipnoans, *Lepidosiren* and *Ceratodus;* species of *Cryptobranchus, Limulus, Pleurotomaria;* points of maximal abundance of landsnails, etc. The map (No. 5) exhibiting the geographical relations of the most striking of these cases of "transversal symmetry" adds much clearness and force to this portion of the text. The predictableness of location of these transversally symmetrical points in the light of a "Pendulations-mechanik" leads the author to observe of the first expedition sent out to search for dipnoans in South America, that the unsuccessful search in the Amazon region was the result of a "false scent" wholly unnecessary had the biologists of those days possessed our present knowledge. Without pendulation "what a keen hypothesis were necessary," he asks, in order to furnish so clear and certain an elucidation of these instances! That all species or faunas caught by the swing should thus move out laterally from the Schwingungskreis and their little (or much) modified descendants so come to occupy such symmetrically situated habitats is too much to be expected and is not a meaning intentionally conveyed by the author. The length of time required for a full pendulation, for example, the interval between the Jurassic and the Tertiary, would seem, for one thing, to leave ample time for such of the forms affected as might choose to remain stationary to adapt themselves to the changed conditions. And, again, as we shall see, the ways in which pendulation may work in influencing the changes and movements of organisms are more than one.

That mode of distribution called by the author "meridial symmetry" is another interesting phenomenon on which light is thrown by the pendulation theory. Thanks to it, the occurrence of closely related forms, for example, in California and Chili and in Japan and Australia need no longer puzzle. "Forms once carried northward with the polar swing, in the next equatorial phase are carried into too warm a temperature, and either move out eastward or westward or ascend mountains. On the latter they can go further south and even cross the equator. On the other side of the equator they may come down gradually from the mountains. . . . Close investigation always discloses the fact that the original starting point of these migrations was on the Schwingungskreis."

Still another useful function of the Reibisch theory is the explanation of the common arc-shaped (Bogenförmig) life-area. This type of distribution is assumed to be due to the effect of the organism's meeting the "Kulminationskreis" in its eastward or westward migration. It should be explained that the Kulminationskreis is a great circle which passes through Ecuador and Sumatra at right angles to the equator, and is so named because it marks the position of nearest approach to the rotational poles that can be attained by any point on the globe's surface during pendulation. In an eastward or westward movement of a species, when the Kulminationskreis is reached, a halt and change of direction is likely to be made, since at this point opposite conditions of climate set in. For example, an organism passing northwestward through that portion of North America lying in the Atlantic-Indic North Quadrant (which is in equatorial phase) enters, when it crosses longitude 80° west, a quadrant which is in its polar phase. The turn southward follows and the "Bogenförmig Areal" is the result.

Especially interesting is Professor Simroth's very brief discussion of the character of the fauna of the swing-pole regions themselves. Here, where pendulation has been so little as to be practically negligible as an agent of climatic change, we might expect to find the homes of many very ancient forms of life, such as have never experienced the necessity of moving. That a comparison of the faunas of both east and west swing-pole regions with that of extra-polar areas reveals a gratifying number of primitive forms is held to be true by the author. And the existence is asserted of a mass of botanical writings whose purpose has been to establish how little the recent flora of both swing-pole regions differs from that of the Tertiary.

The preceding brief review of the effects on the movements and evolutionary changes in species and faunas that might be expected through the operation of pendulation has been without reference to the effects of the land upheavals and submergences that are a necessary consequence of the pendulation principle. Of these latter and their effects, so largely speculative, little is offered by the author or could be expected. As further examples of equatorial sinkings are mentioned the Caspian area, the Dead Sea, North Africa and North Australia. Such broad low flat areas as the Sahara, in particular, because of their lack of defensive or refuge-furnishing barriers, are believed to have been of high importance as factors in the initiation of evolutionary changes. Animals and plants originating in such a place must make more than ordinary effort to keep in an equable climate. For such pendulation has the mandate: move or vary. In considering the eventuality that some might stay, it is ventured that "only the strongest mutations would suffice" those that did. To those that move several alternatives are open. They may go east or west on their own meridian. If there are mountains, they may ascend them. In a polar movement they may attain greater warmth, perhaps, by voluntarily descending into the sea; while in an equatorial movement which involves a stretch of continent already low, many will be forced into the sea with the gradual submergence.

Estimates of the value of as purely speculative a piece of work as this are so apt to vary with individual temperament or scientific interest that they are little better than gratuitous. When the issue between the author and his public (for the book is confessedly a brief) is so largely one of interpretation, the pointing of minor errors of fact, unavoidable in so great a massing of material from so wide a field, has scant relevance. Beside the conception in defense of which the author's thesis has been written, even a vaster compilation of biological data than Professor Simroth has brought together might well have for many an appearance of comparative insignificance. So it will doubtless be easier for most readers to admit a considerable measure of explaining value in the theory, once granted, than to grant it and its retinue of corollary assumptions. But the mere novelty and unfamiliarity of the conception, not to say the strange difficulty that the reader experiences at first in orienting himself in a pendulating world, need hardly of itself invite to indifference or contempt. A hypothesis, however unproven or unprovable, which puts into such new and clear light so many obscure phenomena seems to me to deserve, at least at the hands of students of distribution, a modicum more of attention than has recently been accorded it by a British reviewer. As for the ultimate disposition of such theories as those of Reibisch and Kreichgaur, that is clearly more likely to fall within the province of astrophysics than of faunistic biology.

ROBERT E. RICHARDSON
DEPARTMENT OF BIONOMICS,
STANFORD UNIVERSITY

MOREHOUSE'S COMET

A COMET was discovered photographically at the Yerkes Observatory on the evening of September 1, by Professor D. W. Morehouse, of Drake University, Des Moines, Ia., who has been engaged in graduate work during the summer under the direction of Professor Barnard.

The comet's position on the three plates simultaneously exposed on that night was approximately: R. A. $3^h\ 20^m$; Dec. North $+ 66°$.

Several photographs were also obtained by Professors Barnard and Morehouse on September 2 and 3, from which quite accurate positions will be determined. The tail is shown on the plates for a length of about six degrees, and exhibits some interesting structure. Although the comet made a strong impression on the discovery plates, it was faint visually when seen on the following night, and was without any definite nucleus. The coma was not large, but was uniformly diffuse.

A micrometric position was obtained with the 12-inch refractor by Mr. Fox, as follows: Sept. 2, G. M. T., $17^h\ 45^m$, R. A. $= 3^h\ 21^m\ 55^s$; Dec. $= + 66°\ 52'\ 24''$.

The motion is thus seen to be toward the north, with a slight westerly component. The comet is of course above the horizon in northern latitudes through the whole night.

EDWIN B. FROST
YERKES OBSERVATORY,
September 4, 1908

SPECIAL ARTICLES

NOTE UPON THE STRUCTURE OF THE SANTA CATALINA GNEISS, ARIZONA

THE extensively-developed pre-Cambrian gneiss of the South side of the Santa Catalina Mountains near Tucson, Arizona, is remarkable for its tabular form; its regular stratification; its altitude at low angles; its broad flat surfaces and in places, for its extreme foliation, passing from coarse grained tabular granitic-gneiss into micaceous, sericitic and hornblende schists. Seen from a distance, especially from the locality known as Gibbon's Ranche, the croppings appear like ordinary stratified sandstones and shales. Close inspection reveals an elongated drawn out and flattened structure, which it is the special object of this paper to note.

The whole series appears to have been elongated under great pressure, resulting in flattening and spreading out into thin layers with a consequent reduction of thickness and an increased lamination.

I purposely refrain from describing this modification of form as a "flow" or as "flow-structure" for these terms convey the impression of a much more mobile condition than existed and of superficial movement rather than of the interior elongation by stretching under great pressure of a deeply seated mass of comparatively solid rock.

The compression and extension are shown in several ways, but specially by the elongation of nodules of feldspar; by sheets of quartz which seem to have been rolled out like dough and impressed by nodular masses of feldspar above and below.

The phenomena remind the observer of the curiously elongated rocks in California; the "grave-stone slates" and sandstones of the middle gold region, which are there uplifted at high angles, while in the Catalina gneiss the dip is gentle, approaching horizontality.

The sections of the Catalina rocks show a great variety of mineral composition ranging from quartzite to muscovite-schist and biotite-schist. There can be little doubt of their elastic origin, though they are now penetrated by layers of pegmatitic granite, which partake of the deformation.

These gneissic and schistose rocks are members of the series of pre-Cambrian schists for which I proposed the name "Arizonian." They are widely distributed in middle and southern Arizona and offer an inviting field for investigation.

Wm. P. Blake

Tucson, Arizona

PHYSIOGRAPHIC SKETCH OF LEWIS COUNTY, N. Y.

The county of Lewis, bounded on the northeast by St. Lawrence, on the west by Herkimer, on the south by Oneida and on the east by Oswego and Jefferson counties, extends from the 43° 25′ of northern latitude for fifty-four miles northward and from the 75° 50′ western longitude for nearly thirty-four miles to the east, and is naturally divided by Black River into two heterogeneous sections from a genetic point of view, an eastern section, made up to the greatest extent of igneous and metamorphic rocks, and a western one that chiefly comprises a sedimentary series.

Successive manifestations of dynamical forces upon the igneous rocks in the east, as the crushing of the granites into gneisses and the intrusions of syenites, as well as gabbros, into the gneissic series and into the crystalline limestone series, have affected also to some extent the sedimentary rocks in the west in such a manner as to slightly bend during post-Ordovician time Cambrian, Ordovician and (Lower) Silurian strata into a flat synclinal fold that plunges at a very small angle to the north-northeast, while subsequent erosion nearly completed one of its cycles by reducing post-Ordovician topography to a peneplain, remnants of which can still be traced in the most elevated portions of the western section.

During another cycle of erosion that was never completed, but only brought about the partial destruction of the peneplain and exposed in succession the different members of the Ordovician, *i. e.*, the Black River and Trenton limestone, as well as the Utica-Frankfort slates and the Pulaski sandstone shales, at least one member of the Silurian, namely the Oswego sandstone, and, bordering the Ordovician in the east, the Potsdam sandstone of the Cambrian, a strike fault west of Black River, extending through the entire length of the county and possibly beyond, caused the disappearance of the Potsdam sandstone along the fault line, thus bringing the pre-Cambrian igneous and metamorphic series into contact with the Ordovician.

Succeeding the faulting of the region and the invasion of ice sheets of local character from the Adirondack, as well as from the Lake Ontario region, which led to the formation of two distinct sets of ground and terminal moraines, a second flood plain was established, adjacent to the former, but on a much lower level, which we might consider a base-leveled plain, as its uniformity of level is admirable for its entire extension from the utmost northwestern points of the county for over forty miles, as far as Forestport, beyond the southern boundary line of Lewis County.

Into this flood plain post-glacial erosion has sunk in several successions, of which two are more prominently marked by river-terraces, the channel that is now occupied by Black River, and has modified the topography of the regions east and west of Black River to such an extent as to impart to them the physiognomy of uplands and highlands, respectively.

At present the area under discussion is passing through a cycle of erosion that has started recently, speaking geologically, and conditions have been established that apparently favor the rejuvenation of the entire drainage system of the region and the carving into the sedimentary strata in the west along joint planes and into the igneous and metamorphic rocks in the east without special regard to basal structure, of those deep gulfs and precipitous gorges that contribute so much to the charms and scenic effects of a region.[1] T. A. Bendrat, M.S.

Constableville, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE HANOVER MEETING, SECTION E, JULY 1–3, 1908

At the Hanover meeting of the American Association for the Advancement of Science, Section E, Geography and Geology, held two sessions for the reading of papers and participated in the excursions to Mt. Ascutney and Corbin Park. Prior to the gathering at Hanover, a party of geologists, which varied in number from eight to ten, enjoyed a trip from Bellows Falls, Vt., to Rutland under the guidance of Professor J. E. Wolff, to the marble quarries at West Rutland with Mr. G. H. Perkins, state geologist, and from Rutland to Woodstock in company with Professor Wolff and Professor C. H. Hitchcock.

The scientific sessions began Tuesday, June 30, at ten o'clock and, with an intermission for dinner, continued till 4:30 p.m. Mr. Bailey Willis, vice-president, called the meeting to order. In the absence of the sectional secretary, Dr. F. P. Gulliver, who was unfortunately too ill to attend, Professor J. E. Wolff consented to serve as secretary. After the opening of the afternoon session, Professor C. H. Hitchcock took the chair at the request of Mr. Willis and presided to the close of the session. The following papers were presented and discussed:

Local Geology of Hanover, N. H.: C. H. Hitchcock.

Professor Hitchcock after referring to his early work as state geologist and its continuation during forty years, described a large relief map of New Hampshire which he had prepared and from time to time brought up to date as geological investigations progressed. It is now colored to represent the state of knowledge in 1908. The accumulated collections and their arrangement in the Butterfield Museum of Dartmouth College were described, and attention was called to the device of connecting each specimen by an identical number with its locality shown in one of the eighteen sections, which had been prepared on a large scale to illustrate the relations of the rocks. Professor Hitchcock then stated in some detail the known and probable relations of the various igneous and metamorphic rocks of the Hanover quadrangle and showed a preliminary draft of a geologic map of that area. The strata being, so far as known, unfossiliferous, their age is inferred from comparison with related fossiliferous sections, which indicate that Cambrian, Ordovician and Silurian rocks may be present in the geosyncline that lies east of the Pre-Cambrian axis of the Green Mountains and extends into the western half of the Hanover quadrangle. The eastern half is a complex of intrusive and metamorphic rocks, on the western margin of a large area related to the zone of intrusions which traverses the middle of New Hampshire and culminates in the White Mountains. Passing on to the subject of glacial geology, the speaker described two sets of striæ, the one ranging south 10° west down the Connecticut Valley, the other southeast. Evidence that local glaciers occupied the valleys tributary to the Connecticut after the disappearance of the general ice sheet was briefly presented, and incidentally a map of Connecticut on a scale of 400 feet to the inch, prepared by the students of Dartmouth, was exhibited.

In discussion Mr. Willis stated that wide areas of schists and gneiss of New England, which were formerly considered to be Archean, are now generally classed as Paleozoic sediments and intrusives. These do not include the axis of the Green Mountains, which Professors Hitchcock and Wolff had described as Archean, but they cover all the province east of that range in Vermont, New Hampshire and Maine.

Recent Explorations in Mammoth Cave, with a Revised Map of the Cave: Horace C. Hovey.

Mr. Hovey stated that, of late, explorations in the unfrequented parts of Mammoth Cave have been pushed by several visitors, especially Messrs. Parrish and Einbigler, aided by the local guides. The results were laid before the author of this paper, who verified them by a personal visit in 1907; finding the newly discovered domes more grand than any previously known. These additions, and a number of minor corrections, had led him to prepare a new guide map, with an index and table of approximate distances, which he had now published and exhibited in connection with this paper. Dr. Hovey courteously presented copies of the new map of Mammoth Cave to those present at the meeting of the section.

The Warm Stratum existing at a Great Height in the Atmosphere: A. Lawrence Rotch.

In 1901 it was discovered in Europe, by the use

[1] This article is a chapter of a report to be published on the geology of Lewis County, based on three seasons of field work.

of "ballons-sondes," that there was a warm, or isothermal, stratum in the atmosphere at a height of about 10 kilometers. In 1904 the author made the first use of "ballons-sondes" in the United States and in this and the following years sent up 77 balloons from St. Louis. Nearly all of the 71 recovered which rose higher than 12 kilometers entered the warm stratum. The largest inversion of temperature found was during the first ascension on September 15, 1904, when the minimum temperature of — 52° C. occurred at a height of 14,600 meters, the temperature rising to — 36° C. at 17,000 meters, the maximum height attained. Again, on October 8, 1907, the temperature fell to — 67° C. at 14,500 meters and rose to — 58° C. at 16,500 meters, the stratum of inversion descending 2,500 meters within the next two days. In summer its level is somewhat lower than at other seasons. It seems probable that this warm stratum extends completely around the globe. It lies lower in northern Europe, but it was not discovered at the equator by the balloons that rose 15 kilometers from a yacht sent to the South Atlantic in 1906 by M. T. de Bort and the author.

Discussed by Professor T. C. Chamberlin.

High-level Terraces of New England: J. W. Spencer.

The author presented and described longitudinal sections of the river valleys radiating from the White Mountains. They show a succession of terrace steps descending the valleys, the surfaces of which slope very gently down the valleys, each one passing by abrupt transition to the next below. Each begins in a river flat, becoming a terrace further down the stream, where remains oi several terraces, one above the other, may be seen. In one case, as in the Lemaile Valley, the slope was found to be forty-five feet in fifteen miles. These phenomena are found from the high mountain passes, such as Profile and Crawford notches, to within a few hundred feet above sea level. They suggest that in them be found data bearing on the Post-glacial elevation of the mountain masses.

Discussed by Professor J. W. Goldthwaite.

Note upon the Structure of the Pre-Cambrian Gneiss of the Santa Catalina Mountains, Arizona: Wm. P. Blake.

The Pre-Cambrian gneiss of the Santa Catalina Mountains is remarkable for its tabular stratification at a low angle of dip; its permeation by pegmatite with the formation of feldspar nodules, and its extreme foliation in some parts, passing from coarse-grained gneiss to schists in various forms, micaceous and hornblendic.

But the chief characteristic to be here noted is its evident elongation under great pressure.

Studies of the Tracks of Climatichnites: C. H. Hitchcock and W. Patten.

A large slab of sandstone crossed by several trails was exhibited where installed on the walls of Butterfield Museum. Professor Patten described the movements of a modern *Limulus* in advancing up a sandy beach with the tide and the action of the abdominal gill plates making rhythmic ridges in the sand. He compared these with the tracks of Climatichnites, which he ascribed to forms related to the Eurypterids rather than the trilobites. The tracks showed a beginning in a hollow in the sand and where continued on the specimen to the further end there became fainter, as if the animal rose from the bottom. This would correspond with the habit of the *Limulus*, which remains buried on recession of the tide and upon its return first crawls and then swims away. Beside one track were seen two symmetrically placed impressions attributed to the longer arms of a Eurypteroid form.

The Attitude of the Algonquin Beach; and its Significance: J. W. Goldthwaite. (Illustrated by lantern slides.)

Precise measurements of altitude of the Algonquin beach and other "raised beaches" bordering Lake Michigan indicate that in that basin the Algonquin beach slants southward at a repeatedly diminishing rate, becoming horizontal near Manistee, Mich., and Kewaunee, Wis. South of a line through these localities the Algonquin beach is invariably 593–598 feet A. T. This horizontality over the southern half of the Lake Michigan basin appears to mean that the beach there is now at the altitude at which it stood when first formed, and that it has been undisturbea by those differential uplifts which have warped the more northerly parts of the Great Lake district. In other words, Lake Algonquin appears to have stood approximately 600 feet A. T. when the "Algonquin Beach" was built.

Mr. F. B. Taylor found what is probably the same beach at an altitude of 1,220 feet A. T. near South River, 30 miles south of the pass between Lake Nipissing and the Mattawa River. It is quite possible that the plane of this Algonquin beach, extended over the Nipissing Pass, would be at least 1,300 feet A. T. there. If so, that district has risen approximately 700 feet since the beach was formed.

If we restore the district near the Nipissing pass to the position which it had at the Algonquin stage, by lowering it 700 feet below its present position, we put the floor of the Nipissing pass (which is now less than 700 feet A. T.) a little below sea level. This suggests the possibility that the sea may have entered the basins of the Great Lakes from this direction.

The conjectured altitude of Lake Algonquin, 600 feet A. T., is attributed to an ice barrier over the Nipissing pass. It is very probable that this barrier persisted until the floor of the pass had been raised well above sea level, by the differential uplifts which produced the diverging series of beaches below the Algonquin. If the sea did come in through the Nipissing Pass, however, a record of it might be expected in raised beaches north of the pass.

Professor Goldthwaite was followed by Dr. J. W. Spencer, who presented the two following papers, both of which were illustrated by lantern slides.

Changes in the Recession of the Falls of Niagara.

The following is a mere summary of some of many chapters required in describing phenomena which bring to light the changing features of Niagara Falls.

From my own measurements of the recession of Niagara Falls, compared with those of Hall in 1842, I find that the average rate is 4.2 feet a year for the width of the canyon (1,200 feet) made by the cataract; and from the discovery of its position in 1678, approximately the same rate formerly prevailed.

From a point 1,100 feet below the apex of the falls, to the Whirlpool, I find by my new soundings, that the depth of the gorge reaches to the same plane of 86 to 92 feet below the level of Lake Ontario, when allowance is made for the descent of the river surface at the Whirlpool Rapids, where borings show that the canyon was trenched to the same depth as above and below them by the falls. But soundings, which I succeeded in making immediately below the falls themselves, prove that the cataract can excavate to a depth of not over 100 feet below the river surface, consequently the present deep channel of 186 to 192 feet could have been made only when the falls were higher—that was before the gorge at the Whirlpool Rapids had become partly refilled by the recent falling of the adjacent wall-rocks. At this section, for a short time, the volume of the river was diminished by the temporary partial diversion of the Upper Lake drainage, by way of Chicago. Until the falls had crossed the Lyell ridge, about a mile and a half below their present site, they were somewhat higher than now. By the trenching of this ridge the surface of the river was lowered by about sixty feet, on account of the removal of the drift from the pre-glacial valley, which they took possession of, whereupon the Upper Rapids came into existence. The site of the Whirlpool was the head of a pre-glacial canyon, above which was a small tributary heading in the Lyell ridge, two miles away, since deepened by the falls. Below the whirlpool to the head of Foster's Flats (about two thirds of a mile), the gorge is similar to that above, and here there was a slight change in the height of the falls, as explained. Throughout these four miles the greater height of the falls increased the rate of recession. By differentiating the work of the falls at each point, the time required for the formation of this longitudinal stretch of the gorge is now computed to have been 3,500 years only.

The history of the lower three miles is entirely different. At their birth, the falls were only 35 feet high—shown by a terrace at the mouth of the gorge. From time to time the falls increased in height as the Ontario waters retreated to lower levels, even to 180 feet below the level of the present day—shown by the deep inner channel revealed by my recent soundings. The falls then reached over 500 feet in height, but consisted of three separate cataracts, the lowest of which was over 300 feet high; however, its work as rapids was exhausted in excavating a new channel for over eleven miles beyond the end of the gorge, while the upper cataracts were already far advanced within the canyon. Shortly after the third cataract, now a fall, had receded half a mile within the gorge, its height was reduced by nearly 180 feet, owing to the rising of the Ontario waters, due to the warping of the earth's crust at the outlet of the lake.

The second cataract gained upon the upper one, until the two united at a well-marked point at Foster's Flats, less than three miles from the mouth of the gorge. At this time they had each reached about 120 feet in height. A few hundred feet beyond this point, at the head of the flats, occurred the most remarkable change in the history of the river. Until this time the volume of the river was only that of the Erie drainage, the three upper lakes emptying to the northeast, as

I discovered in 1888. The volume of the Erie drainage is now found to have been only 15 per cent. of the present discharge of Niagara River. The change mentioned consisted of a new force breaking through the hard sandstone floor of the river to a great depth, as found by the new soundings, and making a much greater channel than the united falls had been able to produce. This increased force arose from the addition of the full discharge of all the upper lakes, which is now thus established to have taken place, when the falls were at this point.

Throughout this lower section of about three miles, the work performed by the upper cataract has been determined. Therefore, by applying the laws of erosion, it became possible to calculate the approximate age of this section of the gorge. Had it been necessary to depend upon the work of the second and third cataracts, it is hardly likely that any reliable determination could have been made. The results show that a period of 35,500 years was required for the recession of the falls in this lower section or 39,000 years in the whole length of the canyon.

The turning of the Huron drainage into Lake Erie occurred 3,500 years ago, and it is 3,000 years since the falls reached the whirlpool. They were passing the site of the Whirlpool Rapids from 2,500 to 2,000 years ago, while the rapids themselves were completed less than 300 years since.

Pre-glacial Erie Outlet.

The Erie Basin formed a depression in the Devonian shales, bounded on the north by a narrow ridge, capped by Corniferous limestone. This was faced on its northern side by a low escarpment, descending to the basin in the soft rocks of the Salina formation, which was bounded on its northern side by durable Niagara limestone. The escarpment and basin mentioned are now leveled over by drift formations. Beyond the Niagara limestone there was again a parallel trough of the Ontario basin, excavated out of soft Medina shales. Such was the pre-glacial character of the Niagara peninsula between Lake Erie and Lake Ontario.

Many years ago I found that the ridge of Niagara limestone, at the head of Lake Ontario, was trenched sufficiently deep to at least draw water from the Erie basin. Another trench to a depth of 28 feet below the surface of that lake occurs along the Welland Canal.

Upon investigating the character of the rock-bound basin at Niagara Falls, I found that it did not lead to the north, as was supposed, but rapidly widened and deepened to the southwestward, even to one hundred feet below the surface of Lake Erie. Determined to find whither this pre-glacial valley led, I collected the records of borings, and made other borings, with the result that a deep pre-glacial valley was discovered cutting the Corniferous limestone for a breadth of less than two miles, immediately east of Lowbank Post Office, and crossing the Salina basin, and again trenching the ridge of Niagara limestone (here forming a canyon) filled with drift, but partly reopened by the modern streams, just west of De Cou Falls, the inner canyon being somewhat more than a mile, and the outer more than two miles in width. With allowance for the measured post-glacial uplift, this buried valley, revealed by borings at almost every mile, was sufficiently deep to drain the pre-glacial Erie valley, receiving, as it did, the ancient Ohio and Alleghany rivers as tributaries. These gorges through the hard ridges between the buried valleys resemble the courses of streams crossing the Appalachian ridges. The discovery of this ancient water course is one of the most completely demonstrated of all those bringing to light the great changes of drainage since pre-glacial days, and is a lesson for further research.

This closed the sectional meeting.

The excursion to Mount Ascutney, Wednesday, July 1, was shared by twenty-two members. A number accompanied Dr. Daly in a drive about the base of the mountain and to Little Ascutney to examine the igneous rocks and contact phenomena. The others ascended the principal height. In the view from the summit the oldest recognizable peneplain of the region was studied and certain differences of opinion as to its character were developed. To some of those present, the reduction of the surface toward a general peneplain appeared less complete than had been expected, and the appearance of the topography suggested that of certain mid-Tertiary slopes and heights.

From the excursion to Mount Ascutney members of Section E returned to Hanover to take part in the general exercises, including the trip to the Corbin Game Park on Thursday, July 2.

On Friday and Saturday a number proceeded from Hanover to Littleton, N. H., under the guidance of Professor Hitchcock, and examined the stratigraphy of the Silurian rocks, from which trilobites and brachiopods were collected.

Bailey Willis

SCIENCE

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THE ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—II.

HABIT ILLUSTRATED BY MORPHOLOGY

WE have hitherto been considering the mnemic quality of movements; but, as I have attempted to show, morphological changes are reactions to stimulation of the same kind as these temporary changes. It is indeed from the morphological reactions of living things that the most striking cases of habit are, in my opinion, to be found.

The development of the individual from the germ-cell takes place by a series of stages of cell-division and growth, each stage apparently serving as a stimulus to the next, each unit following its predecessor like the movements linked together in an habitual action performed by an animal.

My view is that the rhythm of ontogeny is actually and literally a habit. It undoubtedly has the feature which I have described as preeminently characteristic of habit, viz., an automatic quality which is seen in the performance of a series of actions in the absence of the complete series of stimuli to which they (the stages of ontogeny) were originally due. This is the chief point on which I wish to insist—I mean that the resemblance between ontogeny and habit is not merely superficial, but deeply seated. It was with this conclusion in view that I dwelt, at the risk of being tedious, on the fact that memory has its place in the morphological as well as in the temporary reactions of living things. It can not be denied that the ontogenetic rhythm has the two qualities observable in habit—namely, a certain degree of fixity or automaticity, and also a certain variability. A habit is not irrevocably fixed, but may be altered in various ways. Parts of it may be forgotten or new links may be added to it. In ontogeny the fixity is especially observable in the earlier, the variability in the later, stages. Mr. Darwin has pointed out that "on the view that species are only strongly marked and fixed varieties, we might expect often to find them still continuing to vary in those parts of their structure which have varied within a moderately recent period." These remarks are in explanation of the "notorious" fact that specific are more variable than generic characters—a fact for which it is "almost superfluous to adduce evidence."[1] This, again, is what we find in habit: take the case of a man who, from his youth up, has daily repeated a certain form of words. If in middle life an addition is made to the formula, he will find the recently acquired part more liable to vary than the rest.

Again, there is the wonderful fact that, as the ovum develops into the perfect organism, it passes through a series of changes which are believed to represent the successive forms through which its ancestors passed in the process of evolution. This is precisely paralleled by our own experience of memory, for it often happens that we can not reproduce the last learned verse of a poem without repeating the earlier part; each verse is suggested by the previous one and acts as a stimulus for the next. The blurred and imperfect character of the ontogenetic version of the phylogenetic series may at least remind us of the tendency to abbreviate by omission what we have learned by heart.

[1] "Origin of Species," 6th edition, p. 122.

In all bi-sexual organisms the ontogenetic rhythm of the offspring is a combination of the rhythms of its parents. This may or may not be visible in the offspring; thus in the crossing of two varieties the mongrel assumes the character of the prepotent parent. Or the offspring may show a blend of both parental characters. Semon[2] uses as a model the two versions of Goethe's poem—

Ueber allen Gipfeln, ist Ruh, in allen Wäldern,
hörest du, keinen Hauch.
Ueber allen Gipfeln, ist Ruh, in allen Wipfeln,
spürest du, kaum einen Hauch.

One of these terminations will generally be prepotent, probably the one that was heard first or heard most often. But the cause of such prepotency may be as obscure as the corresponding occurrence in the formation of mongrels. We can only say that in some persons the word "allen" releases the word "Wäldern," while in others it leads up to "Wipfeln." Again, a mixture of the terminations may occur leading to such a mongrel form as: "in allen Wäldern hörest du kaum einen Hauch." The same thing is true of music; a man with an imperfect memory easily interpolates in a melody a bar that belongs elsewhere. In the case of memory the introduction of a link from one mental rhythm into another can only occur when the two series are closely similar, and this may remind us of the difficulty of making a cross between distantly related forms.

Enough has been said to show that there is a resemblance between the two rhythms of development and of memory; and that there is at least a *prima facie* case for believing them to be essentially similar. It will be seen that my view is the same as that of Hering, which is generally described as the identification of memory

[2] "Die Mneme," 2d edition, pp. 147, 221, 303, 345.

and inheritance.[3] Hering says that "between the *me* of to-day and the *me* of yesterday lie night and sleep, abysses of unconsciousness; nor is there any bridge but memory with which to span them." And in the same way he claims that the abyss between two generations is bridged by the unconscious memory that resides in the germ cells. It is also the same as that of Semon and to a great extent as that of Rignano.[4] I, however, prefer at the moment to limit myself to asserting the identity of ontogeny and habit, or, more generally, to the assertion in Semon's phraseology, that ontogeny is a mnemic phenomenon.

Evolution, in its modern sense, depends on a change in the ontogenetic rhythm. This is obvious, since if this rhythm is absolutely fixed, a species can never give rise to varieties. This being so, we have to ask *in what ways* the ontogenetic rhythm can be altered. A habitual action, for instance, a trick learned by a dog, may be altered by adding new accomplishments; at first the animal will persist in finishing his performance at the old place, but at last the extended trick will be bonded into a rhythm of actions as fixed as was the original simpler performance. May we not believe that this is what has occurred in evolution?

We know from experiment that a plant may be altered in form by causes acting on it during the progress of development. Thus a beech tree may be made to develop different forms of leaves by exposing it to sunshine or to shade. The ontogeny is different in the two cases, and what is of special interest is that there exist shade-loving plants in which a structure similar to that of the shaded beech-leaf is apparently typical of the species, but on this point it is necessary to speak with caution. In the same way Goebel points out that in some orchids the assimilating roots take on a flattened form when exposed to sunlight, but in others this morphological change has become automatic, and occurs even in darkness.[5]

Such cases suggest at least the possibility of varieties arising as changes in or additions to the later stages of ontogeny. This is, briefly given, the epigenetic point of view.

But there is another way of looking at the matter—namely, that upheld by Galton and Weismann. According to this view ontogeny can only be changed by a fundamental upset of the whole system—namely, by an alteration occurring in its first stage, the germ cell, and this view is now very generally accepted.

The same type of change may conceivably occur in memory or habit, that is, the rhythm as a whole may be altered by some cause acting on the nerve-centers connected with the earlier links of the series. The analogy is not exact, but such an imaginary case is at least of a different type from a change in habit consisting in the addition of a new link or the alteration of one of the latest formed links. If we were as ignorant of the growth of human actions as we are of variation, we might have a school of naturalists asserting that all changes of habit originate in the earliest link of the series. But we know that this is not the case. On the other hand, I

[3] Everyone who deals with this subject must take his stand on the foundation laid by Hering in his celebrated address given at Vienna in 1870 and reprinted in No. 148 of Ostwald's "Exakt Klassiker." The passage quoted (p. 14) is from Samuel Butler's translation of Hering in "Unconscious Memory," 1880, p. 110. Butler had previously elaborated the view that "we are one person with our ancestors" in his entertaining book "Life and Habit," 1878, and this was written in ignorance of Hering's views.

[4] "Sur la transmissibilité des caractères acquis," Paris, 1906.

[5] Goebel's "Organography of Plants," part II., p. 285.

fully admit that the structure of an ovum may in this way be altered, and give rise to a variation which may be the starting-point of a new species.

But how can a new species originate according to an epigenetic theory? How can a change in the later stages of ontogeny produce a permanent alteration in the germ-cells? Our answer to this question will depend on our views of the structure of the germ-cells. According to the mnemic theory they have the quality which is found in the highest perfection in nerve-cells, but is at the same time a character of all living matter—namely, the power of retaining the residual effects of former stimuli and of giving forth or reproducing under certain conditions an echo of the original stimulus. In Semon's phraseology germ-cells must, like nerve-cells, contain engrams, and these engrams must be (like nerve-engrams) bonded together by association, so that they come into action one after another in a certain order automatically, *i. e.*, in the absence of the original stimuli.

This seems to me the strength of the mnemic theory—namely, that it accounts for the preformed character of germ-cells by the building up in them of an organized series of engrams. But if this view has its strength, it has also its weakness. Routine can only be built up by repetition, but each stage in ontogeny occurs only once in a lifetime. Therefore if ontogeny is a routine each generation must be chemically connected with the next. This can only be possible if the germ-cells are, as it were, in telegraphic communication with the whole body of the organism; so that as ontogeny is changed by the addition of new characters, new engrams are added to the germ-cell.

Thus in fact the mnemic theory of development depends on the possibility of what is known as somatic inheritance or the inheritance of acquired characters. This is obvious to all those familiar with the subject, but to others it may not be so clear. Somatic inheritance is popularly interesting in relation to the possible inherited effects of education, or of mutilations, or of the effects of use and disuse. It is forgotten that it may be, as I have tried to show, an integral part of all evolutionary development.

WEISMANN'S THEORY

Every one must allow that if Weismann's theory of inheritance is accepted we can not admit the possibility of somatic inheritance. This may be made clear to those unfamiliar with the subject by an illustration taken from the economy of an ant's nest or beehive. The queen,[6] on whom depends the future of the race, is cut off from all active experience of life: she is a mere reproducing machine, housed, fed and protected by the workers. But these, on whom falls the burden of the struggle for life and the experience of the world generally, are sterile, and take no direct share in the reproduction of the species. The queen represents Weismann's germ-plasm, the workers are the body or soma. Now imagine the colony exposed to some injurious change in environment; the salvation of the species will depend on whether or no an improved pattern of worker can be produced. This depends on the occurrence of appropriate variations, so that the queen bee and the drones, on whom this depends, are of central importance. On the other hand any change occurring in the workers, for instance, increased skill due to practise in doing their work or changes in their structure due to external conditions, can not possibly be inherited, since workers are absolutely cut off from the reproduction

[6] Nor do the drones share the activity of the workers.

of the race. According to Weismann, there is precisely the same bar to the inheritance of somatic change.

The racial or phyletic life of all organisms is conceived by him as a series of germ-cells whose activity is limited to varying, and whose survival in any generation depends on the production of a successful soma or body capable of housing, protecting, and feeding the germ-cell. Most people would *a priori* declare that a community where experience and action are separated must fail. But the bee's nest, which must be allowed to be something more than an illustration of Weismann's theory, proves the contrary.

It is clear that there must be war to the knife between the theory of Weismann and that of the somatists—to coin a name for those who believe in the inheritance of acquired characters. A few illustrations may be given of the strength of Weismann's position. Some trick or trivial habit appears in two successive generations, and the son is said to inherit it from his father. But this is not necessarily a case of somatic inheritance, since according to Weismann the germ-plasm of both father and son contained the potentiality of the habit in question. If we keep constantly in view Weismann's theory of continuity, the facts which are supposed to prove somatic inheritance cease to be decisive.

Weismann has also shown by means of his hypothesis of "simultaneous stimulation"[7] the unconvincingness of a certain type of experiment. Thus Fischer showed that when chrysalids of *Arctia caja* are subjected to low temperature a certain number of them produce dark-colored insects; and further that these moths mated together yield dark-colored offspring. This has been held to prove somatic inheritance, but Weismann points out that it is explicable by the low temperature having an identical effect on the color-determinants existing in the wing-rudiments of the pupa, and on the same determinants occurring in the germ-cells.

It does not seem to me worth while to go in detail into the evidence by which somatists strive to prove their point, because I do not know of any facts which are really decisive. That is to say, that though they are explicable as due to somatic inheritance, they never seem to me absolutely inexplicable on Weismann's hypothesis. But, as already pointed out, it is not necessary to look for special facts and experiments, since if the mnemic theory of ontogeny is accepted the development of every organism in the world depends on somatic inheritance.

I fully acknowledge the strength of Weismann's position; I acknowledge also most fully that it requires a stronger man than myself to meet that trained and well-tried fighter. Nevertheless, I shall venture on a few remarks. It must be remembered that, as Romanes[8] pointed out, Weismann has greatly strengthened his theory of heredity by giving up the absolute stability and perpetual continuity of germ-plasm. Germ-plasm is no longer that mysterious entity, immortal and self-contained, which used to suggest a physical soul. It is no longer the aristocrat it was when its only activity was dependent on its protozoan ancestors, when it reigned absolutely aloof from its contemporary subjects. The germ-plasm theory of to-day is liberalized, though it is not so democratic as its brother sovereign pangenesis, who reigns, or used to reign, by an elaborate system of proportional representation. But in spite of the skill and

[7] I borrow this convenient expression from Plate's excellent book, "Ueber die Bedeutung des Darwin'schen Selectionsprincips," 1903, p. 81.

[8] "An Examination of Weismann," 1893, pp. 169, 170.

energy devoted to its improvement by its distinguished author, Weismannism fails, in my opinion, to be a satisfactory theory of evolution.

All such theories must account for two things which are parts of a single process but may logically be considered separately: (1) The fact of ontogeny, namely, that the ovum has the capacity of developing into a certain more or less predetermined form; (2) the fact of heredity—the circumstance that this form is approximately the same as that of the parent.

The doctrine of pangenesis accounts for heredity, since the germ-cells are imagined as made up of gemmules representing all parts of the adult; but it does not account for ontogeny, because there seems to me no sufficient reason why the gemmules should become active in a predetermined order unless, indeed, we allow that they do so by habit, and then the doctrine of pangenesis becomes a variant of the mnemic theory.

The strength of Weismann's theory lies in its explanation of heredity. According to the doctrine of continuity, a fragment of the germ-plasm is, as it were, put on one side and saved up to make the germ-cell of the new generation, so that the germ-cells of two successive generations are made of the same material. This again depends on Weismann's belief that when the ovum divides, the two daughter cells are not identical; that in fact the fundamental difference between soma and germ-cells begins at this point. But this is precisely where many naturalists whose observations are worthy of all respect differ from him. Weismann's theory is therefore threatened at the very foundation.

Even if we allow Weismann's method of providing for the identity between the germ-cell of two successive generations, there remains, as above indicated, a greater problem—namely, that of ontogeny. We no longer look at the potentiality of a germ-cell as Caliban looked on Setebos, as something essentially incomprehensible, ruling the future in an unknown way—"just choosing so." If the modern germ-cell is to have a poetic analogue it must be compared to a Pandora's box of architectonic sprites which are let loose in definite order, each serving as a master builder for a prescribed stage of ontogeny. Weismann's view of the mechanism by which his determinants—the architectonic sprites—come into action in due order is, I assume, satisfactory to many, but I confess that I find it difficult to grasp. The orderly distribution of determinants depends primarily on their arrangement in the ids, where they are held together by "vital affinities." They are guided to the cells on which they are to act by differential divisions, in each of which the determinants are sorted into two unequal lots. They then become active, *i. e.*, break up into biophores, partly under the influence of liberating stimuli and partly by an automatic process. Finally the biophores communicate a "definite vital force" to the appropriate cells.[9] This *may* be a description of what happens; but inasmuch as it fails to connect the process of ontogeny with physiological processes of which we have definite knowledge, it does not to me seem a convincing explanation.

For myself I can only say that I am not satisfied with Weismann's theory of heredity or of ontogeny. As regards the first, I incline to deny the distinction between germ and soma, to insist on the plain facts that the soma is continuous with the germ-cell, and that the somatic cells may have the same reproductive qualities as the germ-cells (as is proved by the facts of regeneration); that, in fact, the germ-cell

[9] "The Evolution Theory," English translation, I., 373 *et seq.*

is merely a specialized somatic cell and has the essential qualities of the soma. With regard to ontogeny, I have already pointed out that Weismann does not seem to explain its automatic character.

THE MNEMIC THEORY

If the mnemic theory is compared with Weismann's views it is clear that it is strong precisely where these are weakest—namely, in giving a coherent theory of the rhythm of development. It also bears comparison with all theories in which the conception of determinants occurs. Why should we make elaborate theories of hypothetical determinants to account for the potentialities lying hidden in the germ-cell, and neglect the only determinants of whose existence we have positive knowledge (though we do not know their precise nature)? We know positively that by making a dog sit up and then giving him a biscuit we build up something in his brain in consequence of which a biscuit becomes the stimulus to the act of sitting. The mnemic theory assumes that the determinants of morphological change are of the same type as the structural alteration wrought in the dog's brain.

The mnemic theory—at any rate that form of it held by Semon and by myself—agrees with the current view, viz., that the nucleus is the center of development, or, in Semon's phraseology, that the nucleus contains the engrams in which lies the secret of the ontogenetic rhythm. But the mode of action of the mnemic nucleus is completely different from that of Weismann. He assumes that the nucleus is disintegrated in the course of development by the dropping from it of the determinants which regulate the manner of growth of successive groups of cells. But if the potentiality of the germ nucleus depends on the presence of engrams, if, in fact, its function is comparable to that of a nerve-center, its capacity is not diminished by action; it does not cast out engrams from its substance as Weismann's nucleus is assumed to drop armies of determinants. The engrams are but cut deeper into the records, and more closely bonded one with the next. The nucleus, considered as a machine, does not lose its component parts in the course of use. We shall see later on that the nuclei of the whole body may, on the mnemic theory, be believed to become alike. The fact that the mnemic theory allows the nucleus to retain its repeating or reproductive or mnemic quality supplies the element of continuity. The germ-cell divides and its daughter cells form the tissues of the embryo, and in this process the original nucleus has given rise to a group of nuclei; these, however, have not lost their engrams, but retain the potentiality of the parent nucleus. We need not, therefore, postulate the special form of continuity which is characteristic of Weismann's theory.

We may say, therefore, that the mnemic hypothesis harmonizes with the facts of heredity and ontogeny. But the real difficulties remain to be considered, and these, I confess, are of a terrifying magnitude.

The first difficulty is the question how the changes arising in the soma are, so to speak, telegraphed to the germ-cells. Hering allows that such communication must at first seem highly mysterious.[10] He then proceeds to show how by the essential unity and yet extreme ramification of the nervous system "all parts of the body are so connected that what happens in one echoes through the rest, so that from the disturbance occurring in any part some notification, faint though it may be, is conveyed to the most distant parts of the body."

A similar explanation is given by Nägeli.

[10] E. Hering in Ostwald's *Klassiker der exakten Wissenschaften*, No. 148, p. 14; see also S. Butler's translation in "Unconscious Memory," p. 119.

He supposes that adaptive, in contradistinction to organic, characters are produced by external causes; and since these characters are hereditary there must be communication between the seat of adaptation and the germ-cells. This telegraphic effect is supposed to be effected by the network of idioplasm which traverses the body, in the case of plants by the intercellular protoplasmic threads.

Semon faces the difficulty boldly. When a new character appears in the body of an organism, in response to changing environment, Semon assumes that a new engram is added to the nuclei in the part affected; and that, further, the disturbance tends to spread to all the nuclei of the body (including those of the germ-cells), and to produce in them the same change. In plants the flow must be conceived as traveling by intercellular plasmic threads, but in animals primarily by nerve-trunks. Thus the reproductive elements must be considered as having in some degree the character of nerve-cells. So that, for instance, if we are to believe that an individual habit may be inherited and appear as an instinct, the repetition of the habit will not merely mean changes in the central nervous system, but also corresponding changes in the germ-cells. These will be, according to Semon, excessively faint in comparison to the nerve-engrams, and can only be made efficient by prolonged action. Semon lays great stress on the slowness of the process of building up efficient engrams in the germ-cells.

Weismann[11] speaks of the impossibility of germinal engrams being formed in this way. He objects that nerve-currents can only differ from each other in intensity, and therefore there can be no communication of potentialities to the germ-cell. He holds it to be impossible that somatic changes should be telegraphed to the germ-cell and be reproduced ontogenetically—a process which he compares to a telegram despatched in German and arriving in Chinese. According to Semon[12] what radiates from the point of stimulation in the soma is the primary excitation set up in the somatic cells; if this is so, the radiating influence will produce the same effect on all the nuclei of the organism. My own point of view is the following. In a plant (as already pointed out) the ectoplasm may be compared to the sense-organ of the cell, and the primary excitation of the cell will be a change in the ectoplasm; but since cells are connected by ectoplasm threads the primary excitation will spread and produce in other cells a faint copy of the engram impressed on the somatic cells originally stimulated. But in all these assumptions we are met by the question to which Weismann has called attention—namely, whether nervous impulses can differ from one another in *quality*?[13] The general opinion of physiologists is undoubtedly to the opposite effect—namely, that all nervous impulses are identical in quality. But there are notable exceptions, for instance, Hering,[14] who strongly supports what may be called the qualitative theory. I am not competent to form an opinion on the subject, but I confess to being impressed by Hering's argument

[11] Weismann, "The Evolution Theory," 1904, Vol. II., p. 63; also his "Richard Semon's 'Mneme' und die Vererbung erworbener Eigenschaften," in the *Archiv für Rassen- und Gesellschafts-Biologie*, 1906. Semon has replied in the same journal for 1907.

[12] Semon, "Mneme," ed. I., p. 142, does not, however, consider it proved that the nucleus is necessarily the smallest element in which the whole inheritance resides. He refers especially to the regeneration of sections of *Stentor* which contain mere fragments of the nucleus.

[13] I use this word in the ordinary sense without reference to what is known as *modality*.

[14] "Zur Theorie der Nerventhätigkeit, Akademische Vortrag," 1898 (Veit, Leipzig).

that the nerve-cell and nerve-fiber, as parts of one individual (the neuron), must have a common irritability. On the other hand, there is striking evidence, in Langley's[15] experiments on the cross-grafting of efferent nerves, that here at least nerve impulses are interchangeable and therefore identical in quality. The state of knowledge as regards afferent nerves is, however, more favorable to my point of view. For the difficulties that meet the physiologist —especially as regards the nerves of smell and hearing—are so great that it has been found simpler to assume differences in impulse-quality, rather than attempt an explanation of the facts on the other hypothesis.[16]

On the whole it may be said that, although the trend of physiological opinion is against the general existence of qualitative differences in nerve-impulses, yet the question can not be said to be settled either one way or the other.

Another obvious difficulty is to imagine how within a single cell the engrams or potentialities of a number of actions can be locked up. We can only answer that the nucleus is admittedly very complex in structure. It may be added (but this not an answer) that in this respect it claims no more than its neighbors; it need not be more complex than Weismann's germplasm. One conceivable simplification seems to be in the direction of the pangenes of De Vries. He imagines that these heritage-units are relatively small in number, and that they produce complex results by combination, not by each being responsible for a minute fraction of the total result.[17] They may be compared to the letters of the alphabet which by combination make an infinity of words.[18] Nägeli[19] held a similar view. "To understand heredity," he wrote, "we do not need a special independent symbol for every difference conditioned by space, time or quality, but a substance which can represent every possible combination of differences by the fitting together of a limited number of elements, and which can be transformed by permutations into other combinations." He applied (*loc. cit.*, p. 59) the idea of a combination of symbols to the telegraphic quality of his idioplasm. He suggests that as the nerves convey the most varied perceptions of external objects to the central nervous system, and there create a coherent picture, so it is not impossible that the idioplasm may convey a combination of its local alterations to other parts of the organism.

Another theory of simplified telegraphy between soma and germ-cell is given by Rignano.[20] I regret that the space at my command does not permit me to give a full account of his interesting speculation on somatic inheritance. It resembles the theories of Hering, Butler and Semon in postulating a quality of living things, which is the basis both of memory and inheritance. But it differs from them in seeking for a physical explanation or model of what is common to the two. He compares the nucleus to an electric accumulator which in its discharge gives out the same sort of energy that it has received. How far this is an allowable parallel I am not prepared to say, and in what follows I have given Rignano's results in biological terms. What interests me is the conclusion that the impulse conveyed to the nucleus of the germ-cell is, as far as re-

[15] *Proc. Roy. Soc.*, 1904, p. 99. *Journal of Physiology*, XXIII., p. 240, and XXXI., p. 365.

[16] See Nagel, "Handbuch der Physiologie des Menschen," III. (1905), pp. 1–15.

[17] De Vries, "Intracellular Pangenesis," p. 7.

[18] I take this comparison from Lotsy's account of De Vries's theory. Lotsy, "Vorlesungen über Deszendenztheorien," 1906, I., p. 98.

[19] Nägeli's "Abstammungslehre," 1884, p. 73.

[20] For what is here given I am partly indebted to Signor Rignano's letters.

sults are concerned, the external stimulus. Thus, if a somatic cell (A) is induced by an external stimulus (S) acting on the nucleus to assume a new manner of development, a disturbance spreads through the organism, so that finally the nuclei of the germ-cells are altered in a similar manner. When the cellular descendants of the germ-cells reach the same stage of ontogeny as that in which the original stimulation occurred, a stimulus comes into action equivalent to S as regards the results it is capable of producing. So that the change originally wrought in cell A by the actual stimulus S is now reproduced by what may be called an inherited stimulus. But when A was originally affected other cells, B, C, D, may have reacted to S by various forms of growth. And therefore when during the development of the altered germ-cell something equivalent to S comes into play, there will be induced, not merely the original change in the development of A, but also the changes which were originally induced in the growth of B, C, D. Thus, according to Rignano, the germ-nucleus releases a number of developmental processes, each of which would, according to Weismann, require a separate determinant.

If the view here given is accepted, we must take a new view of Weismann's cases of *simultaneous stimulation, i. e.,* cases like Fischer's experiments on *Arctia caja,* which he does not allow to be somatic inheritance. If we are right in saying that, the original excitation of the soma is transferred to the germ-cell, and it does not matter whether the stimulus is transferred by "telegraphy," or whether a given cause, *e. g.,* a low temperature, acts simultaneously on soma and germ-cell. In both cases we have a given alteration produced in the nuclei of the soma and the germ-cell. Nägeli used the word *telegraphy* to mean a dynamic form of transference, but he did not exclude the possibility of the same effect being produced by the movement of chemical substances, and went so far as to suggest that the sieve tubes might convey such stimuli in plants. In any case this point of view[21] deserves careful consideration.

Still another code of communication seems to me to be at least conceivable. One of the most obvious characteristics of animal life is the guidance of the organism by certain groups of stimuli, producing either a movement of seeking (positive reaction[22]) or one of avoidance (negative reaction). Taking the latter as being the simplest, we find that in the lowest as in the highest organisms a given reaction follows each one of a number of diverse conditions which have nothing in common save that they are broadly harmful in character. We withdraw our hands from a heated body, a prick, a corrosive substance, or an electric shock. The interesting point is that it is left to the organism to discover by the method of trial and error the best means of dealing with a sub-injurious stimulus. May we not therefore say that the existence of pleasure and pain simplifies inheritance? It certainly renders unnecessary a great deal of detailed inheritance. The innumerable appropriate movements performed by animals are broadly the same as those of their parents, but they are not necessarily inherited in every detail; they are rather the unavoidable outcome of hereditary but unspecialized sensitiveness. It is as though heredity were arranged on a code-system instead of by separate signals for every movement of the organism.

It may be said that in individual life the penalty of failure is pain, but that the

[21] See Semon, *Archiv f. Rassen- und Gesellschafts-Biologie,* 1907, p. 39.

[22] See Jennings, "Behavior of the Lower Organisms."

penalty for failure in ontogenetic morphology is death. But it is only because pain is the shadow cast by Death as he approaches that it is of value to the organism. Death would be still the penalty of creatures that had not acquired this sensitiveness to the edge of danger. Is it not possible that the sensitiveness to external agencies by which structural ontogeny is undoubtedly guided may have a similar quality, and the morphological variations may also be reactions to the edge of danger. But this is a point of view I can not now enter upon.

It may be objected that the inheritance of anything so complex as an instinct is difficult to conceive on the mnemic theory. Yet it is impossible to avoid suspecting that at least some instincts originate in individual acquirements, since they are continuous with habits gained in the lifetime of the organism. Thus the tendency to peck at any small object is undoubtedly inherited; the power of distinguishing suitable from unsuitable objects is gained by experience. It may be said that the engrams concerned in the pecking instinct can not conceivably be transferred from the central nervous system to the nucleus of the germ-cells. To this I might answer that this is not more inconceivable than Weismann's assumption that the germ-cell chances to be so altered that the young chicken pecks instinctively. Let us consider another case of what appears to be an hereditary movement. Take, for instance, the case of a young dog, who in fighting bites his own lips. The pain thus produced will induce him to tuck up his lips out of harm's way. This protective movement will become firmly associated with, not only the act of fighting, but with the remembrance of it, and will show itself in the familiar snarl of the angry dog. This movement is now, I presume, hereditary in dogs, and is so strongly inherited by ourselves (from simian ancestors) that a lifting of the corner of the upper lip is a recognized signal of adverse feeling. Is it really conceivable that the original snarl is due to that unspecialized stimulus we call pain, whereas the inherited snarl is due to fortuitous upsets of the determinants in the germ-cell?

I am well aware that many other objections may be advanced against the views I advocate. To take a single instance, there are many cases where we should expect somatic inheritance, but where we look in vain for it. This difficulty, and others equally important, must for the present be passed over. Nor shall I say anything more as to the possible means of communication between the soma and the germ-cells. To me it seems conceivable that some such telegraphy is possible. But I shall hardly wonder if a majority of my hearers decide that the available evidence in its favor is both weak and fantastic. Nor can I wonder that, apart from the problem of mechanism, the existence of somatic inheritance is denied for want of evidence. But I must once more insist that, according to the mnemic hypothesis, somatic inheritance lies at the root of all evolution. Life is a gigantic experiment which the opposing schools interpret in opposite ways. I hope that in this dispute both sides will seek out and welcome decisive results. My own conviction in favor of somatic inheritance rests primarily on the automatic element in ontogeny. It seems to me certain that in development we have an actual instance of habit. If this is so, somatic inheritance must be a *vera causa*. Nor does it seem impossible that memory should rule the plasmic link which connects successive generations—the true miracle of the camel passing through the eye of a needle—since, as I have tried to show, the reactions of living things to their surroundings exhibit in the plainest way the universal presence of a mnemic factor.

We may fix our eyes on phylogeny and regard the living world as a great chain of forms, each of which has learned something of which its predecessors were ignorant; or we may attend rather to ontogeny, where the lessons learned become in part automatic. But we must remember that the distinction between phylogeny and ontogeny is an artificial one, and that routine and acquisition are blended in life.[23]

The great engine of natural selection is taunted nowadays, as it was fifty years ago, with being merely a negative power. I venture to think that the mnemic hypothesis of evolution makes the positive value of natural selection more obvious. If evolution is a process of drilling organisms into habits, the elimination of those that can not learn is an integral part of the process, and is no less real because it is carried out by a self-acting system. It is surely a positive gain to the harmony of the universe that the discordant strings should break. But natural selection does more than this; and just as a trainer insists on his performing dogs accommodating themselves to conditions of increasing complexity, so does natural selection pass on its pupils from one set of conditions to other and more elaborate tests, insisting that they shall endlessly repeat what they have learned and forcing them to learn something new. Natural selection attains in a blind, mechanical way the ends gained by a human breeder; and by an extension of the same metaphor it may be said to have the power of a trainer—of an automatic master with endless patience and all time at his disposal.

Francis Darwin

[23] This subject is dealt with in a very interesting manner in Professor James Ward's forthcoming lectures on the "Realm of Ends." Also in his article on "Mechanism and Morals" in the *Hibbert Journal*, October, 1905, p. 92; and in his article on Psychology in the "Encyclopedia Britannica," 1886, Vol. XX., p. 44.

THE ANALYST, THE CHEMIST AND THE CHEMICAL ENGINEER[1]

Let us consider that the terms, the analyst, the chemist and the chemical engineer, represent those members of the chemical profession who devote their time to the practical and industrial aspects of the science, as contrasted with the teachers of chemistry and the workers in abstract research.

The teacher of chemistry and the man of abstract research may be compared to the exciter, the industrial chemist to the dynamo, which supplies whatever power is to be derived from the science of chemistry, to the industrial world.

It is essential that the industrial chemist and the teacher should work closely together, that each should know the aims and needs of the other, if the power of chemical science is to be developed to its full capacity.

There is no more important member of the community to-day than the chemist. I doubt that there ever were more important members of the community even in the more primitive conditions of society than the men who smelted the iron, and tanned the leather, or the women who wrought and burned the earthen pots and dyed the fibers for weaving. And these technologists were the early representatives of the chemical profession, they were the industrial chemists of those early times—chemists to this extent: they knew the properties of certain substances and the chemical transformations in certain directions which these substances were capable of undergoing.

The soldier, the priest and the medicine

[1] Address delivered before the New Haven meeting of the American Chemical Society.

man were the members of the primitive horde to whom gravitated the honors, the wealth and the positions. But those who worked up natural resources, those who started manufacture, who developed industry and created wealth, were these not in reality the important members of the early community? Were they not in fact the founders of our modern civilization?

The reader of histories of chemistry is impressed at times by the emphasis laid upon the early speculators in chemistry who were all too apt in forming hypotheses. The known facts of chemistry, as shown by their applications in the industries, for some periods, have not been so well investigated and presented—I do not wish to disparage the hypothesis, but it seems as though the history of industrial chemistry had not had its due. When the shadow of the middle ages was lifting, in the fourteenth, fifteenth and sixteenth centuries, and inquisitive physicians and priests and others began to investigate and write on chemical subjects they found in the chemical industries of that time a wealth of material. Through the times of church and military domination, through the period of alchemical investigation and alchemical fraud, the industries appear to have maintained their integrity and on the whole to have handed down traditionally the sure knowledge of those who had gone before, along with additions as additional knowledge was acquired.

There is still a great opportunity for the man who will trace the development of industrial chemistry through all time and show its continuous and logical development. That there was such a continuous development in spite of migration, war, pestilence and theocracy, one must feel certain. The industrial man usually escapes many of the vicissitudes of life except poverty and work. It is easy for priest and soldier to quarrel with the man of strongly expressed ideas and of great self assertion, with the man striving for wealth and power, difficult with the simple manufacturer of raw materials into various commodities. It would not do to say that the manufacturer fared well through all the changing fortunes of ancient and medieval history, but we can well believe that in spite of adverse conditions he maintained his processes, added to them, and transmitted them to his successors by the traditional route.

The chemical technologist, represented by the early workers in chemical industries, preceded the industrial chemist as we know him to-day. Unarmed by systematic knowledge, unversed in the definite methods used to-day in investigating chemical industrial problems, he yet developed chemical industry in some instances to a condition which has not been modified in essential particulars, by the accumulated scientific knowledge of the present time. Consider, for example, the soap industry. The world over, soap is boiled to-day essentially as it was in the sixteen hundreds, before the birth of modern chemistry, two hundred years before the composition of fats was known, two hundred years before the nature of the alkalies or the process of saponification were understood. To-day we recover glycerol and salt, we use more soda and less potash, we are more skilled in the use of fillers in the manufacture, but on the whole the procedure is the same empirical one which has been used for three hundred years. In recent months something has been accomplished by Leimsdörfer in Germany and Mercklen in France, to rescue soap manufacture from empiricism, but the day is yet distant when scientific practise will be substituted for practical experience.

In many chemical industries the same

conditions prevail or prevail to a large extent. Think for a moment of the iron industry and other metallurgical branches, of the glass and particularly the pottery industry, and of other lines, and it is not difficult to see that the chemist has already much work laid out for him. The traditional empirical knowledge of chemical manufacture has always proved a rich field for the chemical investigator and it is as broad and rich and fruitful to-day as ever.

It is the chemist's prominent connection with the industrial life which characterizes our civilization, which gives him the preeminence which he enjoys in our own times. Along with the engineer he is the creator for good or bad of whatever originality there is in our modern life. Contrast his position in the community with that of other scientific men, the zoologist, the geologist, the botanist, and you are impressed with his somewhat closer connection with modern affairs and tendencies than theirs.

As I have stated there is no more important member of the community to-day than the chemist, and I think there is none who feels his importance less. Up to a certain point modesty is a pleasing attribute and desirable, but modesty which through inaction fails to obtain its just reward in position and emolument is scarcely so commendable.

We have heard the broader education of the chemist and the chemical engineer treated of with the fulness and the insight which the subject deserves, by members of the profession who spoke with authority. I want to speak for the broader *life* of the chemist. The broader life in the sense of his coming more in contact with men and affairs and tendencies of the times, of coming to play the important part he should play in the modern world. If I can indicate some of the points of contact, some of the opportunities in America, I shall be satisfied. And first I desire to consider the work of the analyst. The analyst is a chemist who, by various devices called methods of analysis, endeavors to ascertain the composition of substances. The chemical work of all manufacturing plants is mainly analytical and the analyst has come to be a great and important factor in the industrial world.

When one analyst meets another, he usually asks him the question "What method do you use?" and the reply is "I have a method of my own."

I trust that in my remarks I shall not in any way discourage originality among analysts, but I want to direct your attention to some of the consequences of individualism in matters of chemical analysis and suggest a remedy for them.

It will occcur to anybody at once that if a person has a chemical method which is worth applying, he ought convince others of its excellence. Much adverse criticism has been aimed at chemists and chemistry through their failure to deliver agreeing analytical results. A part of the trouble is due to incompetent analysts and a part to unsatisfactory methods and methods which are not uniform. The incompetent man is apparently a necessary evil in every line of work and is difficult to eliminate. Possibly an institute of chemists with strict qualifications would help in this matter. But there is no good reason why we should not have well-tried and uniform methods of analysis.

The reactions on which analytical methods are based are for the most part old and well known. The working out of a method is usually done by a chemist of inventive ability, who is able by various means to make a reaction complete and definite enough so that it will yield quantitative results. We may grant that such work can not be done by every analyst, but we must admit that every analyst is capable of using an analytical method and also of proving its value or the reverse: otherwise he is not worthy the name of analyst.

The great majority of analytical chemists are not inventors of analytical methods, they are only users of them. Usually when an analyst says: "I use a method of my own," he means that he has perhaps substituted a porcelain for a platinum crucible or one form of burette for another or altered the time of precipitation—in other words, introduced an unimportant variation into a standard method and named it his own. And thus we have in laboratories working in the same line a host of modifications of standard methods, which, while they do not necessarily cause a great difference in analytical results, do introduce a dangerous principle. And in some cases the application of this principle, that every analyst is privileged to modify methods as he chooses, leads to absolutely incorrect methods, as numerous cases which might be cited prove.

The remedy for this state of affairs is the recognition of the principle that no chemist is privileged to use any method or modification of a method which has not the approval of a representative committee of his brother chemists, authoritatively appointed by a chemical society to investigate the method. Further, that when a method is adopted by such a committee, no deviation from it should be allowable in the practise of any individual. In short, we should have standard methods of analysis and adhere to them.

The argument against these ideas will be that we do not want cook-book recipes in place of general analytical methods. If analytical chemistry is to be developed in a scientific way it must be made to yield absolute and not comparative results. There is much justice in these views. They were the views I held for a number of years. But it should be understood that these principles in their application and these general methods in hands less expert than they should be, have brought down upon the heads of chemists much indiscriminate criticism. A merely practical or business man does not have and can not be expected to have any particular insight into chemical methods, nor can he be expected to be able to judge of chemists. So long as he deals with one chemist only, and if this one happens to be a good analyst and to have good judgment, his faith in the profession may remain unchallenged. But if, for the sake of checking results he sends out ten identical samples to ten different chemists and receives ten reports of varying degrees of disagreement, his faith is likely to receive a shock. If he repeats the experiment and fares no better and if he finds that succeeding repetitions do not bring reasonable agreement, he may come to have in time nothing but cynical remarks to make about chemists and the science of chemistry. Of course the inaccurate and inexperienced analyst is a factor in the problem and must be considered, and while other means must be devised to eliminate this factor, as a practical necessity the large chemical societies must take up consistently and determinedly the problem of the unification of methods of analysis. The time has come when no analytical method can be left to individual judgment. Individual differences and individual preferences must be abandoned in favor of the greater good which will come from concerted action and unification in methods of analysis.

Something has already been done in the line I have suggested. The Agricultural Chemists, the Mechanical and Civil Engineers, the Leather Chemists' Association, the Society for Testing Materials, the National Fertilizer Association and individual firms employing many chemists or operating several laboratories, have done or are doing work along the line of unifying methods. Those whom I have mentioned are not the only ones who are doing this important work, but if they alone were engaged upon it it could fairly be assumed that perfect unification might not result. To be sure, they might not all be working on the same things, but it is certain that much more could be accomplished if the work were being done by one central organization such as our Chemical Society.

There are great advantages in work on unification of methods. It trains the chemist in the art peculiar to chemistry. The work does not require men of great or special talents; on the other hand, it can be done satisfactorily by good careful analysts of ordinary skill and common sense. What it does require before everything else is organization and after this reasonably careful analysts and organized effort. There is no body better able to take up the work in so far as it concerns industrial methods than the Division of Industrial Chemists and Chemical Engineers.

I should say that work of this kind should be considered under eight heads: (1) definitions of all terms requiring definition which come up during the progress of the work; (2) methods of sampling, which, if correct results are to be delivered, are fully as important as correct analyses; (3) uniformity in reporting analyses; (4) methods of analysis themselves—that is methods recommended; (5) other methods which deserve mention but which are not recommended; (6) comments on the methods recommended, possibly detailing the results of a committee's analytical work; (7) publication in convenient and suitable form so that the results may reach all who are interested; (8) provision for a permanent committee to keep the work alive and up to date.

If some such plan as this is carried out, every chemist in the country who is called upon to do analytical work in a given line, will know where to go for approved methods of analysis, and while this will not assure the public, in the absence of capable chemists, of accurate results, it will at least solve a part of the problem. In regard to a distinguishing mark which would guide the public in the selection of competent analysts, possibly a properly organized institute of chemistry would be able to set such a stamp upon a man. But no institute can be considered as worthy of its high calling unless it is organized from among the acknowledged representative leaders of the profession. Mediocre men at the head of an institute of chemistry can do little for the movement which we all must hope will in due season come to pass.

In regard to publication, I suppose there will be some who will say when the work is in full blast—if it ever is—"Nothing in the Journal but methods." But in the first place not all the detailed work need be printed, and if it appears necessary to print a good deal, I can only say that it is important work—as important for the general good of the chemical profession as any research now being conducted. Further, it is not only desirable work, but, as things stand now, it is necessary work, which we can not evade if we would. We as analysts will have to admit that through lack of enterprise or for some other reason we have in some cases, and I am afraid the cases are numerous, allowed the matter of commercial analysis to be forced upon our attention by manufacturers and business men, instead of foreseeing and meeting these demands. Content with discoveries in pure science and in the life within the laboratory, we have at times held too much aloof from the needs of the manufacturing and commercial community in which we dwell. The analyst has done much, but we may easily believe that he can do more.

By the unmodified term *chemist* in the industrial sense, we may understand one who does more than analytical work, but who has relatively little to do with construction or industrial operations on the large scale. He may be a consulting man, a research man and an analyst besides these, or in charge of a laboratory employing a number of men. Whatever his particular line of work, there are a number of his class who appear to come in contact too seldom with chemists in other lines, with men of affairs, and with the activities of their community. Their time is spent in their laboratory or in their dwelling. Their lives are, in the familiar phrase, too narrow. There is such a thing as development by indirection, and who shall say that that man is not literally a better chemist who is more active in entirely different lines during a portion of his day? I say this particularly to the younger men who are industriously working their way up in large laboratories—get in touch with business men and methods and with merely practical manufacturers. Such associations lead to new points of view and are most beneficial and suggestive.

The sadly abused term "chemical engineer" may even yet be rescued from disaster and placed where it belongs, describing that adequately trained chemist who is capable of applying chemistry where construction work and operation are required. The chemist who is an engineer has much to answer for, and when I use the term I mean the one who is at least as much a chemist as he is an engineer, and not merely an engineer who, by contact with chemists or laboratories, has picked up a vague idea of chemical methods and problems. Engineering is extremely attractive to the younger chemist on account of its spectacular works and there is a little danger of his over-estimating it as a profession and under-estimating his own. This attitude will easily be outgrown with age, but that it is a factor in diverting men from the serious study of chemistry after leaving the university is unquestionable. Great are the works of the chemical engineer, but even greater the opportunities. I shall try to indicate what I consider some of them.

The chemical engineers have let go and are still letting go many opportunities. They have allowed the civil and the mechanical engineers to appropriate fields peculiarly their own. For example, water and sewage purification, fuels and smoke consumption. They have allowed the engineer, by his greater enterprise, to enter and appropriate to a large extent many kinds of chemical manufacture on the large scale. By chemical manufacture I do not mean the manufacture of chemicals such as acids, alkalies and salts alone, but any manufacture which is based upon chemical change. Many of the very old industries such as ceramics and metallurgy are pre-eminently chemical industries, but it would seem in many cases as though they were conducted by engineers with the chemist hired as an aid in a minor capacity. And when I make this statement please understand it is not a criticism of the engineer but of the chemist.

There may be some who will say, as I have heard it said, that the problems connected with the lines of work I have mentioned are more of a mechanical than a chemical kind, or at least the chemical problems connected therewith are less difficult of solution than the mechanical. It seems equally foolish to make a claim of this sort and to answer it, but since the point has come up, a few suggestions may not be out of place. In the purification of sewage, it is true that there are needed well-designed conduits, tanks, filters, holding basins, etc., but it is equally true that the problem is from beginning to end a chemical one, whether precipitation methods or bacterial methods are used. You may say that bacteriology belongs to the biologist, but I think it is true that the problems connected with technical mycology are so largely chemical in nature that the chemist has at least an equal claim to them with the biologist. In bacterial sewage purification, we are not dealing with pure cultures; we supply the proper chemical conditions of oxidation or reduction, of alkalinity, etc., and assume that if the conditions are right the expected reactions under the influence of microorganisms will take place. If any engineer who is not a thorough chemist has a proper conception of the chemistry of sewage purification, I have not heard of him or read his works. I need not say more except that sewage works are usually constructed under the superintendence of engineers who hire analysts to make chemical determinations for them.

The problems connected with fuels and smoke consumption are chemical throughout, and again it is the exceptional engineer who has an adequate understanding of them; yet it can not be denied that the field belongs to the engineer at the present time by right of possession. The problem of smoke consumption was first adequately treated by an engineer and while we say now, glibly enough, that the solution of the problem lies in bringing the gases and solids in the furnace in contact with a sufficient air supply at a sufficiently high temperature, the problem was not so simply stated a few years ago. The problem is solved now at the cost of fire brick frequently renewed, but I am afraid the chemists' contribution to its solution was smaller than it should have been.

In conclusion, I trust that the future will see a closer contact between the votaries of the pure science of chemistry, the teachers of chemistry, the industrial chemists and the community at large. In that union lies the future successful development of the science and profession of chemistry.

W. D. Richardson

PRESENTATION TO PROFESSOR GOLDSCHMIDT

Professor Victor Goldschmidt, of the University of Heidelberg, to-day the foremost crystallographer, was, on his fifty-fifth birthday, presented with a silver punch-bowl by his former students in the United States and Canada. It is doubtful if any teacher of mineralogy either in America or Germany has instructed so many Americans who have since occupied positions of prominence having relation to the geological sciences. The following persons, twenty-five in all, contributed to the gift and signed the letter of birthday felicitation: M. B. Baker, Queens University (Kingston); Dr. Florence Bascom, professor of geology, Bryn Mawr College; Reginald W. Brock, acting director, Geological Survey of Canada; Dr. Hermon C. Cooper, associate professor of chemistry, Syracuse University; Dr. Reginald A. Daly, professor of geology, Massachusetts Institute of Technology; C. W. Dickson, Queen's University; Dr. William E. Ford, Jr., assistant professor of mineralogy, Sheffield Scientific School; Dr. C. H. Gordon, professor of geology, University of Tennessee; Dr. W. F. Hillebrand, U. S. Geological Survey; Dr. Wm. H. Hobbs, professor of geology, University of Michigan; Dr. T. A. Jaggar, Jr., professor of geology, Massachusetts Institute of Technology; Dr. A. C. Lawson, professor of geology and mineralogy, University of California; Dr. E. B. Mathews, professor of mineralogy, Johns Hopkins University; Dr. W. C. Mendenhall, U. S. Geological Survey;

Dr. W. G. Miller, provincial geologist, Ontario; William Nicol, professor of mineralogy, Queen's University; Dr. Chas. Palache, assistant professor of mineralogy, Harvard University; Dr. Joseph W. Richards, professor of metallurgy and mineralogy, Lehigh University; Walter S. Landis, Lehigh University; Dr. H. Monmouth Smith, professor of chemistry, Syracuse University; J. S. Stanley-Brown, editor Geological Society of America; Dr. Frank R. Van Horn, professor of mineralogy and geology, Case School of Applied Science; Dr. T. L. Walker, professor of mineralogy and petrography, University of Toronto; Dr. Fred E. Wright, Carnegie Institution; Dr. C. W. Wright, U. S. Geological Survey.

SCIENTIFIC NOTES AND NEWS

At the Put-in-Bay meeting of the Astronomical and Astrophysical Society of America, the following officers were elected for the ensuing year:

President—E. C. Pickering.
First Vice-president—G. C. Comstock.
Second Vice-president—W. W. Campbell.
Secretary—W. J. Hussey.
Treasurer—C. L. Doolittle.
Councilors—Ormond Stone, W. S. Eichelberger, Frank Schlesinger, W. J. Humphreys.

A committee was appointed with power to determine the time and place of the next meeting.

The British Ornithologists' Union will celebrate its fiftieth anniversary in December next, when gold medals will be presented to the four surviving original members: Dr. F. Du Cane Godman, F.R.S., Mr. P. S. Godman, Mr. W. H. Hudleston, F.R.S., and Dr. P. L. Sclater, F.R.S.

Dr. Josiah Royce, of Harvard University, gave one of the principal addresses before the third International Philosophical Congress, which began its sessions at Heidelberg on September 1.

The First International Moral Educational Congress is being held at the University of London, September 25–29, under the presidency of Professor Michael E. Sadler.

Professor D. J. Hamilton, F.R.S., has, in consequence of ill health, resigned the chair of pathology in the University of Aberdeen.

Mr. F. B. Smith, director of agriculture for the Transvaal, is visiting England.

Dr. Emil Kraepelin, professor of psychiatry at Munich, who has been visiting this country, has returned to Germany.

Dr. J. C. Bose, professor in the University of Calcutta, India, author of "Response in the Living and Non-living," "Plant Response, as a Means of Physiological Investigation" and of "Comparative Electro-physiology," has been lecturing for the past few months on the continent and in England on the phenomena as brought out by his methods of experimentation. He expects to visit this country during October and November, and wishes to visit the more prominent institutions of the east and middle west. He will be very glad to lecture on his researches free of charge to university audiences or before scientific societies. Any institution that may wish to make arrangements for a series of three or four lectures by Dr. Bose, may address him in care of Mr. R. N. Tagore, Box 135, University Station, Urbana, Ill.

Professor C. H. Hitchcock will leave for Hawaii on the first of October. He goes to complete his book upon the Hawaiian volcanoes, which is to be published by the Hawaiian Gazette Company of Honolulu. Kilauea was never in better condition for study than now. The great pit is gradually filling up, and when the hydrostatic pressure of the column is too great to be maintained in its place the lava will escape into some unseen subterranean caverns, if it does not flow out at the surface on the lower ground.

Brigadier General James Allen, chief of the United States Signal Corps, attended the International Electrical Congress at Marseilles, France, from September 14 to 19, as a representative of the United States army. Incidentally he will make a general investigation of what is being done in the development of war balloons and aeroplanes.

President Charles W. Eliot, of Harvard University, is to deliver, on October 15, the address to mark the opening of the Brooklyn Institute of Arts and Sciences, on which occasion his subject will be "The Building and Administration of a Modern City."

The president of the British Local Government Board has arranged for the making of the following additional researches in connection with the annual grant voted by parliament in aid of scientific investigations concerning the causes and processes of disease: 1. A chemical and bacteriological investigation by Mr. C. G. Moor, M.A., F.I.C., and Dr. Hewlett, professor of pathology at King's College, London, as to the influence of softening and of other chemical processes on the purity of water supplies from the chalk, as shown in actual experience and under experimental conditions. 2. An investigation by Professor Sidney Martin, F.R.S., into the powers of production of disease possessed by certain streptococci and by the poisonous substances produced by them, in continuance of previous investigations by him on the same subject.

We much regret to record here the death of Lieutenant Thomas E. Selfridge and the injury to Orville Wright in the aeroplane experiments, which up to that time had proceeded so auspiciously.

Dr. Charles Harrington, professor of hygiene in the Harvard Medical School and chairman of the Massachusetts State Board of Health, died suddenly in England on September 11, at the age of fifty-two years.

The death is announced of the Earl of Rosse, F.R.S., who, like his father, made valuable contributions to astronomy.

M. E. Mascart, since 1871 director of the French Meteorological Office, has died at the age of seventy-one years.

Dr. Ernst Ebermeyer, formerly professor of agriculture at Munich, has died at the age of seventy-nine years.

Dr. Hermann von Peetz, docent for geology at St. Petersburg, died on July 18, as the result of an accident while engaged in geological explorations.

We regret also to record the death of M. Auguste Daguillon, professor of botany at Paris, and of Prince Iwan Romanowitsch Tarchanow, professor of physiology at the Military Medical College at St. Petersburg.

The growth of the American Chemical Society has been so rapid this year that the publications for the early part of the year are exhausted. As new members are still coming in rapidly and are entitled to back *Journals* for this year on payment of their dues the Council has by the force of circumstances been obliged to grant half-year membership with half year dues for the last half of 1908 only. The size of the editions of the *Journal* and the *Abstracts* has been largely increased and the difficulty will probably not arise again.

It is announced that plans have been filed for the main hospital building and isolation annex of the Rockefeller Institute for Medical Research. The main building is to be a seven-story brick edifice, and the isolation wards will be in a two-story building connected with the main building by steel bridges. The estimated cost of the hospital is $350,000, the isolation annex $50,000, and the additional power house $4,000.

It is stated in *Nature* that the herbarium formed by Mr. Duthie, and hitherto quartered at Saharanpur, has been transferred to the Imperial Forest Institute, Dehra Dun; any correspondence in connection with it should be addressed to the imperial forest botanist of that institute.

The Second Annual Congress of the Playground Association of America met at the American Museum of Natural History, New York, from September 8 to 12. The association endeavors to show that properly supervised playgrounds help to produce good citizens, and an effort will be made to interest every American city in playgrounds.

In view of the very rapid development and progress of aerial navigation, it is proposed to establish a section at the Royal Polytechnic School of Naples, in which young engineers shall be trained in all that refers to the problems of flight, so far as it is known, both from a theoretical and practical point of view.

THE condition on September 1, with comparisons, of the various crops investigated by the Bureau of Statistics of the United States Department of Agriculture is as follows:

Crops	September 1			Aug. 1, 1908
	1908	1907	10 year Aver.	
Corn	79.4	80.2	81.0	82.5
Spring wheat	77.6	77.1	77.9	80.7
Oats	69.7	65.5	30.7	76.8
Barley	81.2	78.5	83.5	83.1
Buckwheat	87.8	77.4	86.5	89.4
Tobacco	84.3	82.5	83.7	85.8
Flaxseed	82.5	85.4	87.0	86.1
Rice	93.5	87.0	88.8	94.6
White potatoes	73.7	80.2	80.8	82.9
Sweet potatoes	88.7	85.7	85.3	88.8
Tomatoes	82.5	82.9	....	84.5
Cabbage	80.3	85.2	....	84.5
Onions	85.8	88.0	....	88.4
Beans	82.8	82.7	....	....
Apples	52.3	34.7	54.7	52.2
Peaches	67.5	30.7	53.0	67.1
Grapes	84.6	81.1	83.0	87.1
Pears	74.1	....	....	70.6
Watermelons	80.8	76.3	....	79.5
Cranberries	67.7	77.7	....	....
Oranges	88.2	84.1	....	89.1
Lemons	92.9	91.4	....	93.0
Sugar cane	91.3	94.1	90.4	88.3
Sorghum	85.5	82.4	....	85.4
Sugar beets	86.0	92.4	....	87.3
Broom corn	76.6	82.8	....	80.3
Hemp	73.0	85.9	....	77.4
Hops	79.3	88.5	....	86.4
Peanuts	86.0	85.6	....	85.5
Cotton (August 25)	76.1	72.7	73.9	83.0
Alfalfa (production)	90.7	91.8	....	88.8
Cloverseed (Acreage compared with preceding year, per cent.)	120.0	99.6	....	....
Cloverseed (condition)	89.7	76.5	.. ..	89.7
Millet	86.9	84.4	....	86.3
Kafir corn	85.1	83.1	....	....
Hay, yield per acre, tons	1.52	1.45	1.44	....
Hay, yield, tons (000 omitted)	67,743	63,677	....	....
Hay, quality	94.5	90.4	....	....
Rye, yield per acre, bu.	16.4	16.4	15.8	....
Rye, yield, bu. (000 omitted)	30,921	31,566	....	....
Rye, quality	92.7	91.6	....	....
Stock hogs, No. compared with preceding year	92.5	10.06	....	....
Stock hogs, condition	94.5	19	....	....

THE following facts were taken by Vice-consul James L. A. Burrell, of Magdeburg, from a brochure by Dr. Ernst Friedrich, of the German commercial high school at Leipzig: The world's lumber trade amounts to $285,600,000 annually, of which the United States furnishes about 20 per cent, Austria-Hungary 19 per cent., Russia 16 per cent., Canada 13 per cent., Sweden 18 per cent., Finland 10 per cent., Norway 4 per cent. and Roumania also a small quantity. The countries importing wood are those on the highest economical plane, which were themselves in earlier times densely wooded, but whose forests have been denuded to a greater or less extent to make room for agriculture, industry, etc. Only 4 per cent. of the territory of Great Britain is covered with forests, and during the year 1906 that country imported lumber to the value of $135,561,750. Germany has still 26 per cent. of its territory covered by forests, but imported in 1906 lumber valued at $61,285,000. Belgium and the Netherlands, that have but 8 per cent. forest lands, Denmark, that has 7 per cent., France and Switzerland, with a small percentage of forest land, are compelled to import lumber. Besides these countries, those lands lying on the dry western side of the subtropical zone lacking forests are forced to import wood. Egypt imports wood and coal to the value of about $16,660,000 annually; Algeria, Tunis, Spain, Portugal (3 per cent. forest land), Italy, Greece (with 9 per cent. forest land), the eastern part of Asia, British South Africa, the western parts of Chile and Peru, the Argentine Republic and Australia, all poor in wood, are dependent upon import.

THE Royal Commission on Sewage Disposal, appointed by the British government in 1898, has issued its fifth report, which deals chiefly with the relative merits of the various methods which are available for the purification of sewage of towns. The commissioners have held 144 meetings and called before them a large number of witnesses. A number of local authorities have carried out experimental investigations in association with the commission, the members of which have personally inspected a large number of sewage works. The general conclusion of the commissioners is as follows: "We are satisfied that it is practicable to purify the sewage of towns to any degree required, either by land treatment or by artificial filters, and that there is no essential difference between the two processes, for in each case the purification, so far as it is not mechanical, is chiefly effected by means of microorganisms. The two main questions, therefore, to be considered in the case of a town proposing to adopt a system of sewage purifications are: First, what degree of purification is required in the circumstances of that town and of the river or stream into which its liquid refuse is to be discharged? Second, how the degree of purification required can, in the particular case, be most economically obtained? . . . We may state that we know of no case where the admixture of trade refuse with the sewage makes it impracticable to purify the sewage either upon land or by means of artificial processes, although in certain extreme cases special processes of preliminary treatment may be necessary."

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Mrs. Jane A. Townsend, Yale University received $50,000 for the endowment of a professorship of history.

Maryville College at Knoxville, Tenn., has received $5,000 from Mrs. William Thaw, of Pittsburgh.

A fire on the fourth floor of McCoy Hall of the Johns Hopkins University, on the night of September 17, destroyed valuable manuscripts and archeological collections and damaged a large collection of books and pamphlets.

There were 137 students in attendance at the graduate school of agriculture, held this year at Cornell University, in addition to regular students of the university. In the summer session of the university there were 841 students.

According to a press cablegram, the chancellor of St. Petersburg University, Professor Ivan Ivanovic Borgmann and the vice-chancellor, Professor Fedor Alexandrovic Braun, have resigned from the institution. The faculty of the university has sent a collective declaration to M. Schwartz, the minister of education, stating that his recent repressive measures against professors and students endanger peace at the university, and declines to accept the responsibility for disorders that may occur.

In stating that in 1907 there were in Europe 125 universities, which were visited by 228,732 students, Vice-Consul James L. A. Burrell, of Magdeburg, sends details. Of these the university of Berlin had the largest number of students, viz., 13,884; next came Paris with 12,985, Budapest with 6,551, and Vienna with 6,205. The list by country follows:

Country	No. of Universities	Students
Germany	21	49,000
France	16	32,000
Austria-Hungary	11	30,000
England	15	25,000
Italy	21	24,000
Russia	9	23,000
Spain	9	12,000
Switzerland	7	6,500
Belgium	4	5,000
Sweden	3	5,000
Roumania	2	5,000
Holland	5	4,000

The smaller countries—Greece, Norway, Portugal, Denmark, Bulgaria, and Servia—have each one university.

Dr. William Osler, regius professor of medicine at Oxford University, has been elected lord rector of Edinburgh University.

Dr. Harry A. Garfield will be installed as president of Williams College on October 7.

Mr. Robert Forsyth Scott, the author of works on mathematics, has been elected master of St. John's College in place of the late Rev. Dr. Charles Taylor.

The trustees of the University of North Carolina have made the following appointments: Professor Charles H. Herty to be dean of the School of Applied Science; Associate Professor J. E. Latta, professor of electrical engineering; Professor A. H. Patterson, formerly of the University of Georgia, professor of physics; Associate Professor W. C. Coker to be professor of botany; Associate Professor Archibald Henderson to be professor of pure mathematics; instructors in mathematics, G. K. G. Henry and J. C. Hines, Jr.; instructor in physics, T. J. McManis. The university has just completed at the cost of $35,000, a new laboratory for the department of biology.

Recent appointments at the University of Kansas are as follows: L. D. Havenhill, professor of pharmacy; assistant professors, G. W. Hartwell in mathematics, Burton McCullum in physics, H. C. Allen in chemistry, and A. H. Sluss in mechanical engineering; instructors Paul Wernicke, Mayer Gaba, C. A. Pierce in mathematics; F. U. G. Agrelius in botany; R. L. Moodie in zoology; Cecil Smith in physiology, and C. H. Wittington museum assistant in entomology.

The following appointments have been made at Lehigh University: Instructors, R. G. Fogg, B.S., in civil engineering; H. E. Hendricks, B.S., in civil engineering; H. A. S. Howarth, Ph.B., in mechanical engineering; F. T. Leilich, E.E., in physics; Edgar T. Wherry B.S., and Chester G. Gilbert, Ph.B., in mineralogy; Assistants: Walter K. Van Haagen, B.S., in chemistry; Edwin E. Reinke, B.A., in biology.

Dr. S. N. Taylor, of Pittsburg University, has been appointed professor of electrical engineering at the University of Cincinnati.

Washburn College, Topeka, Kans., has established this year a department of botany and zoology with Dr. C. H. Edmondson, of the University of Iowa, in charge of zoology and Dr. Ira D. Cardiff, University of Utah, in charge of botany.

Mr. A. B. Frizell has been appointed professor of mathematics at Midland College, Atchison, Kansas.

In Manchester University, Mr. J. E. Petavel, D.Sc., F.R.S., lecturer in mechanics and in meteorology and demonstrator in physics, has been appointed professor of engineering; Mr. C. H. Lander, lecturer in engineering; Mr. T. G. B. Osborn, lecturer in economic botany; Mr. F. H. J. A. Lamb, M.D., now demonstrator in physiology, Cardiff University College, senior demonstrator in physiology; Mr. A. E. Woodall, junior demonstrator in physiology; Mr. T. W. Todd, senior demonstrator, and Mr. E. E. Hughes, and Mr. S. H. J. Kilroe, junior demonstrators in anatomy.

Dr. Heinrich Burkhardt, professor of mathematics at Zurich, has been called to the Technical Institute at Munich.

DISCUSSION AND CORRESPONDENCE

THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING

To the Editor of Science: The observations of Professor George F. Swain, of The Massachusetts Institute of Technology, in the issue of August 28, on "The Teaching of Mathematics to Students of Engineering," are as valuable and suggestive as they are frank and progressive. They stand out clearly as the practical judgment of one in close touch with the needs of engineering. While these observations touch primarily the field of mathematics, and applied mathematics, and while we are compelled to let each specialty speak for itself; yet the same ideas, of using school training as a tool for practical use, and the necessity of developing the practical imagination, these ideas are quite as essential in other fields of natural science. As a teacher of chemistry, and one specially interested in the newer industrial and trades-school movement, I wish to emphasize the value of Professor Swain's remarks for chemistry in particular, and, presumably, for most of the other sciences in general. The contrast of view between the remarks of Professor Schlichter and Professor Swain is obviously that between the traditional teacher and the progressive engineer. The one looks at science from the standpoint of the teacher of theory; the other, from that of the user of school training. And in this difference, as clearly shown by Professor Swain, is the new suggestion which is probably destined to be the basis of all industrial training. In a word, it is the pedagogical idea that the practical man learns by using. The question, "What is it good for?" has often been feared and avoided as the badge of cheap superficiality, on the one hand; and, on the other hand, as a serious menace to sound and honest research. But are we not now in a position where we may safely trust the well-trained teacher to use the actual need, and to employ the use of a science, as guides in teaching and learning that science? The immense advantage to be gained, for many students, by the combined assistance of the eye and the hand suggests that it may be best to start with actual tests and problems. This will place the student squarely face to face with facts and needs. This will also quicken the interest of the student; and it may prove to be the perpetual provider of a keen interest, that subtle psychological stimulus which spurs every good worker to success. Once given this start, and with the well-trained teacher, the student is naturally led to the helpful guidance of books and theory. Necessity is still the mother of progress; and we need not fear the sad augury implied in Professor Schlichter's remarks on teaching "dyeing and not chemistry." The student need not be "out of date," either at the start or later, if he is naturally led to the books and literature on his special field. Moreover, the student who starts with the practical, is always in touch with the actual needs of his craft—something which is often a sealed book to the theorist. It is not to be denied that this reversal of the application of theory to fact and need has its difficulties and dangers; so do all systems of education. But it looks like the solution of the technical and industrial education problem. It is to be hoped that this idea will not be allowed to slip from the attention of educators—the idea of using the fact, the problem, the need, the experiment—as the natural starting point for education, for teaching theory, and to catch the interest of the student. It bears three marks of genuineness, namely: It meets the practical needs; it catches the interest of the student; and it exemplifies the inductive method of learning through use.

Charles S. Palmer
23 Park Place,
Newtonville, Mass.,
August 29, 1908

HUMMINGBIRD AND HORNET

Early in the summer of 1907 a dish of sweetened water was placed on the railing of the veranda of a cottage in North Acton, Mass. The next morning a female hummingbird was seen hovering over it. In a few days she became so accustomed to the presence of the family that she would feed from the vessel while a number of persons were sitting only a few feet away.

This year (1908) the cottage was first occupied on June 2. The next morning a pair of hummers were seen hovering over the railing where the sweetened water had been placed the year before. A saucer of water containing a few lumps of sugar was immediately provided for them.

They helped themselves frequently from this for several days, when the male disappeared. The female has continued her visits to the saucer many times each day up to the present time (August 24).

On July 22, while sitting within five feet of the vessel, I noticed, for the first time, a bald-faced hornet (*Vespa maculata*) inside the saucer. As I watched its motions, the hummingbird appeared, hovering over its accustomed feeding place. Instantly the hornet darted at it, and the hummer fled, closely pursued by the insect. The spectacle exactly resembled, on a small scale, the driving of a hawk or crow by a kingbird. In a minute or two the hornet was back exploring the contents of the saucer.

Presently the hummer returned, poised itself over the tempting dish, long enough to see that its enemy was on the ground, when it fled precipitately. She still (August 24) continues to come many times each day, only attempting to feed when the field is clear of hornets.

Charles W. Mead
American Museum of Natural History

QUOTATIONS

THE NEW BRITISH PATENTS ACT

This act, the Patents and Designs Act, became operative on August 28. Its principal clause runs as follows: "At any time, not less than one year after the passing of this act, any person may apply to the Comptroller for the revocation of the patent, on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside of the United Kingdom." In future, foreign manufacturers, if they wish their patents to remain valid in Great Britain, will have to make the goods they sell within the United Kingdom. Otherwise their patents may be copied or infringed at will. Germany and the United States are particularly hit by the new enactment, and they are meeting the altered conditions by (1) building factories of their own in England; (2) acquiring premises already built for the purpose of carrying on their business; (3) arranging with British manufacturers to lay down plant and cooperate in the production of the special articles which are the subject of the patent. Already some thirty foreign firms—many of them conducting operations on a large scale—have begun, or are about to begin operations in this country, most of them choosing the north of England as the scene of their operations. It is said that as a rule the foreign manufacturer is providing a factory many times larger than is really necessary for the construction of his patented article, his explanation being that he can not run works in England on patents alone, and he intends therefore to manufacture in this country goods that have hitherto been imported ready-made. So far as can be seen at present the act must profit British labor. It is said in some quarters that these manufactures, at any rate the German ones, will be worked by foreign staffs, but this is not the case at present with Messrs. Meister, Lucius and Brünning (Limited), of Germany, a company with a capital of £11,000,000, which has just erected a new chemical factory at Ellesmere Port. Here all the workers employed are English, with the exception of a few German overseers. The working of the act will be watched with keen and anxious attention, for British manufacturers are beginning to realize that foreign competition is about to invade their own particular territory, and that there will be a fair but strenuous fight on British soil for British custom. That is not a prospect that can be viewed altogether without anxiety when the perfection of German organization is remembered. The German things to be manufactured in England will be mostly aniline dyes, pottery, plants for gas making, rifles, plated goods, electrical contrivances, furnaces, sanitary appliances; the American, typewriters, safety razors, phonograph records, shoes, telephones and wire roofing.—*Journal of the Society of Arts.*

SCIENTIFIC BOOKS

The Physiology of the Stomata. By Francis Ernest Lloyd. Pp. 1–142; f. 40, pl. 14. Carnegie Institution of Washington, Publication, No. 82.

The purpose of this study has been twofold: first, to determine to what extent the stomata are able to regulate transpiration; secondly, to ascertain the physiological cause of stomatal movement. The investigation was carried on almost exclusively with two desert plants, *Fouquieria splendens* and *Verbena ciliata.* Both of these plants were found to have leaves of the usual tropophytic character and without any of the obvious adaptive characters related to desert conditions. The rate of transpiration was determined by reading the volume of water absorbed from burettes to which cuttings of the plants were attached. By weighing any error due to the absorption of water by the tissues of the shoot or its loss by wilting was corrected. To determine the area of the stomatal openings at various times of day and so to correlate the movements of the guard-cells with the fluctuations of transpiration, portions of the epidermis were removed and fixed in absolute alcohol. It was found that this treatment had no appreciable effect upon the guard-cells and consequently the exact area of the stomatal openings could be determined at any moment desired. The experiments revealed no correlation between the daily periodicity of transpiration and stomatal movement. On the other hand, it was first of all found that the rate of transpiration increased for a considerable time after the maximum stomatal opening in the early morning and that finally the rate may undergo sudden and wide changes without the accompaniment of a sufficient change in the dimensions of the stomata to account for them on the theory of stomatal regulation of transpiration. This latter result is in accord with the conclusions of Brown and Escombe who have found that the diffusion capacity of the stomata are quite generally greatly in excess of the actual maximum rate observed.

The experiments conducted under constant conditions demonstrated that transpiration is a physiological process, and not a physical one and that it is not to be looked upon as a necessary evil with which the plant has to contend. The rhythm of transpiration under constant conditions could not be correlated with stomatal movements and indeed it was later found in the case of wilting leaves that the beginning of the closure of the stomata occurs somewhat later than the initial wilting of the leaf and this movement appears rather as a result of the loss of water by the leaf as a whole than as a response in anticipation of wilting. The results of all the experiments indicate that the stomata are not adaptive structures in the active sense and if a regulation of transpiration exists it is effected by other means.

A valuable portion of the study is to be found in the second part of the work, dealing with the physiology of the guard-cells. By comparisons of the contents of the guard-cells taken at periods corresponding to the stomatal movements observed in connection with the work on transpiration, the writer found that these movements are correlated with marked changes in the nature of the cell contents. Thus it was found that starch begins to accumulate in the guard-cells in the afternoon, the maximum amount being observed in the night, while during the earlier hours of the morning the starch largely disappears, globules of oil, frequently one in each guard cell, taking its place. The movements and periods of stacis of the stomata were closely correlated with these fluctuations of the starch contents and it is inferred that the disappearance of the starch and the openings of the stomata are connected with the action of some unknown ferment. This conclusion necessitated the hypothesis that the metabolism of the guard-cells is radically different from that of the mesophyll cells and evidence was found to warrant this conclusion. The guard-cells were seen to accumulate starch at a time when it was disappearing from the ordinary chlorenchyma and on the other hand they were quite free of starch when photosynthesis was most active. This difference in function was further emphasized by experiments in which the leaves were exposed to the blue end of the spectrum, to darkness and to air devoid of carbon dioxide—under all of these conditions the plastids of the guard cells continued to accumulate starch though photosynthesis was impossible. It is maintained that the starch occurring in the guard cells is derived from the carbohydrates in the mesophyll and that the function of the chlorophyll in the guard-cells is in part, probably largely, secretory. It becomes necessary in accepting this hypothesis on the rôle of the guard-cells to assume that the ferment operative in the transformation of starch is of a radically different nature from other amylases since it is absent or inactive during the night and because of its marked activity during the earlier morning hours.

In conclusion the author finds no evidence in the behavior of the stomata studied to justify the conclusion that they in any way adapt these plants to the unfavorable conditions of the desert. He holds that the prevalence and magnitude of the devices that characterize xerophytes does not indicate that these plants have become fitted to their environment, but being fitted, they have survived. It must be conceded, however, that practically identical xerophytic characters occur under a wide range of external conditions that are physiologically equivalent.

Carlton C. Curtis

The Principles of Direct-current Electrical Engineering. By James R. Barr, A.M.I.E.E., Lecturer in Electrical Engineering, Heriot-Watt College, Edinburgh. New York, The Macmillan Company; London, Whittaker & Co. 1908. Pp. viii + 551; 294 illustrations.

There are several ways in which the general subject of electrical engineering may be divided for study or treatment in text-books. One very general scheme is first to take up the study of direct-current phenomena as applied to direct-current machinery, then to consider the study of alternating currents and alternating-current machinery, and finally to study the subject of transmission and distribution of power by both direct and alternating currents. A second method of division is to consider direct currents as a special case of periodic currents and to make the general division of the study of generators and receivers between induction apparatus and synchronous machines. Here again the subject of transmission and distribution is treated after a study of the machinery of both classes. A third classification consists of dividing the general subject into direct-current engineering and alternating-current engineering, treating under each head the generators, receivers, and systems of distribution utilizing direct currents or alternating currents as the case may be. For those who prefer the third classification the author has prepared a volume on the first division which should find a considerable application in colleges and technical schools.

The general method of treatment is not different from that used by other authors who prefer to consider direct-current engineering as separate from alternating-current phenomena. The first chapter is devoted to a review of the subject of units used, the relation of all practical units to the fundamental units being carefully stated. This is followed by chapters dealing with the laws of the electric circuit and the magnetic circuit, but before the application of these laws to the direct-current generator is taken up in detail a carefully written chapter on measuring instruments, in which the principle of operation and the sources of error of most of the instruments in common use are considered, is introduced, and this is followed by a brief study of the storage battery, electric lighting and cables. Three chapters are devoted to the direct-current generator, and in these three chapters the author has placed in a logical manner most of the information desired by those not interested directly in the details of designing. The subjects of motors and boosters are similarly treated and the book is completed by chapters on testing and electricity control, the final chapter setting forth the general principles involved in the design of the switchboard and of protective apparatus.

From the beginning the book deals primarily with the principles involved, the details of apparatus being introduced as illustrations of the manner in which the principles are applied rather than for the purpose of furnishing a catalogue of apparatus. To further aid the student in making application of general principles to calculations, carefully prepared problems with their complete solutions are introduced at intervals throughout the text, and similar problems for solution by the students themselves are stated in an appendix. The problems as given are practical and the illustrations of machinery and instruments are taken from modern practise. The use of two colors in the diagrams of armature windings and other connections should aid the student greatly in his study of the subject. The index of the book is complete enough to make it a ready work of reference.

Geo. C. Shaad

Massachusetts Institute of Technology,
June 26, 1908

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. V., No. 4 (June, 1908), contains the following papers:

The Chromosomes in Diabrotica vittata, Diabrotica soror and Diabrotica 12-punctata: N. M. Stevens.

Diabrotica vittata has an unpaired heterochromosome which passes undivided to one pole of the first spermatocyte spindle and divides in the second maturation division. *Diabrotica soror* and *Diabrotica 12-punctata* have, in addition to the unpaired heterochromosome, in about fifty per cent. of the male individuals collected, one, two, three or four small "supernumerary" heterochromosomes, the number being constant for the individual. The supernumeraries divide sometimes in the first, sometimes in the second spermatocyte mitosis.

The Experimental Control of Asymmetry at Different Stages in the Development of the Lobster: Victor E. Emmel.

In the adult lobster asymmetry of the chelæ is very stable and not subject to reversal, but in the first four larval stages it was found that right or left asymmetry can be produced at the will of the experimenter; consequently it appears that the possibility for experimental control of asymmetry is correlated in some way with the degree of differentiation or development of the organism. These facts indicate that the factors controlling asymmetry become operative after the organism leaves the egg, and that "right- or left-handedness" is not necessarily a question of "inheritance" or even of "alterations in germinal organization."

The Physiological Basis of Restitution of Lost Parts: C. M. Child.

The paper includes a discussion of Holmes's hypothesis of form-regulation and a statement of the writer's position regarding the physiological basis of the process of restitution, which is that a lost part can be replaced only when some other remaining part is physiologically sufficiently similar to it to perform its chief functions qualitatively if not quantitatively, after its removal.

The Process of Heredity as exhibited by the Development of Fundulus Hybrids: H. H. Newman.

Heredity is conceived of as essentially a resemblance in developmental process between offspring and parents and is studied experimentally as such.

In hybrids between these two species of fish the earliest disturbances of the normal developmental process produced by the introduction of foreign spermatozoa are noted, the origin and rhythmic flux of characters are studied, and attempts are made to get some light on the ultimate physiology of the process. Accompanying the paper are pictorial tables showing the comparative developmental processes of the two pure breeds and the reciprocal crosses.

Variation, Heredity and Evolution in Protozoa. I. The Fate of New Structural Characters in Paramecium, with Special Reference to the Question of the Inheritance of Acquired Characters in Protozoa: H. S. Jennings.

The author followed the fate at reproduction of many new or "acquired" structural characters, some produced experimentally, some found in nature. These were not inherited. Sometimes such a character is handed on bodily to a single individual of each generation; one was thus followed for twenty-two generations. But there is no tendency for them to multiply and produce a race bearing them. Such a tendency shows itself only in the case of the very rare characteristics arising from something permanently modifying the process of fission. "The inheritance of acquired characters" takes place no more readily nor generally in protozoa than in higher organisms.

LITHIUM IN RADIOACTIVE MINERALS[1]

The question as to whether lithium is or is not a widely occurring element, and whether it is found associated with any other element, more particularly with copper than with the alkalies or the alkaline earths, arises from the assumed transmutation of copper contained in solutions, into lithium, neon and possibly other substances.

[1] Abstract of a paper by Professor W. N. Hartley at the Dublin meeting of the British Association.

It has been stated by Sir William Ramsay:[2] "As sodium and potassium are much more widely distributed than lithium, it is more likely that they are the chief products from copper, and that some modifying circumstance has determined the formation of a trace of lithium. . . . Lithium was mentioned because it is an unlikely constituent of dust, glass, copper, etc., which were tested specially to prove its absence."

There are two statements here which, according to my experience, appear to require modification. That potassium and sodium are more abundantly distributed than lithium is true, but that these are more widely distributed is not strictly correct; nor can it be accepted as unquestionable that lithium is an unlikely constituent of dust, glass, copper, etc. Evidence to the contrary is based upon facts divided into three categories—firstly, those derived from the qualitative spectroscopic analysis of common ores and minerals usually associated with the alkali metals; secondly, analysis of the crude salts of the alkalies, such as the Stassfurth minerals and nitrates from Chili and Bengal, show that they contain lithium and rubidium, with not unfrequently cæsium. Facts belonging to the third category are derived from experimental evidence, which is both quantitative and spectrographic, the source of the spectra being the oxyhydrogen flame. When half a gram of material yields a photograph of the spectrum of lithium on which the four chief lines are visible—namely, $\lambda\lambda$ 6708, 4603.07, 4132.93 and 3232.82—there cannot be less than 0.0089 gram of lithium present. When only the lines 6708.0 and 4603.07 are visible, the quantity is not less or more than 0.0041 gram.

When only the red line is photographed the quantity is not more than 0.002 gram, and with half this quantity the line ceases to be photographed. It follows, therefore, that from the evidence afforded by the number of plates on which this line appears there could scarcely be less lithium in the 0.5 gram of material analyzed than 0.2 per cent.

Further results have been obtained with several other metallic compounds, but the sensitiveness of the flame reaction varies extraordinarily with the spectra of different elements.

Mr. Ramage and I found in 170 common ores and minerals potassium and sodium, and with these common elements rubidium and lithium were very generally associated. Thus, of sixty-two iron ores, rubidium was found in sixty-one. In sixteen red hæmatites, massive minerals of the purest type, rubidium was contained in four. Where potassium and rubidium occurred lithium was invariably found. It was found in limestones, in dust, in the Bessemer flame, in ordinary pipeclay, tobacco pipes, and a great variety of siliceous minerals, such as the Dublin granites; in Donegal kyanite, which contains 98 per cent. of aluminium silicate; and in asbestos. It was found in dust which fell from the clouds, in volcanic dust, in soot, in flue-dust from chemical works, and in that from copper smelting and refining works. This last material contained lithium, sodium, potassium, rubidium and cœsium, copper, silver, calcium, strontium, aluminium, gallium, indium, thallium, iron, nickel, cobalt, manganese, chromium, lead, zinc, cadmium and tin. Upon such evidence as this it is impossible to corroborate the statement that potassium is a more widely distributed element than lithium, or that lithium is an unlikely constituent of dust, glass, copper, etc.

[2] *Nature*, March 5, 1908, p. 412.

SPECIAL ARTICLES

ON THE ORBITOSPHENOID IN SOME FISHES

I wish to call attention to the following paragraph recently published by Dr. L. S. Berg[1] in reference to an orbitosphenoid alleged by different authors from time to time to exist in various fishes.

> Das Orbitosphenoid fehlt bei allen untersuchten Formen. Prof. Starks, der diesen Knochen bei den Fam. Berycidae und Monocentridae fand, sagt in seiner interessanten Abhandlung folgendes:[2]

[1] "Die Cataphracti des Baikal-See," p. 26. Wissensch. Baikal-See Exped., Lief III., 1907.

[2] *Proc. U. S. Nat. Mus.*, XXVII., 1904, p. 601. "It is remarkable to find this archaic character

among the spiny rayed fishes, though it is well in keeping with the pneumatic duct to the œsophagus, which some of the Berycoid fishes are said to have. The presence of orbitosphenoids is common among the lower forms from the bony Ganoids up to and including the Salmoids. So far as the author can ascertain, they hitherto have not been found in forms more specialized than the last. They have been searched for in vain in the following: *Aulopus, Synodus, Esox, Fundulus, Aphredoderus* and nearly all of the families of the Hemibranchs, Synentognaths and the Percesoces." Den gegenüber kann man einwenden, (1) dass das Orbitosphenoid nicht allen niedrigeren Teleostei eigenthümlich ist. So fehlt es unter den Malacopterygii bei *Osteoglossum, Gonorhynchus, Chanos*,[3] *Cromeria*,[4] unter den *Cobitidini* bei *Cobitis, Misgurnus, Acanthophthalmus*,[5] und (2) dass ein Orbitosphenoid bei mehreren Formen, die im System höher als die Salmoniden stehen, bekannt ist. So besitzt nach Vrolik[6] *Aulopus filamentosus* (*Scopelidae*) ein "sehr ausgedehntes Orbitosph" (p. 270, Taf. XX., Fig. 30). Ferner ist dieser Knochen bei *Galaxias*[7] vorhanden, ebenso unter den Acanthopterygii: bei *Micropterus salmoides*,[8] bei *Pomacanthus paru*,[9] bei *Grammicolepis*,[10] bei *Regalecus*.[11] Wir finden folglich das Orbitosphenoid unter den Acanthopterygii bei den verschiedensten Familien, von so niedrig organisierten wie die *Berycidae* angefangen bis zu so hohen wie die *Trachypteridae*. Weitere Forschungen werden wahrscheinlich zeigen, dass dieser Knochen noch mehr verbrietet ist, als man früher angenommen hat.

Referring to part 1 of Dr. Berg's conclusions I wish to point out that in my above quotation I said that an orbitosphenoid was *common* in fishes below the Salmonidæ, not that it was always present as Dr. Berg appears to have inferred.

In reference to part 2 of his conclusions I have carefully examined a number of specimens of both *Micropterus* and *Pomacanthus* and several of their close relatives, and find no orbitosphenoid, nor is there any mention of this element in any other report on these forms. The common yellow perch is a close relative of *Micropterus*, and since the time Cuvier first took it as an anatomical type of spiny-rayed fishes its skeleton has been described a great many times, but without mention of an orbitosphenoid. Dr. Boulenger, in the first volume of the second edition of the "Catalogue of Fishes in the British Museum" has worked out the osteology of a great number of the basses, perches and sun-fishes, but without finding an orbitosphenoid.

Either the internal descending wing from the frontal, or the anterior part of the alisphenoid, has been mistaken for this element in *Micropterus* and *Pomacanthus*. There is often a slight mark across the alisphenoid which may have been interpreted as a suture dividing the bone into two parts. This appears to have been the case in *Grammicolepis*, to judge from the picture, though I have had no opportunity for examining the skeleton. As to *Aulopus*, my specimen (*A. japonicus*) certainly has no orbitosphenoid, though the picture of *A. filamentosus* published by Vrolik shows a well-developed one. It seems probable that somewhere there has been a misidentification of material. Dr. Berg has misinterpreted Dr. Swinnerton's statement in regard to *Galaxias*. Swinnerton referring to this genus, says, "owing to the absence of an orbitosphenoid [etc.]." On the preceding page, however, he gives a figure of the cranium of *Galaxias* in the anterior part of the orbital cavity of which is a portion marked "os." To "os" I find no reference in the text, though it may as well refer to a cartilaginous or membranous orbital septum as to an ossified orbitosphenoid.

[3] Ridewood, *Proc. Zool. Soc. Lond.*, 1904, p. 59; *op. cit.*, 1905, p. 485, fig. 140–1, p. 489.

[4] Swinnerton, *Zool. Jahr. Abt. Anat.*, XVIII., 1903, p. 63, fig. F.

[5] Sagemehl, *Morph. Jahr.*, XVII., 1891, p. 579.

[6] *Neid. Arch. für Zool.*, I., 1873.

[7] *Haplomi:* Swinnerton, *Zool. Jahr. Abt. Anat.*, XVIII., 1903, p. 63, fig. G.

[8] Centrarchidæ, Shufeldt, U. S. Fish Comm. Rept. 1883, XI., 1885, p. 804.

[9] Chætodontidæ, Shufeldt, *Jour. Morph.*, II., 1889, p. 290, fig. 10.

[10] Zeidæ, Shufeldt, *Jour. Morph.*, II., 1889, p. 280.

[11] Trachypteridæ, T. Parker, *Trans. Zool. Soc. Lond.*, XII., 1886, p. 12, T. IV., fig. 7, 11.

Regalecus has a large orbitosphenoid, and Mr. Tate Regan has recently shown[12] that *Lampris* and *Velifer* also have one. I believe these and the Berycoid fishes to be the only spiny-rayed fishes in which the orbitosphenoid has been proved to exist.

Dr. Berg has apparently not appreciated the true significance of the presence of an orbitosphenoid in *Regalecus* when he remarks towards the end of his paragraph that this element has been found from so low a group as the Berycoids to so high a one as the Trachypteridæ. Instead of indicating that an orbitosphenoid may be looked for anywhere among the Acanthopterygii it rather indicates the primitive character of *Regalecus*. Mr. Regan (*op. cit.*) has, in fact, recently placed it in close relationship with the Berycoid fishes, but whether or not *Regalecus* (with its relatives forming the group Tænisomi) originated from the Berycoid fishes, it is at least as primitive as they are, and belongs in the system not far from them. If it is true that *Grammicolepis* has an orbitosphenoid it would indicate its position also to be not far from the beginning of the series of spiny-rayed fishes.

EDWIN CHAPIN STARKS
STANFORD UNIVERSITY

[12] *Proc. Zool. Soc. Lond.*, 1907, pp. 634–643.

AN EXPLANATION OF THE CAUSE OF THE EASTWARD CIRCULATION OF OUR ATMOSPHERE

IN SCIENCE for December 20, 1907, I have shown that the principle of the conservation of energy demands that *temperature must be taken as a measure of the intensity of ether vibration;* this mandatory condition at once gives us the information that only the Newtonian law of radiation can be true, and this claim is upheld by my interpretation of existing observations (as explained in the closing paragraph of that paper). I then demonstrate that the absolute temperature of space at the earth's distance from the sun is probably less than two degrees centigrade.

As known gases become either liquid or solid when the temperature is reduced to within a few degrees of the absolute zero, a planet can have no atmosphere unless its surface-temperature is above the critical temperature of the gas which forms the atmosphere.

From the differences between the polar and equatorial temperatures near the earth's surface, and from the decrease in temperature with increasing height above the surface, it is known that the atmospheric layers near the surface of the earth act as a trap to retain the heat until the temperature reaches a limit which varies with varying atmospheric conditions; beyond this limit the loss of heat through radiation into space is just equal to the heat received, so that no farther increase in temperature takes place.

As the direct rays of the sun can strike only one half of the earth's surface at a given instant, while the equivalent heat is later on radiated from the whole surface of the earth, it is plain that the mean *solar* component of earth-radiation can not at its maximum exceed one half of the sun's radiant effect at the earth's distance from the sun, or 0°.75, if 1°.5 is adopted as the temperature of space; practically, therefore, the whole terrestrial radiation into space is due to inherent earth-heat.

Let us, provisionally, take it for granted that on the average the atmospheric layers near and in contact with the earth's surface have, by reason of the trapped heat, a temperature 100° higher than would be the case if no heat were stored in these lower layers, we then readily arrive at the results given in the following table:

Distance above Earth's Surface (in Miles)	Terrestrial Radiation		Temperature of Direct Solar Rays	Gravity
	Earth's Component	Sun's Component		
0	200.°	0.°7	0.°7	1.00
10	199.	0.7	1.+	0.99
100	190.	0.7	1.+	0.95
1,000	128.	0.6	1.+	0.64
10,000	16.	0.1	1.5	0.08
100,000	0.1	0.0	1.5	0.04

From an inspection of the above table we learn that during the first few hundred miles the decrease in temperature, due to radiation, is only one degree for each additional ten miles of altitude, so that in the higher available regions of the atmosphere (where the decrease in the stored heat, for accessible increasing heights, is probably insensible) observational data should reveal a practically constant temperature for all superior distances that can be reached by the known means at our disposal. *The experimental results recently obtained by means of kites and balloons confirm in a striking manner the run of the data given in the above table,* in which the *earth,* not the sun, is taken as the controlling influence so far as temperature conditions are concerned.

The ever-varying unstable conditions in the lower strata of high temperature cause more or less continuous ruptures of these strata, each vent containing an uprush of the heated air fed by a horizontal inrush on all sides. In the equatorial regions the inrushing air has a more or less uniform temperature, and the direction of motion is nearly straight towards the axis of the uprush, so that great cyclonic motions are not to be expected as a regularly recurring phenomenon in these regions. In the middle latitudes, however, the conditions are always such that cyclonic movements of the lower air are almost inevitable.

Owing to the decrease in the diurnal surface-velocity of the earth with decreasing polar distance, an uprush of air in a middle latitude will, in general, be supplied as follows: on the equatorial side, by warm air rushing polewards, not directly towards the axis of the uprush, but always towards a region on the east side of this axis; on the pole side, by cold air moving equatorwards towards a region on the west side of the axis. Owing to this arrangement of the moving air, equilibrium can not at once be restored, and a great cyclonic motion of increasing intensity results, to be overcome later on by the destruction of the vertical motion through the now increasing want of sufficient air-pressure from below.

The cyclonic motion of the atmosphere, brought into action through the axial rotation of the earth, has long been known, but so far as I am aware no satisfactory answer has ever been given to the question—*Why does the atmosphere, taken as a whole, have a greater angular velocity of rotation (diurnal) than the earth itself?* I offer the following explanation:

An inspection of the above table shows that the uprushing expanding air may rise many hundred miles and still have a temperature far above the critical point.[1] *As the air-mass rises (and loses its moisture through condensation) its diurnal angular velocity diminishes, so that by the time this same (now dry) air again reaches the lower layers of the atmosphere, to cause an increase of pressure, the region of the uprush will be far to the east of the place where the pressure has increased. To restore the equilibrium the piled-up mass of air now flows back into the region of low pressure farther to the east and thereby causes an eastward motion of the atmosphere with reference to the earth's surface.*

As each "low" is forced to move eastward by its necessarily following "high," the general eastward circulation of our atmosphere is explained. It is evident that the observed equatorial acceleration of the sun's atmosphere, and of planetary atmospheres in general, can be explained in a similar manner.

In an atmosphere quiescent throughout, the different gases constituting the envelope would be arranged in concentric layers, the lightest gas being at the top; through the vertical circulation, however, a mechanical mixture of these gases must take place, and other phenomena must also result.

J. M. Schaeberle

Ann Arbor,
March 24, 1908

[1] It is proper to state here that during the progress of my investigations it was found necessary to reject the kinetic theory of gases and to substitute in its place a simpler and more rational theory, which is so general in its application that even gravitation is satisfactorily accounted for. According to this theory the force which causes an uprush, or which causes radiation in general, has the same source and the same properties as the force which causes gravitation and other physical phenomena of nature.

SCIENCE

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FRIDAY, OCTOBER 2, 1908

CONTENTS

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

OUR PRESENT KNOWLEDGE OF PLANT PROTEINS[1]

To the biological chemist few substances present so many features of interest as the proteins of plants. These lie at the very foundation of the nutrition not only of plants but of animals, and from them are derived a multitude of products directly connected with physiological processes. The study of the chemistry of plant proteins, although it early interested several of the leading chemists of their time, has received in the aggregate so little attention that to-day our knowledge of this subject is but slightly advanced beyond what may properly be called a beginning. How slow the progress has been may be shown by a brief review of the literature that is on record.

HISTORICAL

In 1746, Beccari announced his discovery of a peculiar substance which he obtained by washing wheat flour with water, that had all the properties which up to that time had been considered to be characteristic of animal life only. This substance, which we now know to be wheat gluten, appears to have been for more than fifty years the only form of vegetable protein that was known, for Beccari failed to obtain similar products from other seeds.

In 1805, Einhof discovered that a part of the gluten of wheat was soluble in alcohol, and he described the existence of similar proteins in rye and barley. Einhof

[1] An address delivered before the American Chemical Society at New Haven, Conn., July 1, 1908.

overlooked the fact that only a part of the gluten of wheat was dissolved by alcohol, and he considered this property to be characteristic of all plant proteins except the "Eiweiss," which he obtained by heating the aqueous extracts of seeds and other parts of plants. When, therefore, he later discovered in leguminous seeds another form of protein which was not soluble in alcohol, but had in pronounced degree the properties of "animal matter," he assumed that he had obtained a substance belonging to a distinctly different group but yet related to the gluten or "Kleber" that had been found in other seeds.

Taddei, in 1820, showed that only a part of the wheat gluten was soluble in alcohol and he applied distinctive names to each part; gliadin to the substance soluble, and zymom to that insoluble, in alcohol.

From this time, chemists were more and more attracted to the study of vegetable proteins, and among those thus engaged are found many of the most distinguished chemists of the earlier part of the last century, such as Berzelius, Dumas, De Saussure, Boussingault, Liebig and many of his pupils.

In 1841, Liebig reviewed the work done in his and other laboratories on the properties and composition of plant proteins. The state of knowledge which then prevailed respecting this subject is well illustrated by the following quotation from his review:

> Another, in number very limited, class of nitrogenous compounds is very abundantly distributed. There are four of these substances, of which one occurs, without exception, in all plants, while the others are only constituents of certain families of plants. These are the nitrogenous food substances properly known under the names of Vegetable "Eiweiss," Pflanzenleim and legumin. . . . These substances, to which a fourth must be added, which I will name Pflanzenfibrin, are the true food substances of the plant-eating animals.

In discussing these four proteins, Liebig asserted that each was identical with the protein of animal origin bearing the corresponding name. The identity of legumin with milk casein was claimed and this protein he therefore named plant casein.

The work undertaken by Liebig was continued for twenty years or more by Ritthausen, who was one of his pupils. Ritthausen, in 1860, began the first serious study of these important substances and devoted much time and care to the production of preparations of the highest attainable purity, and to accurate determinations of their ultimate composition. His work greatly extended the scope of the prevailing knowledge of the plant proteins, and made it plain that these substances exist in much more diverse forms than had before been supposed. He also added much to our knowledge of the decomposition products of vegetable proteins by showing that they yielded many substances already obtained from proteins of animal origin, and discovered glutaminic acid which is now recognized as a constituent of practically all proteins, whatever their origin. He was also the first to obtain aspartic acid from the products of protein hydrolysis.

In 1877 Hoppe-Seyler and his pupil Weyl applied to seeds the then recently developed method of extraction by solutions of neutral salts. They showed that a large part of the protein of a number of different seeds was soluble in such solutions, and had the properties of the so-called globulins of animal origin. While the experimental work of these investigators was hardly more than qualitative and of very superficial character, the conclusions which they drew and the criticisms of Ritthausen's work which they put forth were generally accepted as final by most physiologists, and threw it into general discredit.

Although Ritthausen afterwards showed that a large part of many of his previously described preparations, which had been obtained by extraction with dilute alkalies, was soluble in solutions of neutral salts, and that the composition of many of the proteins which he had previously analyzed was the same as that of preparations obtained by extraction with solutions of sodium chloride, nevertheless physiologists continued to repeat the criticisms of Hoppe-Seyler, and the work of Ritthausen failed to receive the recognition which it deserved.

REVIEW OF THE WRITER'S WORK

Since Ritthausen ceased his work with vegetable proteins little has been done in this field outside of my own laboratory. It is true that from time to time papers have appeared dealing with special questions in the chemistry of these substances, but no other connected and extensive investigation has been described, and as the work which I have been doing during the past twenty years has now reached a point where it can be profitably reviewed, I propose to take up some of its more important features and briefly discuss them.

As Ritthausen's researches were far from exhaustive and left the subject in such a state of confusion that it was impossible to form definite conclusions respecting much that he had described, it seemed best to me to direct attention chiefly to those seeds which had been previously studied by him and by others, and to try to clear up the existing uncertainties, rather than to add to them by describing new proteins. As a result, we now have about twenty-five different proteins of vegetable origin, the important characters of most of which have been studied by all the means at present available. These proteins appear to represent the different types to be found in seeds and are, I think, sufficient in number to form a suitable foundation for the future study of their chemistry. All of these are constituents of seeds. A few of them represent constituents of the physiologically active embryo, but the majority represent the reserve food protein of the endosperm, and serve not only for the nutrition of the growing seedling, but also for the nutrition of men and animals. Of the protein constituents of other parts of plants very little indeed is known.

CHEMICAL INDIVIDUALITY OF PROTEINS

In considering the position of our present knowledge of the seed proteins, the question of chemical individuality should first be considered. We are now well past the time when agreement in solubility, ultimate composition and color reactions, are to be accepted as evidence of the identity of two preparations of protein. It is not necessary to explain why it is at present not possible to demonstrate the chemical individuality of any single protein, for the reasons are evident to all who will give this question the slightest consideration from the standpoint of the organic chemist. While it is not possible to establish the individuality of any protein, it is possible to show differences between the various forms which can be isolated, and to establish a constancy of properties and ultimate composition between successive fractional precipitations which give no reason for believing the substance to be a mixture of two or more individuals.

On the basis that agreement in ultimate composition affords no evidence of identity of two similar proteins, but that distinct and constant differences in composition are conclusive evidence that they are not alike, I have endeavored to differentiate the several seed proteins that I have studied, and have since subjected them to careful comparisons in respect to their physical properties and the proportion of their decomposition products, so that those which are alike in their more apparent characters have been still further distinguished from one another. Whether these are in fact chemical individuals, must await the development of new methods of study. For the present they must be accepted as the simplest units with which we can deal.

SUITABILITY OF SEED PROTEINS FOR A STUDY OF PROTEIN CHEMISTRY

The various proteins thus established furnish material for further study, and are characterized by wide differences not only in physical properties, but in the proportion of their decomposition products. They can be prepared in large quantity in a high state of purity, and, being a part of the reserve food stored up for the nutrition of the developing embryo, are by nature more stable than the animal proteins which form a part of physiologically active tissues. Furthermore, they are not associated with tissues and fluids rich in other forms of protein from which they are to be separated, and they are mostly obtained in the form of dense precipitates, often crystalline, which are little inclined to adsorb other substances from which they can afterwards be separated with difficulty. Although associated intimately in the seed with many forms of soluble and insoluble carbohydrates, they can, in many cases, be separated from every trace of the latter, as is shown by appropriate reactions.

It is my firm belief that a careful examination of them will ultimately afford a better knowledge of the chemistry of proteins in general than can be obtained from proteins of animal origin. Although the problems immediately connected with the animal proteins are of greater importance to physiology than those at present recognized as connected with seed proteins, there is no question but that definite knowledge of the chemistry of seed proteins will be directly applicable to many important problems of animal physiology.

THE DIFFERENT GROUPS OF PROTEINS FOUND IN SEEDS

The seed proteins for the most part can be grouped in much the same way as the proteins of animal origin, but in so doing, it is necessary to modify to some extent the requirements to which the animal proteins belonging to some of these groups are at present assumed to conform. The necessity of some scheme of classification for the proteins is recognized by all who write or teach about them, and although the present method of classifying proteins according to their solubility is wholly unsatisfactory from a purely chemical standpoint, it is practically the only one now available. On chemical grounds there is no more reason for dividing the proteins into two groups of animal and vegetable proteins, than there is for making a similar distinction between the carbohydrates. I have, therefore, endeavored to assign the various forms of seed proteins to the commonly recognized groups established for those of animal origin, and have proposed to slightly modify the definitions usually given for these groups, but only so far as this is necessary.

1. *Globulins* form much the greater part of the reserve protein of all seeds except those of the cereals. By globulin is meant protein soluble in solutions of neutral salts but insoluble in water. This definition does not strictly apply to many of the seed proteins assigned to this group, for these behave as globulins only under certain conditions. As these conditions prevail during the extraction and isolation of these proteins and depend on the presence of free acid in the extracts, it is important

to consider the relations of the proteins to this acid.

The behavior of seed globulins toward acid is shown by studies made in my laboratory on edestin. Crystallized preparations of edestin, obtained by dialyzing or cooling sodium chloride extracts of hemp-seed, frequently contain protein in three forms; one, soluble in pure water and also in strong saline solutions, another, insoluble in water but soluble in strong saline solutions, and still another, insoluble either in water or in saline solutions. The proportion of these products varies with slight differences in the conditions under which the edestin is isolated, and plainly depends upon changes in the protein which take place during its preparation.

The explanation of these changes has been found in the presence of a small amount of acid extracted from the seed together with the protein. The part of the edestin preparation just referred to, which is insoluble in neutral saline solutions, has been found to be a product of the hydrolytic action of the acids of the extracts. This product is not the result of a profound splitting of the edestin molecule, for the changes leading to its formation are so slight that they can be detected only by the altered solubility. For such primary products of protein hydrolysis, which were designated "albuminates" by Weyl, I have proposed the name "protean" and for the products derived from the individual proteins, a corresponding name ending with the affix *an*. Thus the product derived from edestin may be called *edestan*. The part of the edestin above referred to which is soluble in water contains more combined acid than the part insoluble therein. The preparation, therefore, contains a mixture of salts of edestin. These edestin salts contain some of all the anions present in the solution at the time of precipitation, that salt being predominant whose free anion was most abundant in the solution from which the edestin was last precipitated. When freed from this combined acid by making the preparation neutral to phenolphthalein, the edestin is wholly insoluble in water, but soluble in neutral saline solutions. Edestin has, consequently, the properties of a true globulin. Other seed proteins behave towards acids in a similar way, except that some of them, when neutral to phenolphthalein, are soluble in water. Many of these latter behave as globulins when in the form of salts, and as they are obtained as salts by the methods employed in preparing them, I have for convenience, placed them among the globulins.

The fact that our protein preparations, as usually obtained, are protein salts is fundamental for a correct conception of their behavior under the conditions of isolation and purification, and for an explanation of many of their physiological relations.

The seed proteins which are described as globulins, differ in some of their properties from some of those that are commonly assumed to characterize the globulins of animal origin. In this connection, however, the fact should not be overlooked that our knowledge of animal globulins is relatively small, and it is probable that further study will modify our present conception of them. It has become customary for physiologists to consider that all *globulins* are precipitated by adding to their solutions an equal volume of a saturated solution of ammonium sulphate, and of recent years it appears to have become an almost universal practise to designate as globulin all the protein that can be thus precipitated. This practise is unfortunate and leads to confusion, for it wholly ignores the original conception of a globulin, namely, a protein soluble in neutral saline solutions but insoluble in water.

Globulins are commonly described as proteins that are coagulated by heat. This is doubtless true of the globulins of seeds if sufficient acid is present in their solutions. It is, however, difficult to add to the saline solutions of most seed globulins a sufficient amount of acid to cause complete coagulation on heating, for even a very minute quantity of acid in a strong saline solution alone precipitates a large quantity of the globulin.

The deportment of edestin in this respect is well illustrated by the experiments of Chittenden and Mendel,[2] who showed that a saline solution of edestin was only partly coagulated by boiling, that the edestin remaining in solution could be recovered unchanged and in well-formed crystals, and that addition of acid to the solution filtered from the coagulum gave rise to a new coagulum on again heating.

2. *Prolamins*[3] form a unique and sharply differentiated group of proteins which occur in quantity in the seeds of cereals, but not in those of any other plant yet examined. These are soluble in all proportions in alcohol of 70–80 per cent., and are not affected by boiling their alcoholic solutions, even for a long time. They are practically insoluble in water and saline solutions, but are soluble in dilute solutions of acids and alkalies.

The prolamins are better characterized, from a chemical standpoint, than any of the other groups of seed proteins, for on hydrolysis they all yield a very small amount of arginine and histidine and no lysine whatever. On the other hand, they yield from 20 to 30 per cent. of their total nitrogen in the form of ammonia and also contain relatively large amounts of glutaminic acid. Gliadin from wheat and rye, and the related hordein from barley, yield about 37 per cent. of glutaminic acid, which is very much more than that found in any other protein yet examined, and zein yields nearly 20 per cent., which places it among the proteins relatively rich in this amino-acid.

Prolamins have been found in the seeds of all the cereals examined in my laboratory, namely—oats, wheat, maize, rye, barley and sorghum. That this form of protein is characteristic of the seeds of all grasses is rendered improbable by the recent report of Rosenheim and Kajiura,[4] who found none in rice. A detailed statement of their results, however, has not, to my knowledge, yet been published.

3. *Glutelins* constitute a large part of the proteins of all the cereals that have been studied, and possibly occur in seeds of other kinds. These proteins are insoluble in all known neutral solvents, but are easily dissolved by very dilute acids or alkalies. Only one member of this group is known which is accessible to satisfactory investigation. This is the glutenin of wheat which forms nearly one half of the gluten. Owing to the fact that glutenin can be separated from the other components of the seed as a constituent of the gluten, it is possible to make preparations of it of a fair degree of purity.

As the seeds of the other cereals yield no coherent gluten, the protein corresponding to glutenin can not be isolated from them, for the alkaline extracts of these

[2] Chittenden and Mendel, *Journal of Physiology*, XVII., p. 48, 1894.

[3] I propose this name for the group which heretofore has been simply called alcohol-soluble proteins. The name refers to the relatively large proportion of proline and amide nitrogen which they yield on hydrolysis. The English committee on protein nomenclature has very recently proposed to call these proteins gliadins, but as this name has long been used to specifically designate the prolamin obtained from wheat it seems to me important to have a distinctive name for this group.

[4] Rosenheim and Kajiura, *Journal of Physiology*, XXXVI., p. liv, 1908.

seeds are too gummy to filter and the small amount of the preparations that can be obtained is very impure.

Whether glutelins are constituents of other seeds is a question not yet settled. Most seeds, when exhausted with the several neutral solvents, still contain a small amount of protein which can be extracted with alkaline solutions. It has not yet been definitely determined whether these products are residues of the other proteins extracted by the neutral solvents, or are actually different substances. It is quite conceivable that a part of these other proteins may form combinations with other constituents of the seeds which are not soluble in neutral solvents but are extracted by alkalies, and also that a part of the protein is enclosed in tissues which are dissolved by the alkali and the protein then brought into solution. It is also possible that much or all of this protein is the result of a change, whereby a part of the protein originally soluble in neutral solvents is converted into less soluble products, such as those which have been designated as proteans. The quantity of nitrogen which remains in the thoroughly extracted residues of the seeds is small in the case of most seeds other than the cereals, and it is not probable that many of these contain much, if any, protein belonging to the glutelin group.

4. *Albumins* are probably present in *very* small amount in nearly all seeds, and in none of those that I have examined are they present in large amount. The albumin is probably a part of the physiologically active embryo, and resembles the proteins of animal origin in properties, ultimate composition and proportion of the various products of hydrolysis, more closely than do most of the reserve proteins of the endosperm. While the albumins of seeds are like those obtained from animals in the essential properties of solubility in water and coagulability by heat, they differ in their precipitation relations towards strong solutions of inorganic salts.

It is at present almost universally assumed that albumins are not precipitated by adding to their solutions an equal volume of a saturated solution of ammonium sulphate, but this is not the case with all of the albumins from seeds. Many of them are also precipitated by saturating their solutions with sodium chloride or with magnesium sulphate, in which respect they differ from animal albumins.

5. *Proteoses* similar to those of animal origin have been obtained from all the seeds examined, and from some, proteoses closely resembling hetero-, deutero- and proto-proteose were separated. The amount of such proteose is small in all the seeds which have come under my observation, and it is possible that all of this is formed by enzyme action during isolation of the other proteins of the seeds.

There are several groups of proteins which occur in animal tissues, which have not yet been proved to exist in plants. The most important of these are those which contain phosphorus. In the yolk of eggs and in the milk of mammals, a large part of the protein which nourishes the developing animal contains phosphorus which appears to be intimately concerned in the structure of its molecule. No similar phosphorus-containing proteins have been found in seeds, although by analogy such might be expected to occur. It has been asserted that such proteins are found in leguminous seeds, but an examination of the literature will show this assertion to be founded on very little experimental evidence. Czapek, in his "Biochemistry of Plants," describes the proteins of seeds as vitellins which doubtless contain phosphorus. This view, however, has no evidence to support it and is quite incorrect.

The existence of nucleoproteins, that is of compounds of nucleic acid with protein, is a different question and involves consideration of the chemical nature of these substances as now described. The nucleoproteins are, so far as I know, always described as phosphorus-containing proteins, and the phosphorus seems to be generally considered as a constituent of their molecules. This, of course, is strictly true even if the combination be only that of a base and an acid, but from the standpoint of protein chemistry it makes a great deal of difference whether this union is that of a salt, or one in which the phosphorus-containing groups are in intimate organic combination within the protein molecule. That true nucleic acids exist abundantly in seeds has been demonstrated by investigations made in my laboratory on the wheat embryo. In these investigations a great deal of attention was devoted to the protein compounds of the nucleic acid, but all the evidence obtained indicated very plainly that these were simply protein nucleates, the composition of which depended solely on the conditions prevailing at the time of precipitation. That *similar* combinations exist within the embryo is practically certain, but that any of the combinations actually isolated were *identical* with the combinations that exist in the seed, I consider highly improbable. Whether the nucleoproteins that have been described from animal tissues are more definite and intimate combinations between the nucleic acid and the protein than are the protein nucleates just mentioned, I am not prepared to say, but I think that nucleoproteins deserve more consideration from this point of view than they have received.

Whether, or not, true glycoproteins are contained in seeds, remains to be demonstrated. That a large part of the seed proteins are entirely free from any carbohydrate yielding group, is proved conclusively by the fact that these yield no trace of the Molisch reaction. That those that give the Molisch reaction contain a carbohydrate group as a constituent of their molecule is seriously to be questioned, for it is not possible to obtain even traces of furfurol from them.

If one considers how small an admixture of carbohydrate gives a very strong reaction with the Molisch test, it may well be asked whether this reaction is not sometimes caused by a slight contamination. The possibility of this is so great in the preparations of proteins extracted from seeds containing a great variety of carbohydrates, glucosides and nucleic acids, that conclusions drawn from the results of the Molisch reaction have value only when this turns out negatively.

In plants no representative has yet been found of the group of albuminoids which form in animals so large a part of the skeleton, connective tissues, the skin and its appendages.

Although the nucleated cells of the wheat embryo are rich in nucleic acid which closely resembles in its properties and structure the nucleic acids obtained from the nucleated cells of animals, no substances have yet been found in plants which resemble the protamines which in combination with nucleic acid occur so abundantly in the spermatozoa cells of animals. Such substances are to be sought in the pollen cells of plants, but as yet no attempt has been made to isolate them, owing to the difficulty of obtaining a sufficient supply of material, and the fact that the nucleus of the cell forms so small a part of the whole structure.

PRODUCTS OF HYDROLYSIS OF SEED PROTEINS

Of the known primary products of protein hydrolysis all but one (diamino-trioxydodecanic acid, as yet obtained only from casein) have been isolated from seed proteins, and there is no indication that any essential difference exists in the general character of the structure of the proteins from these two forms of life. Some of the seed proteins, like some of those from animals, lack one or more of the amino-acids; and zein, from maize, lacks glycocoll, tryptophane and lysine. The crystalline glubolins, which are possibly more definite chemical individuals, have yielded on hydrolysis as complicated a mixture of amino-acids as any of the amorphous preparations. These, therefore, furnish no ground for the assumption that the several proteins, as we now know them, are mixtures of less complex substances.

Of twenty-three different seed proteins which have been hydrolyzed, all have yielded leucine, proline, phenylalanine, aspartic acid, glutaminic acid, tyrosine, histidine, arginine and ammonia. Five have yielded no glycocoll. Two yielded no alanine which could be positively identified, but did yield impure products which left little doubt but that this amino-acid was present. Four yielded no lysine, and one, no tryptophane. Four of these proteins yielded extremely small quantities of cystine, three others, none. The remaining sixteen have not yet been examined for this amino-acid on account of the difficulties encountered in separating small quantities of it. No attempt has yet been made to isolate isoleucine. If this amino-acid is yielded by the seed proteins it will probably be found in the mixture of undetermined substances from the third fraction of the esters, which has not been converted into products suitable to weigh. Glycocoll, lysine and tryptophane are the only amino acids that have been proved lacking in any one of these proteins.

In respect to the quantitative relations of the amino-acids, the fact must not be overlooked that the determinations of many of them are to be regarded only as approximations to the amounts actually yielded by the protein. The determinations of the monamino-acids by Fischer's method are doubtless comparable within certain limits, if sufficient care is exercised in conducting the analysis. The quantities of these amino-acids recovered are unquestionably less than those actually present, for esterification is never complete and the losses incident to the separations by fractional crystallization are not inconsiderable. Under uniform conditions, however, losses are nearly uniform and the figures representing the quantities of amino-acids found give a good idea of differences and similarities between the different proteins. Such figures are in most cases comparable to within perhaps one per cent. of the protein, and probably represent about seventy-five per cent. of the total quantity of the amino-acids which are determined that were originally formed by hydrolysis, providing that these amino-acids are first subjected to two well-conducted esterifications. Most uncertainty attaches to the results obtained for valine and serine, which are separated from associated substances with such difficulty that the determinations of them must be regarded as simply qualitative. Alanine also is difficult to separate in a condition fit for weighing, and no importance is to be attached to differences in the amount of this amino-acid unless these are pronounced.

A very extensive experience, however, with determinations, of arginine, histidine and lysine has convinced me that it is possible to make quantitative determinations of these bases which are very accurate. The results of these determinations can be controlled by comparing the amount of nitrogen contained in the quantities found with that precipitated by phosphotungstic acid under definite conditions which have been worked out in my laboratory. The amount of ammonia yielded by hydrolysis can be determined with such accuracy that differences of only a very few hundredths of a per cent. occur between determinations made on different preparations of one and the same protein. These four determinations are the most reliable that we now have for comparing proteins with one another, and make it possible to detect differences between them which would otherwise escape notice.

Glutaminic acid can be determined in most cases with a close approximation to its true amount, but there are some proteins, especially those from leguminous seeds, from which it is not easily obtained. Experience has shown that by the ester method alone about seventy-five per cent. as much glutaminic acid is usually obtained as by direct separation as the hydrochloride. It is possible, therefore, to control to a certain extent the results of direct determinations by comparing them with those obtained on a larger scale by the ester method.

Although the methods available for thus quantitatively analyzing the products of protein hydrolysis leave much to be desired, it must not be forgotten that only recently have we been able to make any comparison whatever of the proportion of these products.

A striking feature of these analyses, to which Professor Chittenden directed attention in his address before this society last January, is that the total quantity of the substances determined falls far short of one hundred per cent. The majority of successful analyses foot up between sixty and seventy per cent., and of this a part is made up of water which has been introduced by hydrolysis. Calculation shows this amount of water to be approximately equivalent to the losses that may be assumed to occur through incomplete esterification and separation of the acids, so that the summation of well-conducted analyses may be taken as representing somewhere near the total quantity made up by all the different substances determined.

Nothing is known of the undetermined residue which forms from twenty-five to thirty-five per cent. of the protein. There is no reason to believe that, in the seed proteins, undetermined carbohydrate forms any part of this, for those proteins which give no Molisch reaction give no higher summation than do those that do.

If the amount of nitrogen contained in the quantities of the amino-acids stated in the analyses is subtracted from the total nitrogen of the protein, it is found that this undetermined nitrogen forms about fourteen per cent. of the undetermined part of the protein. This is a higher proportion of nitrogen than is found in any of the monamino-acids that are known to be yielded by proteins, except glycocoll, alanine, serine and tryptophane, even if the proportion of nitrogen is calculated for them as united with one another in polypeptide union. It is improbable that this undetermined residue is made up of these four amino-acids, and we may expect to find still undiscovered substances among the protein decomposition products.

COMPARISON OF THE PROTEINS OF DIFFERENT SEEDS

The results of this comparative study of the seed proteins shows that no two seeds are alike in respect to their protein constituents. Similar proteins are found only in seeds that are botanically closely related.

The cereals are alike in the proportion and general character of their proteins. The seeds of each of these, with the probable exception of those of rice, contain a small amount of proteose, albumin and globulin, and relatively considerable quantities of prolamin soluble in alcohol, and of glutelin insoluble in neutral solvents. With the exception of the nearly related wheat and rye, the proteins soluble in alcohol from each of the cereals are distinct substances. Although no certain difference has yet been detected between the gliadin of wheat and of rye, their glutelins are not alike.

The leguminous seeds are similar in the general character of their proteins, but marked differences exist between the proteins of the various groups. Thus *Lupinus, Vicia* and *Phaseolus* present marked differences in their proteins, whereas the proteins of the species of each genus are very much alike. The proteins of *Lupinus luteus* and of *Lupinus angustifolia* differ slightly but in their physical properties are clearly distinguished from any of the other seed proteins. Although similar proteins are obtained from the horse bean, lentil, pea and vetch, these are distinctly different from the proteins obtained from other leguminous seeds. These seeds are not alike, however, in the proportion of their several proteins. The chief protein of *Phaseolus vulgaris* appears to be identical with that of *Phaseolus radiatus,* but the small amount of other protein was found to be different in properties and composition in each of these seeds.

The cow pea (*Vigna*) and soy bean (*Glycine*) contain distinctly different proteins which, however, are similar to but different from those of *Vicia.* The globulins of the seeds of *Corylus* and *Juglans* are much alike, but not identical, while those from *Juglans regia, nigra* and *cinerea,* so far as they have been compared, show no differences. The proteins of other seeds show marked differences, but the botanical relations of these seeds are not such as to permit of further discussion of this subject.

Although the data for generalizations are as yet few, those that are available plainly indicate a close connection between the chemical constitution of the seed proteins and the biological relations of the plants producing them.

That similar differences exist between homologous proteins of different species of animals is becoming evident from the facts which are gradually accumulating, and these strongly suggest a chemical basis for the multitude of diverse forms of animal and vegetable life.

Thomas B. Osborne
Connecticut Agricultural
Experiment Station

THE FINANCIAL STATUS OF THE UNIVERSITY PROFESSOR IN GERMANY[1]

ORGANIZATION OF GERMAN UNIVERSITIES

All the German universities are government institutions. Like the primary schools and the *gymnasia,* the university is part of the educational system of that German state in which it is located. The professors are officials of the sovereign, and the major part of the university revenues are derived from the state treasury. The government of the university is, in the last resort, in the hands of the sovereign's Minister of Education, who in the constitutional monarchies is responsible to the Chambers, and in Mecklenburg-Schwerin, to the Grand Duke.

The university is thus under the control of the state Parliament and, according to the laws enacted by it, under the immediate supervision of the Minister of Education. The university budget must be passed each year by the Chambers; the creation of a new chair can only be by parliamentary approval. The appointment of professors rests with the sovereign or his minister, and the scheme of instruction together with

[1] Extracted and abridged from Bulletin number two of the Carnegie Foundation for the Advancement of Teaching. See also the issue of Science for July 24.

the entire educational policy of the university is a matter of state control. As will be seen hereafter, however, this is compatible with a very large measure of professorial freedom and self-government.

As the Minister of Education has charge of the entire school system of the state and is generally also minister of ecclesiastical affairs and several other important branches of government supervision, it is impossible for him to give any minute personal attention to the details of university management. When the annual university budget is before Parliament, or Parliament is discussing any bill affecting the university, he is, of course, in his place as the spokesman of the government, and when university matters must be laid before the sovereign, it is he who is granted an audience by the King or reigning Grand Duke. But while any changes in university policy must be considered by the minister and he is responsible for them, the actual management of university interests generally rests with the permanent officials of the bureau of the ministry which is directly charged with university affairs. The director of that bureau is, therefore, often a person of great influence, Director Althoff, of the Prussian Ministry, having had a power in molding the Prussian universities and, through their example, the universities of the other German states, which is likely to become historic.

At each university the ministry is represented by a commissioner who has charge of the economic side of the academic administration, and acts as the general advisory agent of the government, conducting the correspondence of the university with the ministry. At the Prussian universities, and at the University of Jena and the University of Strassburg this official is called the curator. At the University of Leipzig he is styled the government plenipotentiary; at the University of Tübingen the chancellor, and at the University of Rostock the vice-chancellor, the title of chancellor at Rostock being borne by the reigning Grand Duke. The Ministry of Instruction of Prussia itself attends to the curatorial business at the University of Berlin, assisted by the rector and the university judge.

The curator is a trained jurist or administrative official who has charge of the erection of buildings, the management of the special scholarship funds, and of all those administrative functions, apart from the direct supervision of the instruction, which in the United States are vested in the university president under the general direction of the board of trustees. The tenure of office of the curator is a fairly permanent one.

The titular executive head of a German university is the rector, elected by the full professors (at the University of Göttingen and at the Bavarian universities by the associate professors also) from among their own number for one year, with the approval of the reigning sovereign. The rector represents the university on occasions of ceremony, presides over the senate, is in control of the university officials, of matriculation, and of all meetings and societies of students, and in general transacts the current business of the institution. The rector is never reelected, the office being held in rotation by the full professors. At the universities of Erlangen, Freiberg, Göttingen, Heidelberg and Jena the above duties are performed by a Prorector, and at Giessen and Leipzig by the *Rector Magnificus,* these seven universities having as their titular executive a *Rector Magnificentissimus,* who is at Erlangen the King of Bavaria, at Leipzig the King of Saxony, at Freiburg and Heidelberg the Grand Duke of Baden, at Giessen the Grand Duke of Hesse, at Jena the Grand Duke of Saxe-Weimar and at Göttingen a prince of the royal house of Prussia.

The distinguishing characteristic of the German university is the power of the full professor (*ordentlicher Professor*). In American universities the professor is simply the highest in rank of an ascending series of teachers. Like the instructors and assistants, he is appointed by a board from which all teaching officials are excluded and he holds his office during the pleasure of that board. Unless he occupies an endowed chair, his salary is generally the result of a bargain with the university president. The professor, indeed, sits as of right in the faculty, which determines the number of courses in the curriculum and regulates the activities of the student body, but seldom is an American faculty asked to propose candidates for vacant professorships.

In Germany the professors are practically the university. The professor, to borrow Anglo-Saxon legal terminology, holds his office as a freehold. Buildings are for the professors to lecture in and subordinate teachers are for the relief of the professors from the less important parts of instruction. The professor decides for himself how he will best serve the students; the body of professors settles such general university matters as in their nature can not be left to individual control. Each university is subject, as are all other institutions in the land, to the control of the sovereign advised by the representatives of his people. But no intermediate non-academic board is interposed between the ultimate authority of the crown and the plenary academic authority of the professors, and the rector, elected by the professors and serving a limited term, has powers analogous to those of the presiding officer of a legislative body; while the powers of an American college president resemble those of the president of a railroad. It must, however, be kept in mind in making any such comparison that the business life of a German university is conducted by the government, through the Minister of Education. The problem of ways and means does not confront the rector and the professors. It is the ever-present demand for money which has gone far to transform the American university organization into a business corporation, as differentiated from a teaching body.

A German university ordinarily consists of the four faculties of philosophy, theology, law and medicine. At the universities of Bonn, Breslau, Strassburg and Tübingen there are both a Roman Catholic theological faculty and a Protestant theological faculty.[2] The universities of Heidelberg and Strassburg have a separate faculty of mathematical and natural science and the University of Tübingen, besides this faculty, has also a faculty of political economy. The University of Munich likewise has a faculty of political economy and its faculty of philosophy is in two separate divisions—classical-historical and mathematical-scientific.[3] The University of Münster is the one German university having but three faculties, lacking that of medicine.

Each of these faculties is composed of the full professors holding chairs therein. The faculty confers the degrees to which its courses lead, gives (except in Bavaria) to promising young scholars the privilege of acting as *Privat-Dozenten* in the university, proposes candidates for vacant professorships, and in general takes such ac-

[2] In the universities of Freiburg, Munich, Münster and Würzburg the theological faculties are Roman Catholic; elsewhere they are Protestant.

[3] In the universities of Freiburg, Münster, Strassburg and Würzburg political economy is studied under the faculty of law.

tion on matters pertaining to instruction within the faculty as it is inappropriate to leave to the individual professor. The faculty is presided over by the dean, elected each year. The election of the dean must usually be confirmed by the Minister of Instruction. The teaching staff consists of full professors (*ordentliche Professoren*), associate professors (*ausserordentliche Professoren*), lecturers below professorial rank (*Privat-Dozenten*), with numerous laboratory assistants and helpers (*Diener*).

At the universities of Erlangen, Jena, Marburg and Tübingen the entire number of full professors, in all the faculties, make up the senate of the university. This is the general legislative body of the institution. In the other universities the senate is composed of the rector and his immediate predecessor, the university judge, the deans of the several faculties and a certain number of professors elected each year by the entire professorial body. The universities of Freiburg, Giessen and Heidelberg, in addition to this smaller representative senate, have also a senate consisting of all the professors, which deals with general disciplinary and administrative matters not referred to the higher body. The universities of Greifswald, Halle, Kiel, Königsberg and Rostock call this full gathering of the professors the Consistory, or the General or Academic Council.

When a vacancy occurs in a professorial chair, the general usage is for the faculty to submit candidates to the reigning sovereign, who either approves one of those proposed or by the exercise of his prerogative appoints a scholar of his own selection. The exact details of these nominations and the frequency with which they are disregarded by the sovereigns differ in the several states. In Prussia, although the faculty concerned has the right to submit three names to the King, the King often makes an independent choice. In Bavaria the faculty sends three names to the senate of the university, and in Württemberg four names, the nominees being arranged in order of preference. The university senate considers the nominations and, having altered them if it sees fit, forwards the list through the minister to the King. It is seldom that either the King of Bavaria or the King of Württemberg does not make the appointment from one of these nominees. In Baden the senate of the university can append a report to the three names, arranged in order of preference, which have been nominated by the appropriate faculty, but can not change the nominations. The grand-ducal Minister of Instruction then makes the selection himself without referring the matter to the Grand Duke, and it is very unusual for another than one of the faculty nominees to be chosen.

When a new chair is created at a university, the final decision whether it is to be a full professorship or an associate one rests with the legislature of the state (or in Mecklenburg-Schwerin with the Grand Duke) at the time of considering the annual budget. Of course, the proposals of the ministry generally receive the assent of the Chambers. A regular professorship is maintained indefinitely, but occasionally personal professorships are created which expire when the occupant of the chair ceases to exercise the functions of a professor. In Prussia, when a chair is to be filled for the first time, the crown does not ask the faculty in which it is to exist for nominations.

The procedure in the selection of associate professors is generally the same as that which prevails in respect to full professors, except that the Minister of Instruction himself acts upon the nominations of the faculty. The honor of an appointment, coming technically from the reigning sovereign, is usually reserved for the full professor.

The professor, when appointed, is required to announce one public or free lecture course of one hour each week. He must also announce one private or fee lecture course, which may be from two to six hours weekly. These are the only obligations resting upon him. Other fee lecture courses he can announce at will. The professor has entire freedom in arranging his courses and choosing his own lecture subjects. He naturally confines himself to subjects germane to the chair which he occupies and to whose study he has devoted his life, but there is usually nothing in the university regulations which would prevent him from lecturing on any subject he might desire.

The preliminary step necessary to render a scholar eligible for a professorship is for him to secure from a faculty "habilitation," or admission to the privileges of a privat-docent (*venia legendi*). The privat-docent is not an officer of the government, as are the professors, nor does he receive any salary from the university. His "habilitation" means that he is permitted to give lectures in the university to such students as are willing to pay fees therefor, and that the universities will give to students taking such courses the same credit as if the courses were those of a professor.

In Prussia the "habilitation" of the privat-docent rests entirely with the faculty, the ministry of instruction simply signifying through the curator that the royal government has no objection to the candidate. The privat-docent is not required to lecture unless he sees fit, but his name will be dropped from the announcement of lectures if for two successive semesters he fails to give courses. In Bavaria, the King, through the ministry of instruction, grants to a privat-docent the *venia legendi* and he may be removed at will by the royal command. He must conduct each year one course. In Saxony, Württemberg and Mecklenburg-Schwerin the consent of the ministry is necessary for an "habilitation"; in Hesse the rector of the university grants the privilege with the consent of the university senate; and at the University of Jena it is necessary, before a docentship is conferred, to obtain the consent of the Grand Duke of Saxe-Weimar and the reigning Dukes of Saxe-Meiningen, Saxe-Altenburg and Saxe-Coburg-Gotha. In the Roman Catholic theological faculties an "habilitation" must receive the sanction of the bishop of the diocese.

The requirements for an "habilitation" have been constantly rising in recent years, and the average age at which a scholar acquires this privilege is well above thirty. Although instances of large fees by privat-docents have existed, the largest practical possibility is from four to five hundred dollars a year. The average income is certainly not much above two hundred dollars. Students have a strong tendency to pay their fees for the lectures of the better known professors, and the situation to-day of the privat-docent who does not possess a private income or is without the backing of wealthy relatives remains the same as when Herr Teufelsdröckh climbed his many flights of stairs at the University of Weissnichtwo. Nor is there any sure hope of a professorship to solace their years of financial barrenness. A chair in the faculty may never come at all; even if it is attained, the period of waiting is beyond calculation. Probably the situation is more difficult than it was when Kant remained a privat-docent at the University of Jena until he was forty-six.

When a man, however, has been commissioned a full professor or an associate professor in a German university, he has attained a financial status which, although it varies widely, is certain to be well within the margin of comfortable living. His income is a total usually composed of (1) a salary attached to his professorship, (2) a personal supplement, (3) a residence or a residence indemnity, (4) all or part of the fees paid by students for his courses and (5) a part of the more general fees paid by students to the university (faculty fees, examination fees, diploma fees, etc.). The receipts from fees are a very important proportion of the total income of the professor, often far exceeding all the other sources of income combined.

The Carnegie Foundation for the Advancement of Teaching has secured from the governments of the Kings of Prussia, of Saxony and of Württemberg, from the government of the Grand Duke of Baden and from the university authorities, a statement of the individual incomes in 1906, from each of the above-mentioned five sources, of the full professors and the salaried associate professors (*etatsmässig ausserordentliche Professoren*) in thirteen universities. These thirteen universities are the ten Prussian universities of Berlin, Bonn, Breslau, Göttingen, Greifswald, Halle, Kiel, Königsberg, Marburg and Münster, the University of Leipzig (Kingdom of Saxony), the University of Tübingen (Kingdom of Württemberg) and the University of Freiburg (Grand Duchy of Baden).

It is only upon such statements of individual incomes that any final account of the financial status of a professor can rest, and the Carnegie Foundation takes this opportunity to express its thanks for the courteous and efficient cooperation of the governments of the German sovereigns and of the German universities which has enabled the foundation to secure these detailed individual incomes. It is to be regretted that they can not be published, but it was not thought wise to present the facts concerning individuals even though no names should be stated. Only averages will be given.

To the statement of income directly resulting from the teaching is added in each case on our lists a statement of income from other governmental employments. This secondary income varies in its nature from what is really a civil-list pension from the sovereign to the professor to a distinct outside salary for outside work, such as the professor might earn by private tutoring or the practise of a profession. These additions to income will not be considered in any of the text or tables that follow unless a special statement to that effect is made.

GOVERNMENT SALARY SCHEDULES IN THE UNIVERSITIES OF THE DIFFERENT GERMAN STATES

Below will be found the salary schedules for full professors which have been adopted by the different German governments. These salaries are simply the guarantees which the government gives to the professor, and constitute only a small proportion of the total professorial income. Following the account of these government appropriations to the professorial chairs will be a table giving the total academic income of the full professor in German universities, and some discussion thereon. It is with these later figures that the salary of the American professor must be compared.

Kingdom of Prussia.—In 1897 the royal government presented to the professors in all the Prussian universities a contract and invited their signatures. According to this contract the professor was to give up to the kingdom one half of all the fees in excess of 3,000 Marks ($713), except at the University of Berlin, where the surrender was one half of the fees above 4,500 Marks ($1,069). This calculation of 3,000 and 4,500 Marks was not to include the commission of the "Quaestus" for collecting the fees. The professor was to receive these sums of 3,000 and 4,500 Marks net. Professors appointed in 1897 and afterwards were required to sign this contract. In exchange the royal government promised to arrange the salary schedule so that there should be an increase in the professor's salary proportional to his length of service, and guaranteed a minimum income of fees of 800 Marks ($190) from lecture fees, examination fees, and promotion fees, to all of the full professors and the associate professors alike. Many professors whose fees were greatly in excess of 3,000 Marks, or 4,500 Marks at the University of Berlin, declined to accept the government's invitation. According to Professor Biermer, only 361 out of the 738 *etatsmässig* professors in the Prussian universities agreed at once to the proposal. For the others there was thus no regular increase of salary as their period of service lengthened. But many of the professors who at first refused have since given their adhesion to these regulations, and as all of the appointees since 1897 are under its provisions, the plan may now be considered as the normal arrangement in the Prussian universities.

Under the salary schedule thus in force since 1897, the theory is that a full professor begins his service with an annual government salary of $950; at the University of Berlin $1,040. Thereafter there is an increase of $95 every four years until in twenty years a maximum of $1,425 is reached; at the University of Berlin a maximum of $1,711 in twenty-four years. At the discretion of the royal Ministry of Public Instruction the maximum may be raised in special instances to $1,853—at the University of Berlin to $2,233. With the approval of the King the respective maxima may go even higher, and at the University of Berlin it is now $3,563.

Associate professors in the Prussian universities begin usually at an annual salary of $475—at the University of Berlin $570. Their salaries are advanced in the same manner by $95 every four years until the maximum of $950 is reached in twenty years—at the University of Berlin $1,140 in twenty-five years. An associate professor, like the full professor, may likewise receive a special guarantee of fees, or a special salary supplement.

In Prussia each full and salaried associate professor receives an additional sum of money each year as a "residence indemnity," granted quite generally to all the higher civil servants of the King, because of the greater cost of living in the cities. The Universities of Berlin and of Breslau (which has recently been raised to the same class as Berlin) fix this residence indemnity at $214 annually. At the Universities of Bonn, Halle, Königsberg and Kiel, it is $157, and at the Universities of Göttingen, Greifswald and Marburg, it is $128.

Kingdom of Bavaria.—About fifteen years ago the Bavarian government adopted a new salary scale for the university professors, whereby their incomes are considerably augmented. A full professor now commences with a government salary of $1,083 (4,560 M.). At the end of each of three periods of five years $85 (360 M.) are added to the salary, and thereafter the increment is $42 (180 M.) at the end of each period of five years. An associate professor usually commences with a government salary of $756 (3,180 M.), receiving the same increases as the full professor. The salary scale is as follows:

	Full Professor	Associate Professor
To commence	$1,083 (4,560 M.)	$756 (3,180 M.)
After 5 years	1,168 (4,920 M.)	841 (3,540 M.)
After 10 years	1,255 (5,280 M.)	926 (3,900 M.)
After 15 years	1,340 (5,640 M.)	1,013 (4,260 M.)
After 20 years	1,383 (5,820 M.)	1,055 (4,440 M.)
After 25 years	1,426 (6,000 M.)	1,098 (4,620 M.)
After 30 years	1,470 (6,180 M.)	1,140 (4,800 M.)
After 35 years	1,512 (6,360 M.)	1,183 (4,980 M.)
After 40 years	1,555 (6,540 M.)	1,227 (5,160 M.)
After 45 years	1,598 (6,720 M.)	1,264 (5,340 M.)
After 50 years	1,640 (6,900 M.)	1,312 (5,520 M.)

In addition to the above there is also the residence indemnity—called in Bavaria "salary supplement" of $127 (540 M.) for full professors and $99 (420 M.) for associate professors. Besides this, there is a further residence indemnity—called "local supplement" in Bavaria—which was added a few years ago because of the increased cost of living. This amounts to $64 (270 M.) at the Universities of Munich and of Würzburg—in cities of the "first class"—and to $54 (225 M.) at the University of Erlangen—in a city of the "second class." In case the fees of a professor amount to more than $286 (1,200 M.) in one year his residence indemnities for that year are cancelled. If the fees do not amount to $286, so much of the residence indemnities is paid to the professor as is necessary to bring the total up to $286.

Grand Duchy of Hesse.—A full professor at the University of Giessen begins his service with an annual government salary of $1,069. This is increased every four years by $95 until in twenty years the maximum of $1,544 is attained.

The associate professor is appointed at an annual salary of $595 (2,500 M.) and after each period of four years' service $71 (300 M.) is added annually. The maximum is $950 a year. Very recently the grand-ducal government has authorized a residence indemnity. This is calculated on the basis of eight per centum of the maximum salary, and is therefore $123 (520 M.) a year for the full professor and $75 (320 M.) for the associate professor. There is in addition a special fund, amounting at present to $2,350 a year, at the disposal of the Grand Duke's Minister of the Interior for the purpose of adding supplements to individual salaries.

Grand Duchy of Saxe-Weimar.—Until 1902 government salaries at the University of Jena were very meager, the professors being released from all payments of taxes, however, whether grand-ducal or communal. In 1902 there was a salary reform, a schedule being introduced on the Prussian model, optional as regarded the holders of professorial chairs at that time. About one fourth of the professors adhered to the old arrangement. Those who accepted the change and all professors appointed since are liable like other subjects to taxes, all of the grand-ducal taxes so collected and one third of the communal taxes going, however, into the treasury of the university. In return for this the full professor begins his service at an annual government salary of $950, which is raised every four years, until in twenty years he receives $1,425. The associate professor receives a similar increase in the same periods, his annual salary beginning at $475 and reaching in twenty years $950. A part of this increase in the university salary schedules was made possible by the income of the Karl Zeiss Foundation, which is now annually $7,130. The grand-ducal government of Saxe-Weimar, the ducal governments of Saxe-Meiningen and Saxe-Altenburg, and the Gotha duchy of the reigning Duke of Saxe-Coburg-Gotha also contributed a similar amount. These four governments jointly have royal rights over the university.

Grand Duchy of Mecklenburg-Schwerin.

—The full professors at the University of Rostock begin with a government salary of $998 (4,200 M.) and receive a $95 increase at the end of the second and fourth years of service. Thereafter there is an increase of $95 every four years until at the end of twenty years of service the maximum of $1,568 is reached.

The associate professor at the University of Rostock commences with a salary of $570. After three years there is an increase of $71, and thereafter the like increase at the end of each four years. The maximum government salary of $856 is attained at the end of fifteen years' service.

At present, the average government salary for full professors at the University of Rostock is $1,321. By faculties, the averages are as follows: theology, $1,473; law, $1,654; medicine, $1,179; philosophy, $1,249. The averages in theology and law are much above the similar figures for Prussia. The associate professors in the theological and in the law faculty (there is but one each), and the honorary professor of the medical faculty, receive government salaries of $641. The average for associate professors in the philosophical faculty is $615.

Kingdom of Württemberg.—At the University of Tübingen the full professor usually commences at $950 government salary annually, and is advanced at the end of every three years $119. Four such three-year promotions are allowed. Salary supplements are granted by the royal Minister of Public Education and sometimes these supplements equal two thirds of the regular government salary. A newly appointed professor may begin his service with one of these large supplements.

The associate professors are appointed at $570 a year, and every three years receive an increase in salary of $71. There may be five of these advances. There are now but two associate professors at the University of Tübingen receiving personal salary supplements from the royal government, promotion to the rank of full professors being the usual reward for distinguished service.

The University of Leipzig (Kingdom of Saxony) has no government salary schedule, the salary being arranged in each case between the professor and the royal Minister of Education. The grand-ducal Minister of Instruction makes a similar arrangement with the professors in the Baden Universities of Freiburg and Heidelberg, and at the University of Strassburg each professor's government salary is likewise the result of negotiation with the Minister of Instruction of the Reichsland.

INCOMES OF PROFESSORS

Table XI. gives the facts concerning the total professorial incomes of the full professors in the German universities. The incomes range from $1,000 a year to over $10,000, with three professors receiving incomes above that figure. Up to $10,000 the incomes have been segregated, as a convenient division, into two-hundred-dollar groups.

This table shows that a fourth of the incomes are below $2,100, while, on the other hand, a fourth are over $3,200, a trifle short of a half being over $2,500. The most frequent income is one between $1,600 and $2,000. The average is $2,800, but this does not represent the typical income, because, like most averages in financial statistics, it is a result of the compounding of many moderate deviations downward with fewer, but larger, deviations upward.

One of the most significant facts disclosed by this table is the wide variability of the professorial income. On account of the salary schedules announced by their respective governments for all except four of the German universities, these universities give at a superficial glance an aspect of uniformity and rigidity. The truth is far otherwise. There is a much greater variation in income to suit individual merit than is the case with comparable institutions in the United States. It will be seen from Table XI. that in Germany the best paid full professor receives ten times as much as the least paid professor and that the highest income from professorial teaching is more than four times the median income. This is not the case in America.

This adjustment of the financial returns of German professors according to the capability of each individual is due primarily to variations of income within the same institution. Of course, as in the United States, there is a considerable variation among the institutions themselves. Owing to the different fiscal policies of the different governments and the different provisions made by the same government for universities in more important locations, and also on account of the difference in fees due to the size of the student body, there will be found German universities in which the average income of the full professor is from twice to three times the average income in some other university. The wide range of the academic income of professors in the same institution is hardly known in America. In any large German faculty some full professor will generally be found who receives for teaching an income from two to five times as large as some of his colleagues. These larger incomes are due to special allowances from the government, to extra university perquisites, and to fees from the large body of students attracted by a superior reputation. Both the German and the American universities pay for merit. This is understood when a man in either country is made a full professor. The distinction

TABLE XI

Incomes received for Teaching by Full Professors in German Universities

Amount of Annual Income	Total Number of Professors receiving said Income	Percentage of Professors receiving said Income
$1,000–1,199	5	.7
1,200–1,399	17	2.5
1,400–1,599	38	5.6
1,600–1,799	64	9.4
1,800–1,999	71	10.4
2,000–2,199	82	12.1
2,200–2,399	51	7.5
2,400–2,599	52	7.6
2,600–2,799	54	7.9
2,800–2,999	53	7.8
3,000–3,199	24	3.5
3,200–3,399	21	3.1
3,400–3,599	17	2.5
3,600–3,799	16	2.4
3,800–3,999	16	2.4
4,000–4,199	11	1.6
4,200–4,399	9	1.3
4,400–4,599	13	1.9
4,600–4,799	9	1.3
4,800–4,999	6	.9
5,000–5,199	5	.5
5,200–5,399	7	1.0
5,400–5,599	2	.3
5,600–5,799	1	.1
5,800–5,999	3	.4
6,000–6,199	6	.9
6,200–6,399	3	.4
6,400–6,599	3	.4
6,600–6,799	..	..
6,800–6,999	2	.3
7,000–7,199	2	.3
7,200–7,399	2	.3
7,400–7,599	1	.1
7,600–7,799	2	.3
7,800–7,999	1	.1
8,000–8,199	1	.1
8,200–8,399	2	.3
8,400–8,599	..	..
8,600–8,799	..	..
8,800–8,999	1	.1
9,000–9,199	..	..
9,200–9,399	2	.3
9,400–9,599	1	.1
9,600–9,799	1	.1
9,800–9,999[4]	1	.1

[4] Three professors received incomes of over $10,000.

between the two countries is that the German universities pay an unusual amount for unusual merit. In America, on the contrary, the unusual man fares no better than his colleagues of mediocre ability.

Table XII. gives the facts of Table XI., distributing the income among the four faculties of each university.[5] It is evident at a glance that professors of law receive most, and professors of theology least.[6] Professors of medicine occupy the second place.

The associate (*ausserordentliche*) professors in German universities are of two kinds, the *etatsmässig ausserordentliche* professors and the *nicht-etatsmässig ausserordentliche* professors. The former is the class meant when associate professors are spoken of without any qualifying expression. The latter class is about one fourth of the entire number, varying in different universities from ten to eighty per cent. They enjoy the title of associate professor, but the title is not accompanied by an appointment from the government, nor do these associate professors draw the government salary appropriate to their rank. They are either teachers who have practically the financial status of privat-docents but have been given the higher title on account of merit or long service, or they are men who for various reasons are exempt from the responsibilities and the rewards which normally attach to the professorial office. The following statements will deal solely with the *etatsmässig* associate professors.

In the thirteen universities which have been carefully studied, the number of these professors is about three sevenths of the number of the full professors. Four tenths of the associate professors are in receipt of professorial incomes of from $1,000 to $1,400; one fourth of them receive less than $900; half of them receive over $1,200; and one fourth receive more than $1,700. The incomes below $600 and those above $2,400 number about the same. The typical income is one from $1,000 to $1,200. Ninety-six per cent. of the incomes lie between $900 and $2,400, and eighty-seven per cent. between $600 and $2,000, and although this indicates a very large variability of income, it is not as great a variability as was found in the case of full professors. The average income of an associate professor is a trifle over $1,300.

The professorial incomes which have been given must, of course, be interpreted in terms of the cost of living. To compare this cost of living with the similar cost for an American university professor is difficult. The Carnegie Foundation has endeavored to obtain the cost of provisions, servant-wages, and house rent in the German university cities, in order to be able to institute a comparison with a similar investigation conducted in America. The cost of foodstuffs in Germany, especially since the new Imperial Tariff Act, is higher than in the United States; the wages of servants, on the other hand, are very much lower. House rent is lower than in America, although not nearly as much lower as servant hire. For the latter item there is, as in the United States, a great difference between different localities. Marburg and Berlin can no more be considered together in respect to the necessary scale of professorial expenditure than can Charlottesville and New York. Furthermore, in Germany no more than in America is it possible to estimate what a professor and a

[5] Faculties of natural science are counted as faculties of philosophy in this table and throughout this bulletin.

[6] It must be remembered that at eight German universities there are Roman Catholic faculties of theology, which consist largely, if not exclusively, of celibate ecclesiastics.

professor's family need to spend. Individuals and families vary in their necessities and standards of living as much in university circles as in other circumstances of life. Probably, however, it will be a fair approximation to the facts if we estimate the cost of living in the localities of the United States in which universities most comparable to those of Germany are situated, taking all of these variables into account, as one and a half times greater than in Germany.

Compared with other classes in the community, the German university professor is still better off than his American colleague. He ranks financially with very important legal and administrative officers; and no principal of a normal school or head of a city system of schools approaches in income from educational work the income received by a considerable percentage of university professors. The German governments pay teachers in the elementary schools well, and the teachers in the secondary schools especially well, but the full professor in a university receives over four times as much as the former and over twice as much as the latter class. The financial status of the university professor in Germany is thus seen to be at the top in the educational world and on a level with all except the nobility and the more successful of business men. It is unnecessary to revert to the dissimilar position of the university professor in America. And human nature being what it is, the higher relative prosperity of the German professor probably seems as important to him as his higher absolute prosperity.

THE OKLAHOMA GEOLOGICAL SURVEY

The Oklahoma Geological Survey was established by the act of the first legislature of the state of Oklahoma. The sum of $15,000 was appropriated. The law provides that until suitable laboratories, libraries and testing apparatus are provided by the state the survey shall be located at the state university.

The commission, consisting of the governor, the superintendent of public instruction and the president of the state university, met for organization, July 25, 1908. A director was appointed and instructed to begin at once the preparation of reports on building stone, road material and oil and gas.

A number of parties were at once organized and active field work pursued for six weeks. L. L. Hutchison, assistant director of the survey, had charge of a party in the oil fields in the vicinity of Tulsa and Muskogee. Members of this party were: W. J. Cross, B. C. Belt, A. C. Reeds and T. R. Corr. Dr. D. W. Ohern had charge of a party in the northern part of the state engaged in studying building stone, oil and gas and Portland cement rock. H. A. Everest, E. Z. Carpenter and H. G. Powell were in this party. Pierce Larkin made a reconaissance of the Cretaceous deposit along Red River from Ardmore east to the Arkansas line. Dr. J. W. Beede, of Indiana University, studied the Pennsylvania-Permian contact in the northern part of the state. Chester A. Reeds and Key Wolf studied the economic products of the Arbuckle mountains. Gaylord Nelson collected data on the lead, zinc and tripoli deposits in the northeastern part of the state. G. W. Kneisly visited the granite quarries in the Wichita and Arbuckle mountains. Frank A. Herald and Chester C. Clark made a reconnaissance of the gypsum region in western Oklahoma looking for deposits of gypsite.

A geologic map of Oklahoma is being prepared, and it is the intention to publish preliminary reports on the oil and gas regions, the available road material, and the building stone of the state and a report on the economic resources of the Arbuckle mountains.

Chas. N. Gould

THE INTERNATIONAL CONGRESS ON TUBERCULOSIS

The program of the congress in session this week in the new National Museum, Washington, is as follows:

September 21–October 12—Exhibition.
September 28–October 3—Section meetings.
September 24–October 9—Special lectures (Washington, Baltimore, Philadelphia, New York and Boston).
Special days at the exhibition:
Monday, September 21, 8 P.M.—Formal opening.
Saturday, September 26—Women's clubs and allied organizations.
Sunday, September 27—Fraternal organizations.
Sunday, October 4—Labor unions.
Tuesday, October 6—Social and charity workers.
Thursday, October 8—Religious organizations.
Saturday, October 10—School children and teachers.
Monday, September 28, 11 A.M. (Assembly Hall, new National Museum)—Official welcome of delegates.
2:30 P.M.—Opening session of Sections I., II., III. and VI.
3:00 P.M.—Opening session of Section IV. (no sessions of Sections V. and VII. on Monday).
8:00 P.M. (Assembly Hall)—Lecture by Dr. A. A. Wladimiroff, of Russia, on "The Biology of the Tubercle Bacillus."
8:30–11:00 P.M.—Reception to visitors at the Corcoran Art Gallery.
Tuesday, September 29—Opening sessions of Sections V. and VII. and sessions of other sections continued.
2:30 P.M.—Section meetings continued.
8:00 P.M. (Assembly Hall)—Lecture by Dr. Arthur Newsholme, of London, Medical Officer to the Local Government Board of England, London, on "The Causes of the Past Decline of Tuberculosis, and the Light thrown by History on Preventive Measures for the Immediate Future."
Wednesday, September 30–Saturday, October 3—Section meetings continued.
September 30, 8:00 P.M. (Assembly Hall)—Lecture by Dr. Maurice Letulle and M. Augustin Rey, of Paris, on "La lutte contre la tuberculose dans les grandes villes par l'habitation: méthodes scientifiques et modernes pour construction" (The campaign against tuberculosis in large cities by scientific methods in the construction of habitations). Illustrated.
Thursday, October 1, 8:00 P.M. (Chamber of Commerce, corner of Twelfth and F Streets)—Dr. R. W. Philip, of Edinburgh, has been invited by the Chamber of Commerce of Washington to deliver his Boston address, "The Anti-tuberculosis Program; Coordination of Preventive Measures."
Friday, October 2, 2:30 P.M.—Reception by President Roosevelt to the delegates at the White House.
8:00 P.M. (new National Museum)—Lecture by Professor N. Ph. Tendeloo, Leyden, Holland, on "Collateral Tuberculosis Inflammation."
Saturday, October 3, 11:00 A.M. (Assembly Hall, new National Museum)—General Session of the Sections.
8:00 P.M. (Assembly Hall, New National Museum)—Lecture by Professor Bernard Bang, of Copenhagen, Denmark, on "Studies in Tuberculosis in Domestic Animals and what we may learn regarding Human Tuberculosis."

ORGANIZATION OF A BIOLOGICAL BOARD

At the Chicago meeting of the board of trustees of the Marine Biological Laboratory at Woods Hole, measures were taken to institute a central board composed of representatives from all those stations engaged in marine work. Through a committee composed of the undersigned, a circular letter was addressed to all those stations believed to be engaged in the study of marine life. Responses were prompt and expressed a cordial endorsement of the plan. With one or two exceptions in which the directors did not feel that the character of the work would justify cooperation, all expressed their willingness to participate. Since the list was completed, and the report of the committee was ratified at the summer meeting of the board of directors, Woods Hole, one or two other stations have been heard from as now in process of development. It is contemplated that these and others, as they may be organized, will take their places on the board by invitation. The board as now organized consists of the following:

Marine Biological Laboratory, Woods Hole—Dr. F. R. Lillie, director, University of Chicago.
Biological Laboratory, Cold Spring Harbor, Long Island, N. Y.—Professor Henry S. Pratt, Haverford College, Haverford, Pa.
Biological Laboratory, Harpswell, Maine—Dr. J. S. Kingsley, director, Tufts College, Medford, Mass. Professor H. V. Neal, Galesburg, Ill., will act as substitute in the absence of Dr. Kingsley.

Rhode Island Fish Commission—Dr. A. D. Mead, director, Brown University, Providence, R. I.

The Wistar Institute, Philadelphia—Dr. J. M. Greenman, director.

Tortugas Station of the Carnegie Institution, Tortugas, Florida—Dr. A. G. Mayer, Maplewood, N. J.

Biological Station of the University of California, La Jolla, California—Dr. W. E. Ritter, director, University of California.

Biological Station of the Leland Stanford Jr. University, Palo Alto, Cal.—Dr. Harold Heath, Leland Stanford Jr. University.

U. S. Fish Commission, Woods Hole, Mass.—Dr. B. W. Evermann, Department of Commerce and Labor, Washington, D. C.

The Cinchona Station of the New York Botanical Garden, Jamaica, W. I.—Dr. N. L. Britton, director, New York Botanical Garden, Bronx Park, N. Y.

The Bermuda Biological Station of Harvard University, Cambridge, Mass.—Dr. E. L. Mark, director, Cambridge, Mass.

The Biological Stations of Canada.

- The Pacific Coast Station, Nanaimo, B. C.—Professor E. E. Prince, director, Department of Marine and Fisheries, Ottawa.
- The Great Lakes Station, Georgian Bay, Ontario—Dr. R. Ramsay Wright, director, University of Toronto, Toronto, Ont.
- The Atlantic Coast Station, St. Andrews, N. B. —Dr. D. P. Penhallow, director, McGill University, Montreal, P. Q.

The various representatives of the board, as thus announced, are requested to accept this announcement as a notice of their appointment. The first meeting of the board for organization and such other business as may require to be transacted, will be called at a later date, probably at the time of the Baltimore meeting in convocation week, and of this due notice will be given.

D. P. Penhallow, *Chairman*
F. R. Lillie

SCIENTIFIC NOTES AND NEWS

The Winnipeg meeting of the British Association for the Advancement of Science, under the presidency of Professor J. J. Thomson, of Cambridge, will open on Wednesday, August 25, 1909. The meeting of the association in 1910 will be at Sheffield, and in 1911 at Portsmouth.

In connection with the meeting of the British Association, the University of Dublin conferred the following honorary degrees: *D.Sc.,* Mr. Francis Darwin, F.R.S., Sir David Gill, K.C.B., F.R.S., Dr. William Napier Shaw, F.R.S., Captain Henry George Lyons, F.R.S., Professor Horace Lamb, F.R.S., Professor Charles Scott Sherrington, F.R.S., Professor Ernest Rutherford, F.R.S., Professor Archibald Byron Macallum, F.R.S., Dr. Albert Kossel, and Dr. Ambrose Arnold William Hubrecht; *M.D.,* Sir Thomas Lauder Brunton, Bart., F.R.S.; *LL.D.,* Sir James Augustus Henry Murray.

At the meeting of the Paris Academy of Sciences on September 14, M. Jean Becquerel communicated the following clause from the will of his father M. Henri Becquerel: "I bequeath to the Academy of Sciences the sum of 100,000 fr. in memory of my grandfather and father, who were, like myself, members of your academy. I leave to it the responsibility of determining the best use which it can make of the interest on this capital, whether by creating an endowment or prize, or by distributing this income in a manner calculated to encourage the progress of science." The grandfather referred to was Antoine César Becquerel, distinguished for his work in electrochemistry. The father was Alexander Edmund Becquerel, distinguished for his work in light, electricity and magnetism. Louis Alfred Becquerel, the eldest son of A. C. Becquerel made valuable contributions to medical science. The scientific eminence of the family has thus been continued through four generations.

Professor Thomas H. Macbride, of the University of Iowa, has been appointed by Governor Cummins as chairman of the Iowa Forestry Commission, the other members being Professor L. H. Pammel, Mr. Eugene Secor, Mr. William Louden, Mr. I. M. Earle and Mr. Wesley Green. This commission, which grew out of the recent conference of governors on the conservation of natural resources, will cooperate with the national organization in the promotion of scientific and practical forestry.

Dr. H. W. Wiley has received notice of his election as honorary member of the Physico-Chemical Academy of Italy for his services to science and humanity. He has also been awarded the medal of the first class by the same academy.

Professor von Leyden, of Berlin, has been elected honorary president, Professor Czerny, of Heidelberg, president, and Professors Pierre Marie, of Paris, and Fibiger, of Copenhagen, vice-presidents, of the International Association for the Investigation of Cancer, founded at Berlin on May 23.

President Ira Remsen, of the Johns Hopkins University, made the address at the opening of the College of the City of New York.

The Huxley lecture will be delivered at Charing Cross Hospital on October 1, by Sir Patrick Manson. The subject will be "Recent advances in science and their bearing on medicine and surgery."

Professor W. M. Davis, visiting professor from Harvard University at the University of Berlin for the year 1908–9, will give his lectures in the first semester, instead of in the second, as previously announced.

Dr. M. F. Guyer, professor of zoology at the University of Cincinnati, who is in Europe on a leave of absence, has been invited to deliver a series of lectures in the University of Aberdeen.

Dr. Bernhard Fischer, docent at Bonn, has been appointed director of the Pathological Institute of the Senckenberg Society at Frankfort.

The *Electrical World* states that Dr. Edward P. Hyde, now of the Bureau of Standards, after October 1, will organize and direct a department of physical research under the auspices of and at the expense of the National Electric Lamp Association. Dr. Hyde and his staff will, it is announced by the association, operate the new department with entire freedom from commercial suggestion and with the same frank publicity which has characterized his work at the Bureau of Standards.

A monument in honor of Hermann von Wissmann, the German African explorer, has been unveiled at Lauterberg, in the Hartz.

Dr. Morris M. Gibbs, of Kalamazoo, Mich., a student of ornithology and allied sciences and for years a frequent contributor to scientific literature, died at his home on September 18.

General J. F. Nery Delgado, for many years director of the Geological Survey of Portugal, died at Figueira-da-Foz on August 3, in his sixty-fourth year.

Cav. Enrico de Nicolis died at Verona, Italy, on July 4. He had published many important papers upon the geology of northern Italy.

Messrs. J. P. Ault and C. C. Stewart, working under the auspices of the department of terrestrial magnetism of the Carnegie Institution of Washington, made a record canoe trip during the past summer, starting out from Prince Albert and Cumberland House in the Province Saskatchewan, Canada, and extending up to the sixtieth parallel, via Pelican Lake, Reindeer Lake, Lac Du Brochet, Sandy Lake, Husky Portage and Canoe Limit (about one and one half miles north of the sixtieth parallel). The trip embraced sixty-eight days during June, July and August; 1,600 miles were covered by canoe and 71 portages varying from 100 yards to two miles were made. The party encountered various unique experiences and penetrated a region inhabited by Eskimos, but rarely visited by white man. A complete series of magnetic observations was obtained along the entire trip.

Dr. J. Walter Fewkes, of the Bureau of American Ethnology of the Smithsonian Institution, has been assigned to continue the work of excavation, preservation and repair of the cliff dwellings and other prehistoric ruins in the Mesa Verde National Park, Colorado, under the special allotment for that purpose by congress through the Interior Department. The Mesa Verde National Park was created by act of Congress approved June 29, 1906. It is situated on the border of the Montezuma Valley, just south of the ancient Montezuma road, and contains some of the best preserved relics of the prehistoric cliff dwellers in the country. During last spring Dr. Fewkes had charge of the excavation and repair of Spruce-tree House, one of the largest and most typical cliff dwellings of the park. A wall forming the front of this village, formerly hidden under fallen débris, was brought to light and repaired throughout its whole length. The former plazas were restored to their original condition. In the course of the work 120 rooms were cleaned out and repaired. Eight of these, which are circular in form, were found to be ceremonial in nature. They were excavated to their floors and their architectural features revealed. The roofs of two of these circular rooms were restored, following aboriginal lines of construction. Provision was made to prevent destruction of the walls by freshets or water falling on them from the rim of the overhanging cliff. In order to increase the attractiveness of this ruin to visitors, explanatory labels were placed on the more important rooms.

According to the Simla correspondent of the London *Times*, Dr. Sven Hedin sums up the results of his explorations as follows: My great discoveries are, first, the true sources of the Brahmaputra and Indus, and the genetic source of the Sutlej east of Mansorawar Lake; secondly, the exploration of Bongba, which I traversed twice by different routes. But the greatest of all is the discovery of that continuous mountain chain which, taken as a whole, is the most massive range on the crust of the earth, its average height above sea level being greater than that of the Himalayas. Its peaks are 4,000 feet to 5,000 feet lower than Everest, but its passes average 3,000 feet higher than the Himalayan passes. The eastern and western parts were known before, but the central and highest part is in Bongba, which was previously unexplored. Not a tree or a bush covers it; there are no deep-cut valleys, as in the Himalayas, for rain is scanty. The absolute heights remain to be calculated from observations made on the ten passes which I crossed.

The bison range in the Flathead Indian Reservation in Montana, to establish which congress at its last session appropriated $40,000, has been selected. The location of the range is the one recommended by Professor Morton J. Elrod, of the University of Montana, after he had carefully examined several parts of the country. It lies directly north of the Jocko River near the towns of Ravalli and Jocko. Approximately 12,800 acres are embraced in the tract, which will be fenced in a substantial manner under the direction of the engineering department of the United States Forest Service. Of the $40,000 appropriated only $10,000 will be available for fencing the range and constructing the shelter sheds and other buildings necessary for the proper maintenance and care of the bison. The remaining $30,000 will be paid to the owners of the land, many of whom are Indians. Funds for the purchase of bison are being raised under the auspices of the American Bison Society, which was largely instrumental in securing the appropriation. The first person to spend actual money in the effort to preserve the American bison from total extinction was the late Austin Corbin, who many years ago fenced some 6,000 acres at Blue Mountain Park, New Hampshire, and secured a herd of bison. The Corbin herd became in course of time the inspiration of the national movement which is now furthered by the American Bison Society. This society, of which President Roosevelt is honorary president, and William T. Hornaday, director of the New York Zoological Park, is president, was founded in 1904, and the Montana bison range is directly the result of its efforts. Details of the management of the herd in the new national bison range will be worked out as soon as the herd is purchased, when the construction work on fences and buildings will also be begun.

At the recent third International Congress of Philosophy, held at Heidelberg, it was decided that the fourth congress will take place in 1912 at Bologna.

We learn from *Nature* that the following arrangements have been made for the opening of the winter session of certain of the British medical schools. At Guy's Hospital (in connection with the Physical Society), Sir R. Douglas Powell will deliver an address on October 8 entitled "Just Procedure of Medicine"; Dr. Charles Slater is to speak on October 1 at St. George's Hospital on "The Laboratory in Medical Education and Practise"; on the same date an address will be delivered at the Middlesex Hospital by Dr. A. M. Kellas; at King's College Hospital Professor Alexander MacAlister, F.R.S., will deliver an address on October 1; Sir Edward Fry, F.R.S., is to speak at University College Hospital on October 2. At St. Mary's Hospital, on October 1, an address is to be given by Sir John Broadbent; Dr. Harrington Sainsbury is to speak on the same day at the London School of Medicine for Women; at the West London Postgraduate College an address is to be given on October 13 by Sir R. Douglas Powell; Dr. R. Jones is to speak on "Insanity, Wit and Humor" on October 1 at the Polyclinic; at the Northeast London Postgraduate College Mr. Jonathan Hutchinson, F.R.S., is to speak on October 8; Sir T. Clifford Allbutt, K.C.B., F.R.S., is to give an address at the University of Manchester, on October 1, on "Hospitals, Medical Science and Public Health"; and at University College, Bristol, on October 1, Sir Rubert Boyce, F.R.S., is to speak.

According to foreign journals, steps are being taken by the commonwealth government in regard to the adoption of uniform food standards throughout Australia. Under the present system each state fixes its own standards, the result being considerable variance, and consequent annoyance and expense to manufacturers and importers. Now that a commonwealth analyst has been appointed, the way is cleared for federal action, and the proposal is made for a conference of commonwealth and state expert authorities with the object of discussing the basis of united legislation.

Foreign papers state that news has been received from the *Jacques Cartier*, the ship of the French Arctic Expedition, which started in April. After touching at Hammerfest, the ship crossed Barent's Sea and reached the Bailutsia Fjord in Novaya Zemlya, where extensive surveying was undertaken, leading to the discovery of several uncharted fjords. The first sledge expedition left the ship on July 25 with provisions for 20 days, intending to cross Novaya Zemlya from west to east, and it was followed by a second six days later. The expedition will probably not winter in Barent's Sea, but will return to Norway and remain there till the spring.

The Central University of Equador at Quito publishes the following notice requesting exchanges in its monthly "Anales": "The University of Quito, desiring to increase its museums of zoology, botany, mineralogy and ethnology by means of exchanges with public and private museums, has resolved to invite the correspondence of parties who wish to exchange for collections of *Ecuadorian fauna, flora, etc.* Those who wish to have sent any particular specimen or collection (*e. g.*, an ornithological collection) have only to apply to the rector or the secretary of the Central University of Equador at Quito."

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late John B. Brown, of Chicago, the bulk of his wealth, estimated at $7,000,000, is to be devoted to establishing and maintaining a technical school at Ipswich, Mass. A high-school education or its equivalent will be prerequisite for admission, thus placing the school among the higher institutions of learning.

By the will of Henry J. Braker, of New York City, Tufts College receives a bequest of $500,000, to be known as the Henry J. Braker fund, the income to be used for the establishment of a school of commerce, accounts and finance. Mr. Braker also bequeaths $1,000,000 to establish a home for aged people.

President John H. Finley announces that the Board of Aldermen has increased the annual appropriation for the College of the City of New York by the sum of $40,000.

At the Carnegie Technical Schools, Pittsburg, two new buildings in the group for the School of Applied Science have just been erected, and will be ready for occupancy in October. They double the facilities for instruction in this department of the institution, giving 150,000 additional square feet of floor space. The construction is absolutely fireproof throughout, and the laboratory and class-room equipment is of the most modern type. John H. Leete, A.B., becomes dean of the school. New appointments to the faculty include Norman C. Riggs, M.S., assistant professor of mathematics; F. P. Colette, B.L., assistant professor of modern languages; F. W. Witherell, S.E., instructor in sanitary engineering, and John A. Schaeffer, Ph.D., assistant instructor in chemistry.

Dr. Charles H. Judd, professor of psychology at Yale University, has been elected dean of the school of education and head professor of the department of education at the University of Chicago, the appointment to take effect at the close of the present academic year.

Dr. Fletcher Bascom Dressler, associate professor of education in the University of California, has been appointed to the chair of philosophy and education in the University of Alabama, vacant by the removal of Professor Edward Franklin Buchner to the Johns Hopkins University.

Dr. G. A. Tawney, of the University of Illinois, has been elected professor of philosophy in the University of Cincinnati, to succeed Professor H. Heath Bawden.

Dr. Paul G. Wooley, who for the last five years has been director of the Siamese Government Serum Laboratory in Phrapatoom and chief inspector of health and medical adviser to the minister of the interior, has accepted the position of associate professor of clinical pathology in the University of Nebraska College of Medicine, Omaha.

At Northwestern University, Dr. George R. Mansfield, of Harvard University, has been appointed assistant professor of geology, to succeed Professor J. W. Goldthwait, who goes to Dartmouth College. Professor Mansfield will begin work in February, 1909. Mr. C. E. Decker has been appointed instructor in geology at Northwestern University for the first half of the present year. Mr. D. F. Higgins, Jr., has been appointed to an assistantship, and Professor J. H. Cline, of Bridgewater College, Virginia, to a fellowship in the same department.

In the department of geology of the University of Oklahoma, Dr. Chas. N. Gould, while still being retained as head of the department, has relinquished his work of teaching and is devoting his time to the new Oklahoma Geological Survey, of which he is the director. Dr. D. W. Ohern, until recently associate professor of geology at Bryn Mawr College, has taken up Dr. Gould's work in the university, and is being assisted by Mr. Pierce Larkin. Mr. Chester A. Reeds has resigned his position as associate professor in the department, having been elected to a position in the department of geology in the University of Cincinnati.

The following appointments have been made in the school of civil engineering, Purdue University: instructor in structural engineering, Mr. W. A. Knapp, graduate of the University of Illinois, class of 1907; instructor in hydraulic engineering, Mr. R. B. Wiley, graduate of the University of Michigan, class of 1906; assistant in surveying, Mr. J. H. Lowry, Purdue 1908; assistant in railway engineering, Mr. N. A. Lago, Purdue 1906.

The following appointments and changes are announced for the Worcester Polytechnic Institute for the ensuing year: Professor John E. Sinclair, who has held the position of professor of mathematics for thirty-nine years, retires on the Carnegie pension. Professor Levi L. Conant becomes the head of the department of mathematics on the retirement of Professor Sinclair. Two new appointments to the faculty have been made: Carleton A. Read, M.E., professor of steam engineering, who comes to the institute from the New Hampshire College of Agriculture and Mechanic Arts, and Arthur D. Butterfield, B.S., A.M., assistant professor of mathematics. Professor Butterfield is a graduate of the class of 1893, and was formerly instructor in civil engineering at the institute. For the past ten years he has been professor of mathematics at the University of Vermont. A number of appointments have also been made to the corps of instructors as follows: Robert H. Goddard, B.S., W.P.I., '08, instructor in physics; John F. Mangold, B.S., Cornell, Iowa, '07, instructor in civil engineering; Dr. W. F. Holman, University of Nebraska and University of Göttingen, instructor in physics; James A. Bullard, A.B., Williams, '08, instructor in mathematics; Royal W. Davenport, B.S., W.P.I., '08, instructor in civil engineering; Charles J. Adams, A.B., Amherst, '96, instructor in modern languages; J. Howard Redfield, A.B., Haverford, '99, and B.S. M.I.T., '02, instructor in mathematics; Albert A. Nims, B.S., W.P.I., '08, graduate assistant in electrical engineering; John C. Harvey, B.S., W.P.I., '08, Alden W. Baldwin, B.S., W.P.I., '08, and Richmond W. Smith, B.S., W.P.I., '08, graduate assistants in mechanical engineering.

H. J. Eustace has been appointed professor of horticulture in the Michigan Agricultural College and horticulturist of the experiment station. He graduated at the Michigan Agricultural College in 1901 and for five years was assistant botanist at the New York Agricultural Experiment Station at Geneva, N. Y., and for the past two years has been connected with the Fruit Storage and Transportation Investigations of the Bureau of Plant Industry, U. S. Department of Agriculture.

Victor T. Wilson, instructor in drawing, Cornell University, 1893 to 1903, professor of engineering drawing, State College (Pennsylvania), 1907–8, has been elected professor of drawing and design in the Michigan Agricultural College.

The following are the new appointments in the science departments of the University of Maine: L. H. Merrill, Sc.D., professor of biological and agricultural chemistry; F. L. Russell, B.S., V.S., professor of bacteriology and veterinary science; Wallace Craig, Ph.D., professor of philosophy; L. E. Woodman, M.A., assistant professor of physics; V. R. Gardner, M.S., assistant professor of horticulture; W. A. Brown, B.S.A., assistant professor of animal industry; C. E. Lewis, Ph.D., associate vegetable pathologist; M. R. Curtis, M.A., assistant in biology; H. N. Conser, M.S., instructor in botany; E. M. Wallace, B.A., instructor in biology; J. L. Coon, Ph.B., tutor in physics; E. A. Garlock, B.S., tutor in physics; J. P. Farnsworth, B.S., tutor in drawing; R. K. Steward, B.S., tutor in civil engineering; A. G. Durgin, B.S., assistant in chemistry.

QUOTATIONS

AN EDUCATIONAL PARADOX

A European would be put to his wit's ends by the recent Chicago dispatch announcing that a professor of philosophy is about to exchange his university chair for one in a theological seminary in order to enjoy greater academic freedom. "America is more topsy-turvy than China!" the bewildered foreigner might ejaculate. "A university is the very citadel of intellectual liberty; a theological school, dogma's safest stronghold." Reference to catalogues would not clear his mind. The university in question declares that it "was not established with a view of forcing on the attention of students the creed of any particular church, but for the promotion of learning under influences conducive to the formation of manly Christian character." Its charter "carefully provides that no particular religious faith shall be required of those who become students at the institution." Surely, then, if students are not to be reminded of any doctrine, their instructors can not be expected to insinuate one into their professional utterances. In the seminary, on the other hand, teachers and learners are supposed to accept at least the broader Christian dogmas and to center their studies about these. Can the European, noting such facts at long range, be blamed for distrusting the whole story? The paradox may well confuse even our own countrymen who have not been following contemporary tendencies in school and church. Professor George A. Coe's reported difficulties with the Methodists at Northwestern University and his acceptance of a chair at Union Theological Seminary are anomalous products of two conflicting movements in the educational and religious worlds —movements which may, in the course of years, lead to still more curious situations.

Andover's transfer to Cambridge and Union Theological Seminary's approaching shift to Morningside Heights reflect a yearning for university affiliations, born partly of intellectual discontent and partly of necessity. Unlike the college freshman, many theological professors and most theological students have felt the power of modern science and thought, and the weakness of dogmatics, apologetics, and Hebrew grammar as defenders of their faith. Not long ago, one of the largest seminaries in the country was peremptorily ordered by its students to modernize its curriculum; and, on every hand, the demand is being made that religious opinions be left to individuals, and the seminary teach biology, psychology, history, ethics, hygiene, and social reform. The result, at this hour, is incongruous in the extreme. While the universities are crying, "Let the seminaries come to us, that we may be spiritualized!" theological students ask for a chemical laboratory that they may be trained in modern scientific method. But the incongruity is natural. The forces of intellectual conservatism reside in the masses; they make themselves felt most acutely in the ordinary college simply because the latter is the meeting-place of culture and the average man. In the seminary, though, and particularly in those which have lived through an open controversy between dogma and liberalism, a handful of cultivated churchmen, half secluded and full of doubts, are seeking to square their beliefs with modern knowledge and their practises with the needs of modern life. Their own perplexities and their remoteness from the unschooled laity make them liberals. No wonder, then, that a training school for Protestant ministers may welcome a philosopher obnoxious to a nominally unsectarian university.—New York *Evening Post*.

DISCUSSION AND CORRESPONDENCE

MATHEMATICS FOR ENGINEERS

To the Editor of Science: I have followed the recent discussion of mathematics for engineers with much interest and with a great sense of satisfaction that at last the discussion of technical education is being published in a place where it must, perforce, be brought to the notice of our physicists; for our physicists (I mean to refer to them here in their capacity as teachers) have paid but little attention to the remarkably active discussion of technical education that has been going on for several years.

Something is wrong with technical education, that is quite evident, but I am not entirely satisfied with any diagnosis which up to this time has been given of the situation. I think that the most vital question which now confronts us in the field of technical education is how adequately to establish the *perceptive phase* of the physical sciences. In order that I may explain precisely what I mean by this expression, I must use an example:

Nothing is more completely established by experience than the necessity of employing an active agent, such as a horse or a steam engine, to drive the machinery of a mill or factory, to draw a car, or to propel a boat. The common feature of every case in which motion is thus maintained is that *a force is exerted upon a moving body and in the direction in which the body moves.* Such a force is called an *active force,* and to keep up an active force involves continuous effort, or cost. A force which acts upon a stationary body, on the other hand, may be kept up indefinitely without cost or effort; such a force is called an *inactive force.* Thus, a weight resting on a table continues to push downwards on the table, a weight suspended by a string continues to pull on the string, the mainspring of a watch continues indefinitely to exert a force upon the wheels of the watch if the watch is stopped. The idea of an inactive force is applicable also to a force which acts upon a moving body, but at right angles to the direction in which the body moves. Thus, the force with which a driver pushes vertically downwards on a moving cart is an inactive force, the vertical pull of the earth on a railway train which moves along a level track is an inactive force.

An active force is said to do work and the amount of work done in a given time is equal to the product of the force and the distance that the body has moved in the direction of the force.

This is taken almost verbatim from the text-book on "Elementary Mechanics" which was recently used with a freshman class in one of our best technical schools (only 126 pages of the text were covered during the excessively short time allotted to this subject) *and 43 per cent. of the class at the time of the final examination (counting the 20 per cent. who were so hopelessly deficient that they were not allowed even to try the final examination) were so deficient in physical imagination, or power of perception, or whatever one may prefer to call it, that they blindly calculated that the man was doing nearly twice as much work as the mule in the following problem:*

A cart moves northwards with a velocity of 6 feet per second, a mule pulls northwards on the cart with a force of 90 pounds, and a man exerts on the cart a downward force of 150 pounds. At what rate is work done by the mule and at what rate is work done by the man?

To have named the part of his body the man used in pushing down on the cart might have stimulated the perceptive powers of the dullest members of the class; indeed the instruction during the term did resolve itself many times into things as unreservedly elemental as this; but have we not a right to expect our students, at least at examination time when their greatest effort is put forth, to be able to handle abstract (!) problems like this of the hard-working cart driver and his pampered mule?

SCIENTIFIC PERCEPTION

I was greatly pleased to see Professor Swain bring up Sir William Hamilton's ideas, seventy years old. Perhaps your readers will welcome an idea from William Whewell which is also seventy years old. It is almost the only idea I was able to find years ago when I read the "Philosophy of the Inductive Sciences," but it is a creditable thing to have produced one idea; indeed, it would be a creditable thing in our time even to adopt ideas! Whewell says that ideas of perfect precision are a paramount possession (the four p's are Whewell's; he might well have omitted at least one of them as I do in the paraphrase). Nothing is so essential in the acquirement of real knowledge of physical things as the possession of precise ideas, not indeed because a perfect precision is necessary as a means for retaining knowledge, *but because nothing else so effectually opens the mind for the perception even of the simplest evidences of a subject.*

(In the final examination in elementary mechanics above referred to, the following note was appended to one of the questions:

A redundant or wrongly used word in answer to this question will be graded zero,

and a day or two after the examination a member of the faculty (*not* a professor of mathematics) quoted this note in derision, as if the only precision were numerical precision! May the shade of William Whewell protect us!)

In order to be able to define in a general way the perceptive phase of the physical sciences, let me distinguish two chief results of the scientific activity of the nineteenth century, namely, (1) an accumulated mass of fact, under which heading I would include all of the details of applied science, for indeed the most important and compelling facts that have been accumulated by the sciences are the facts which are incorporated in the settled doings of men, and (2) an established mode of thought and inquiry which may be designated, using a suggestive phrase of Bacon's, as "A new engine, or a help to the mind corresponding to tools for the hand." Here is an idea three hundred years old!

We continually force upon the extremely meager data which are obtained directly through our senses an interpretation which in its complexity and penetration would seem to be entirely incommensurate with the given data, and the possibility of this forced interpretation depends upon the use of two complexes, (*a*) a logical structure, that is to say, a body of ideas and conceptions which operates for perception, and (*b*) a mathematical structure, which, in many cases, but by no means in all, supervenes and leads easily to an elaborate conclusion. These two complexes do indeed constitute a new engine which helps the mind as tools help the hand, and if the first (the perceptive phase of physical science) were insisted upon in our technical schools with approximately the same emphasis as pure mathematics, our students would not be so ridiculously perverted by mathematical superventions as to calculate that a two-horse-power steam engine would be required to drive a *willing* mule. But such is the earlier stage of technical education as it is to-day!

PHYSICS TEACHING AT FAULT

The fault, however, seems to me not to lie to any great extent with our teachers of mathematics. Their mode of presenting their subject is, I believe, in a general way correct, but I am firmly convinced that our mathematical courses at present include a great many topics which might well be omitted, and a thorough drill in descriptive geometry should certainly be included. I believe that too much time is devoted to the study of pure mathematics in our technical schools and too little time to the study of elementary physics and chemistry. It is certainly a fact, however, that a large number of our college and university teachers of physics are anything but enthusiastic as teachers, and the subject matter which they place before their students is certainly not up to the requirements of modern technical education. A real fault, as it seems to me, may be charged against our teachers of physics.

In the discussion of engineering education before the American Institute of Electrical Engineers on January 24, 1908, a great deal was said concerning the place of mathematics in technical education; and the exacting character of technical education, which is associated in most men's minds with the teaching of mathematics, was emphasized as important. In the old days mathematics was indeed the only scientific study which could be made definite and exacting. Nowadays, however, nearly every technical subject which is taught in the engineering school can be made as exacting as mathematics and, above all, the elementary sciences of physics and chemistry have been reduced to a basis which enables these sciences to be presented in a way which, in my opinion, must soon entirely revolutionize technical education. I believe that our engineers and many of our engineering professors fail to realize the change which has taken place in the teaching possibilities of elementary physics in the last ten or fifteen years, and therefore we find these men still expecting our teachers of mathematics to lift themselves and a large superstructure by pulling on their boot straps, these faithful teachers being held responsible for the most serious faults which underlie technical education. Let the heads of our technical schools look rather to their teachers of physics, demanding of them the best that modern science teaching can give, and allowing them the necessary time to accomplish what is desired.

ELEMENTARY PHYSICS TEACHING NECESSARY

I do not think we can look to our teachers of mathematics to establish the simple logical structure of physical science.

Nothing is more completely established in psychology nowadays than that ideas can not be formed out of the clear sky, as it were. They must be built of stuff, and *the rational study of the physical sciences especially in its earlier stages is the transformation of simple intimate knowledge into general ideas.* All elemental knowledge, such as the knowing how to throw a ball, how to ride a bicycle, how to swim, or how to use a tool, is locked in the marginal region of the mind (the region of reflexes) as a very substantial but very highly specialized kind of intuition, and the problem of the teaching of elementary physical science is the problem of how, by verbal and concrete suggestion, to drag this material into the field of consciousness, where it may be transformed into a generalized logical structure having traffic relations with every department of the mind. *An abstract treatment of the principles of elementary physics tends, more than anything else, to inhibit the influx of this elemental knowledge from the marginal regions into the field of consciousness and results in the building up of a* *theoretical structure which can have no effectual traffic with any mental field beyond its own narrow boundaries.* Such a state of mind is nothing but a kind of idiocy, and to call it a knowledge of elementary science is weak scholasticism. . . . A large part of simple theoretical physics is constructed out of sensuous elements which are not habitually and fixedly associated with verbal forms of expression, and it is impossible to marshal these elements in any other way than by direct appeal, by sight of feeling, to the actual things which correspond to them.[1]

The equipment and methods of the physical laboratory are a necessity in the teaching of elementary physics. The point of view of many of those who are responsible for the arrangement of our technical courses is more or less confused in regard to elementary science instruction and it may be accurately characterized by a slight variation of a statement of Bacon's:

Natural philosophy [in their minds] is not to be found unadulterated, but it is impure and corrupted by mathematics which ought rather to terminate natural philosophy than to generate or create it.

I have heard that near Nancratis, in Egypt, there was born one of the old gods, the one to whom the bird is sacred which they call the ibis; and this god's name was Teuth. And this god, or demigod, found out first, they say, arithmetic, and geometry, and logic, and gambling, and the art of writing. And there was then a king over all Egypt, in the great city which the Greeks called Thebes. And Teuth, going to Thebes, showed the king all the arts he had invented, and said they should be taught to the Egyptians. But the king said: "What is the good of them?" And Teuth telling him at length of each, the king blamed some things and praised others. But when they came to writing: "Now, this piece of learning, O king," says Teuth, "will make the Egyptians more wise and more remembering; for this is physic for the memory and for wisdom." But the king answered: "O most artful Teuth, it is one sort of person's business to invent arts, and quite another sort of person's business to know what mischief or good is in them. And you, the father of letters, are yet so simple-minded that you fancy their power just the contrary of what it really is; for this art of writing will bring forgetfulness into the souls of those who learn it, because, trusting to the external power of the *scripture* and *stamp* of other men's minds, and not themselves putting themselves in mind, within themselves; it is not medicine of divine memory, but a drug of memorandum that you have discovered, and you will only give the reputation and semblance of wisdom, not the truth of wisdom to the learners: for[2] becoming hearers of many things, yet without instruction, they will seem to have manifold opinions, but be in truth without any opinions; and the most of them incapable of living together in any good understanding; having become seeming-wise instead of wise."

I always think of this prognostication of the old Egyptian king concerning the influence of letters when I consider what may be the true path through the tremendously widened and at present greatly confused field of human endeavor which has come with the discovery of physical science. We are now, in regard to science, in the midst of something like the pandemonium which was imagined by Socrates as a possibility in the field of letters. We have, indeed, become hearers of many, many things, and we seem to have manifold opinions; and, although I believe we are not really without opinions, I certainly do believe that many of us do not take sufficient pains to make ourselves understood when we attempt to express what opinions we may truly have. (It may be justly said, I think, that the voluminous discussion of technical education which has taken place during recent years, especially that which has taken place before our engineering societies, is but slightly edifying.) Nor do I believe that we are *incapable* of living together in any good understanding. As to being seeming-wise instead of wise, we should in all humility admit that wisdom is a

[1] From a paper on "The Study of Science by Young People," by W. S. Franklin, *Proceedings of the Twelfth Annual Meeting of the New York State Science Teachers' Association*, pp. 65–94.

[2] This powerful story of the mythical discoverer of writing was quoted thirty-five years ago by a very severe writer, who inserted the following parenthesis at this point "now *do* listen to this, you cheap education mongers." I believe, however, that technical educators are as far removed as any from the cheap type, except only the one who knows of no other kind of precision but the precision of numbers.

truly wonderful state, not presuming to have reached it in its perfection.

But let me return to the question of the perceptive phase of the physical sciences. A splendid example of almost pure perception is the recent work of Rutherford and others on radio-activity which is based on what would seem to be an absurdly slender group of observable effects. No one can overestimate the power of men who do such work as this. My chief business, however, is the *teaching* of physics; as a teacher I am concerned with average men; and every year I am more and more amazed to see the feebleness with which men hold things in the mind, and more and more impressed with the tremendous power with which men hold things in the hand, a power which, as Plato says, encompasses with eternal security an ancient polity and ancient divisions of rank founded on possession, but which also, alas! as Ruskin says, too often takes the name of Christ in vain and leagues itself with his chief enemy covetousness, which is idolatry.

W. S. Franklin

WHAT CAN BE DONE TO ENHANCE THE VALUE OF THE WORK OF THE BUREAU OF STANDARDS TO THE CHEMICAL INDUSTRIES?

The greater part of the scientific work done in the United States is accomplished through two agencies, the universities and technical schools on one hand and the bureaus of the government on the other. As regards the latter, the principle that the government should undertake, in the main, only such work as can not efficiently be handled by unofficial enterprise, is generally accepted as sound and has, with some exceptions, been adopted as a policy by the bureaus. It must be admitted that it would not be well to draw such a distinction, or any distinction, too sharply or rigidly. To attempt this would certainly impair the usefulness of the work of the governmental departments. But, broadly speaking, it is not impracticable to avoid needless competition with scientific research carried on by other instrumentalities.

It is an indubitable fact that some lines of scientific research lie farther away from practical applications than do others. Those can be and are well cared for by educational institutions. On the other hand, experience has shown that scientific investigations which bear more directly upon the industries can not be so satisfactorily undertaken without government aid and are more or less seriously neglected when left wholly to private enterprize. Such technical researches are by their nature (costliness, necessity of continuity, direct bearing on legislation, etc.) appropriate subjects for governmental treatment. The success and value of the official work of the United States authorities on road building, on the testing of materials of construction and of foods and drugs, and on standards of measurement, are approved and appreciated alike by scientific men and by the general public, and scarcely require special emphasis here.

It is fortunate that popular recognition is accorded to this branch of governmental work, not only in a liberal degree, but also in a way that harmonizes with the principle enunciated above. So long as the bureaus concentrate their labors on the solution of problems of practical interest, so long will they enjoy the approval and support of the public. Just in the measure that they allow themselves to be diverted to the study of scientific questions lying far afield from practical industrial applications, will the public interest cool and the necessary appropriations become increasingly more difficult to obtain, and this quite apart from the intrinsic interest or importance of the work done. As an example of the sort of scientific questions referred to, determinations of the atomic weights of the elements may be cited as typical. If the considerations advanced here have any validity, such determinations had better be left for other institutions and remain untouched by the government. We are free to admire the excellence of the work as much as we like, and to extoll its importance, and we may still without inconsistency take the stand that such work is not within the proper scope of governmental departments, because, (1) it can be and is well taken care of by other agencies, (2) it is not of direct industrial or so-called "practical" application, (3) it is not calculated to command the cordial approval of the people and therefore of congress, (4) it withdraws to an appreciable degree the energies of the bureaus undertaking it from the attack of a class of problems that demand a sort of investigation which other organizations or individuals have been unable or unwilling to give. The question of atomic weights has been selected as typical of a class of scientific inquiries, for the reason that the work done in that direction by the Bureau of Standards is of the highest character and the argument in favor of its inclusion in the scope of bureau activities is the strongest that can be brought in behalf of any scientific work of the category to which it belongs. It is, however, not a question, as I apprehend it, of whether this bureau can do such work well, but rather of whether any bureau should do it at all.

The reply is obvious, that, if the public does not approve of the government doing such work it is because the public does not understand it; therefore educate the public, but do not stop the work. It is possible, however, that the public understands the wider bearings of the questions involved very well, although not very familiar with details. Every one of the bureaus doing scientific work was organized explicitly and absolutely for utilitarian purposes. Every argument used before the congress to secure appropriations needed for organization and maintenance was based on the direct practical usefulness of the bureaus to the commerce and industries of the country and to the transaction of the business of the government itself. Those arguments are looked upon by the people at large as pledges, and in my opinion it is right that it should be so. The utilitarian aim should be first. It can not be doubted that, if this aim is conscientiously kept in mind, incidentally much that possesses a wider scientific interest will be brought out, in the end as much perhaps as if the aim had been primarily scientific in the narrower sense. After all, it should not be forgotten that the industries have contributed no less to the sciences than the sciences to the industries.

In any event, raising the question whether and how the Bureau of Standards may be made still more useful to those engaged in the technical or scientific practise of chemistry, ought not—and I am sure will not—be construed as a reflection upon the valuable work done by it in the past.

The same reasons which have made it necessary to supply the industries with official standards of weight and of volume make it desirable that chemical standards should also be furnished for those industries which are dependent upon chemical processes. It is scarcely to be assumed that the chemical laboratories devoted to commercial technical work should in all or most instances command the time or the skill to establish their own standards. Such laboratories employ methods of analysis that yield results reasonably concordant among themselves, but that are not necessarily in conformity with absolute standards nor with those obtained by other laboratories of the same type. In a word, the methods are, to a certain degree, empirical. This is a fact not subject to control. It is conditioned by the nature of the work and must as such be reckoned with. It is an evil which constantly gives rise to friction between buyer and seller, between manufacturer and consumer. A remedy for this evil which has repeatedly been and still is advocated is the introduction of uniform methods of analysis. This remedy is, however, both inadequate and dangerous. Inadequate, because it is impossible so to specify every step of an analytical process as to secure with certainty identical execution and identical results from it at the hands of workers in different laboratories. Dangerous, because it hampers the development of improved methods and tends to make a mere machine of the technical chemist. A better remedy is at hand. This is, to place at the disposal of all laboratories interested, chemicals which are officially standardized, so that by whatever process a given chemist operates, he may check his results by the standard material, just as he now checks his thermometers or his weights through the aid of the Bureau of Standards. He will thus, if his methods are bad, soon discover the fact and abandon them; if they are concordant among themselves, but not with the absolute standard, he will apply the proper correction. In cases of dispute between two laboratories, an analysis by each of the standardized sample, each working by its usual method, will usually lead to a satisfactory agreement.

The materials which it is proposed to standardize fall into two groups. The first group comprises substances to be employed for standardizing volumetric solutions. These may be either the solutions themselves, or compounds of exactly known content used in establishing the true titer of the solutions belonging to the industrialist's laboratory. In the case of about six of the most used and most permanent, it would probably be well to furnish the solutions and also the standard compounds. The second group comprises standardized samples of commercial materials, by the use of which the manufacturer can control his entire analytical process. This work has already been begun. Its development must naturally be slow, since the field is immense, and in some cases special industrial laboratories have perfected methods of analysis which for commercial reasons have never been published and which are superior to those in general use or to those which would be at the command of the bureau. Exceptional cases of this kind need not, however, stand in the way of the adoption of the general scheme. To decide what portion of the whole field should be first occupied and what left to future growth is a matter that would require very careful study and need not be even touched on here. The question whether the standard solutions or substances should be furnished by the consumer and standardized by the bureau or whether they should be furnished outright by the bureau is a matter of detail which practical considerations would settle. The cost of executing such a programe as that suggested need not be a serious obstacle. From the standpoint of the manufacturer it would be economy to pay very liberal fees for the work, especially in view of the fact that the standardized materials would be consumed in small quantities only and mainly for the purpose of establishing secondary standards.

Whether it is desirable for the bureau to undertake to work out standard methods of analysis, is a question that may fairly be looked upon as an open one. For myself I should be inclined to answer it in the negative. The scope of work is wide enough without this. The difficulty which any institution must have in deciding for the industrial laboratory which are the methods that would be practical for it are insuperable. A method that would be eminently practical for one would be the reverse for another having command of facilities more or less wide. Moreover it is impossible for any outsider to know what the analytical problems are which the industrialist has to handle, and in very many cases the latter will on no account furnish the information. Nevertheless, while for the reasons stated, the writer does not believe it to be wise for the bureau to make the investigation of analytical methods a part of its functions, yet it must of necessity investigate many such methods as an incident in the carrying out of other work, and it will, of course, not refrain from giving to the world the benefit of such work by timely publication.

The chemical profession in this country is only now coming to a consciousness of itself. When it has fully done so, it will doubtless have a Bureau of Applied Chemistry of its own, together with other good things, but the day is probably still distant. It owes it to itself, in the meantime, neither to be backward in acknowledging the great work that the Bureau of Standards has already accomplished, nor in demanding that its scope should be extended and its relations be made more intimate with our chemical industries, whose future is already looming up greater than any man can now fully realize or forecast.

Launcelot Andrews

St. Louis,
July 24, 1908

SCIENTIFIC BOOKS

The Work of John Samuel Budgett, Balfour Student of the University of Cambridge. Being a Collection of his Zoological Papers, together with a Biographical Sketch by A. E. Shipley, F.R.S., and Contributions by

Richard Assheton, Edward J. Bles, Edward T. Browne, J. Herbert Budgett and J. Graham Kerr. Edited by J. Graham Kerr. Pp. x + 494; 28 plates; 173 figures in the text. Cambridge University Press, 1907.

John Samuel Budgett died January 19, 1904, at the age of thirty-two, from malarial fever contracted during his last and successful expedition to Africa in quest of the long and eagerly sought early development of *Polypterus.* The beautiful volume prepared by his friends and colleagues is a fitting memorial of his life and work and one that stirs a keen sense of the loss that science suffered by his untimely death. A collection of Budgett's own works and of others based on his material is preceded by an excellent biographical sketch by Mr. Shipley. From this we learn that his early interest in natural history was encouraged by his father's friends, Professor W. K. Parker and the Rev. Dr. Dallinger, and later by Dr. Lloyd Morgan, but until his entrance to Cambridge University he was largely self taught. The remarkable abilities he displayed at Cambridge brought him the opportunity to accompany Mr. Graham Kerr on his brilliantly successful expedition to Paraguay in 1896–7, the principal result of which was to make known the development of *Lepidosiren.* On this expedition Budgett gave especial attention to the amphibia, afterwards publishing a valuable account of their breeding habits and of the development of Phyllomedusa. The principal result for him was, however, to arouse his determination to attack the development of the crossopterygians; and to the search for this material the next five years were devoted with indomitable persistency and courage. In the effort to procure the early stages of *Polypterus and Calamicthys,* and also of *Protopterus,* he made four successive expeditions to Africa, the last of which, in 1903, was crowned with success but cost him his life. The first expedition, to the Gambia River in 1898–9, failed in its main object, but in the face of great difficulties the breeding time of *Polypterus* was determined and valuable additions to our knowledge of the fauna of the Gambia were made. In a second attempt, made in the same region during the rainy season of 1900, the nests and larvæ of *Protopterus* were discovered and a single larval stage of *Polypterus* was procured which formed the subject of an important memoir published in 1901. His diaries of the expedition give a vivid impression of the courage and enthusiasm with which he pursued his work in the tropical swamps amid incessant heavy rains, and at times attacked by fever. Upon his return to Cambridge he became assistant curator in the zoological museum and delivered lectures on the geographical distribution of animals. In 1902 he was elected to the Balfour studentship, the "zoological blue ribbon of Cambridge," and, with an additional grant from the Zoological Society, was enabled to embark on a third expedition, to the Victoria Nile. For the third time he failed, but held to his purpose. The final and successful attempt was made in 1903. At Assé, on the river Niger, he at last succeeded in artificially fertilizing the eggs of *Polyterus* and in obtaining a practically complete series of the stages of development. But the climate had done its deadly work. Returning to England be began to work out his results, but suffered from recurrent attacks of malarial fever to which within a few months he succumbed, his death occurring on the very day for which a paper by him on the development of *Polypterus* was announced for the Zoological Society. He had finished his drawings of the external features of the early development, but it remained for Professor Kerr to prepare the sections and work out the results in detail.

In the memorial volume are brought together ten of Budgett's papers, the most important of which deal with the development of the skeleton and urino-genital system in *Polypterus,* the early development of *Protopterus,* and that of *Phyllomedusa.* Other less technical papers deal in an interesting way with the general natural history of the tropical regions that he visited. The remaining papers of the volume, based on Budgett's material, include, among others, Professor Graham Kerr's very valuable memoir on the development of *Polypterus;* another on the development of *Gymnarchus* (the first of the Mormyridæ to be made known embryologically) by Richard Assheton; and shorter articles by Mr. Boulenger on the fishes of the Gambia, by Dr. Bles on the development of the Anura; and one by Mr. Browne on a fresh-water medusa, discovered by Budgett in the delta of the Niger, that seems to be identical with the Limnocnida found in Lake Tanganyika. It is impossible here to review the results of these works in detail, but a special word should be spoken in commendation of the excellence, and often the truly artistic quality, of the illustrations, many of which are from Budgett's own drawings.

Budgett showed a rare union of technical skill and morphological insight in laboratory research with uncommon abilities as a field naturalist. His diaries reveal a true lover of nature, one having a wide range of interests in living things, alertly awake to natural beauty, and steadfastly unsparing of himself in the pursuit of his special aim. His was not the only life to be sacrificed in the pursuit of the *Polypterus* development. Nathan R. Harrington died at Atbara in the summer of 1899 while leading an expedition sent out from Columbia University on the same quest. The results attained through Budgett's success are of great and permanent value to science, but they have cost a heavy price.

W.

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. New York, The Macmillan Company. 1908. Pp. vi + 489. $2.75 net.

This is a reprint, without change, of the fourth edition, which appeared in 1902 and was widely reviewed at that time. This well-known work is accurate, lucid and interesting. It is already on the shelves of every astronomer's library, but should more universally be found in school and circulating libraries.

It is to be regretted that the few errors and omissions which are to be found in the fourth edition were not corrected in this reprint. Failure in this respect is doubtless due to the lamented death of the author in 1907. The publishers, however, should have had made such obvious and easy corrections as the change in the date of the death of Lassell from 1818 to 1880 (p. 83), and the substitution of the word "gemination" for "germination" when describing the canals of Mars (p. 279), and should have supplied in Table V. the missing but easily obtainable data regarding focal lengths of various telescopes listed therein.

Storrs B. Barrett

SCIENTIFIC JOURNALS AND ARTICLES

The July number (volume 9, number 3) of the *Transactions of the American Mathematical Society* contains the following papers:

W. H. Roever: "Brilliant points of curves and surfaces."

Oswald Veblen: "Continuous increasing functions of finite and transfinite ordinals."

E. J. Wilczynski: "Projective differential geometry of curved surfaces (third memoir)."

A. L. Underhill: "Invariants of the function $F(x, y, x', y')$ in the calculus of variations."

R. G. D. Richardson: "The integration of a sequence of functions and its application to iterated integrals."

SPECIAL ARTICLES

DEGENERATION, ALBINISM AND INBREEDING

In a paper before the American Philosophical Society last spring I showed that often when the two parents have any organ or quality A in two conditions, A + and A —, of which the former is a highly developed or progressive condition, the latter a poorly developed or even absent condition, the former condition will regularly dominate over the latter. In the particular case of human hair color we find, for example, that children are not ordinarily darker than their darker parent. Consequently, if both parents have flaxen hair the children will have hair of the same sort. From this principle, applied generally, it follows that when both parents have an organ in a low condition of development it will be so also in all of their children. This principle explains the persisting or increasing degeneration in the descendants of two degenerate parents.

When one parent has an organ in a minus

condition and the other in a plus condition the condition of the organ in the children will depend upon the germ cells (and hence on the parents) of the advanced parent. If half of its germ cells are in the minus condition, as may be the case, half of the children will have the organ in question in the minus condition. Even if both parents are in an advanced condition, if they both have the less advanced condition recessive, one quarter of their offspring will have the organ in a minus condition.

The foregoing principles help us to understand the reason for the degeneration that sometimes, but not always, follows inbreeding. If the children can not rise above the level of their parents but may fall below in respect to any organ, it is plain that if brothers and sisters were to mate the average of the offspring would rapidly run down hill to the zero condition of the organ. In the mating of cousins the same result would tend to occur, but not so rapidly and certainly. The more foreign blood introduced the less the danger of degeneration.

Another class of degeneration is illustrated by albinism. Studies that Mrs. Davenport and I have been making show that there are in human hair two pigments, black and red, occurring in various dilutions and combinations, as will be more fully set forth in our paper on human hair color to appear shortly in the *American Naturalist*. There are, however, cases of black (N) hair with no red (r) pigment, and of yellow or red (R) hair without black pigment (n). The gametic formula of the former is Nr and of the latter nR. The grandchildren of Nr and nR consorts will have hair of either of four kinds: black-and-red (NR, chestnut, or mahogany colored), jet black (Nr), clear yellow or red (nR), and colorless (nr); the latter are albinos. Studies that I have been making on albinos reveal an ancestry in conformity with this hypothesis. We see, then, that albinism is not a sport occurring in wholly arbitrary fashion; but a necessary, predictable result of certain combinations of gametes. The only part that inbreeding plays is to make more probable the necessary combination of gametes. The degeneration in this case follows from the union of two negative factors in dihybrids; and this is a common cause of degeneration.

Chas. B. Davenport

THE QUESTION OF CYCLOPIA, ONE-EYED MONSTERS

Two summers ago I found it possible to produce one-eyed fish embryos by means of $MgCl_2$ solutions in sea water.[1] At that time the spawning season of the fish used, *Fundulus heteroclitus*, was nearing a close, so that it was impossible to obtain material showing the early conditions of the defect or to rear the embryos in order to observe their actions after hatching.

During the present summer more extensive experiments have confirmed the fact that cyclopean embryos may be produced in any number desired by treating the eggs with $MgCl_2$ or $Mg(NO_3)_2$ solutions. The effect seems due to the Mg ion in the presence of certain sea-water salts. The embryos may be hatched and the cyclopean eye seems functional, many of the fish swimming in a normal fashion and responding to light. These free-living cyclopean fish may be kept for as long a period as the normal swimming embryos, a period of eight or ten days, after hatching, at which time all die of starvation, since the entire content of the yolk-sac has been absorbed and no other food is furnished. The cyclopean individuals could doubtless be reared if their proper food was known.

A study of these cyclopean embryos from the first appearance of the optic vesicles to hatching, both in life and sections, has proved that the earliest indication of an eye is just as truly cyclopean as it will be later. All degrees from a perfectly single organ through various conditions of doubleness to two intimately approximated optic cups may be found in young embryos. My former statement that the cyclopean eye resulted from a fusion of the elements of the two eyes after their formation, a statement based on comparisons of cyclopean eyes in late stages of development, is incorrect, as is also a similar idea advanced by Dr. Mall in his recent paper.[2]

[1] Stockard, *Archiv für Entw.-Mech.*, XXIII., 1907.

[2] Mall, *Jour. Morphology*, XIX., 1908.

The cyclopean defect, as Spemann[3] contended, is present from the first in the same condition that it will continue throughout development.

In mammalian cyclopean monsters the nose is prevented from descending as it normally does by the presence in its path of the median eye. The nose is thus above the eye and shows as a proboscis-like mass on the forehead. The nasal pits in the fish are laterally placed above the mouth and slightly antero-median of the two eyes. In the cyclopean monsters the two pits are generally united, though at times separate, and are situated unusually far forward and above the eye. The mouth in the normal fish is anterior, the lips projecting beyond the forward limits of the head. In cyclopean fish the median eye occupies this position and often projects forward, suggesting a miner's lantern in the front of the head. This anterior eye prevents the forward development of the mouth, so that its structures remain in a ventral position and hang down as a proboscis-like organ, recalling in a striking way the nose of the mammalian cyclops, and in fact the two are due to like causes. In the mammal the nose is prevented in its downward growth by the median eye, while in the fish the antero-median eye prevents the forward growth of the mouth arrangements.

The magnesium solutions induce the development of two types of one-eyed monsters. First, the true cyclocephali which may have a perfectly single median eye with one optic nerve, one lens and one pupil, or a median eye showing more or less double nature, having two optic nerves and paired retinæ, or in others entirely double eyes with two lenses and two pupils present. A second type of monster, which is new, may be termed *Monstrum monoculum asimmetricum*, a monster with one asymmetrical eye, since it has only one perfect eye, which is one of the normal pair of eyes occupying its typical lateral position. The one eye in all cases is perfect while its mate may be represented by either a small eye, a mere cellular mass indicating an optic cup, or again all evidence of the second optic cup may be wanting. This peculiar one-eyed condition occurs in a great many of the embryos in the various Mg solutions. Should such a monstrosity have been caused by mechanical injury, as cutting or pricking certain early brain areas, the evident conclusion would have been that one of the eye anlagen had been injured while the other had not. Any other interpretation would have been faced by the above conclusion as a criticism and it would have been almost impossible to meet. In the case of the Mg action it is clear that such embryos have developed one eye normally while the production of the other was in some way inhibited, although the anlagen of both were exposed to the chemical.

These embryos throw interesting light on the development of the crystalline lens. In many of them a lens forms from the ectoderm and differentiates independently of the influence of an optic cup. Some embryos with one lateral eye and the other wanting have a perfect lens on the eyeless side. The lens lies freely in mesenchymous tissue and is disconnected entirely from any portion of the central nervous system. Several experimenters, Lewis[4] and others, have held that the lens during its development is in a dependent relationship with the optic cup and they have shown that if the optic cup be removed a lens fails to form. The fish embryos are against the universal application of such a view. Spemann[5] has recently found that in one species of frog, *Rana esculenta*, the lens may arise independently of the optic cup stimulus and is self-differentiating.

To conclude—experiments now show that cyclopean fish embryos may be produced by the action of two salts of magnesium in sea-water solutions. The embryos exhibit various conditions of the cyclopean defect from the earliest appearance of the optic vesicles. Cyclopia is *not* due to a subsequent union or fusion of the two eye elements after their free and distinct origin.

C. R. Stockard

Woods Hole, Mass.,
September 3, 1908

[3] Spemann, *Zool. Jahrbuch*, Supp. VII., 1904.

[4] Lewis, *Am. Jour. Anatomy*, 1904.

[5] Spemann, *Zool. Anzeiger*, XXXI., 1907.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 9, 1908

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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.

ADDRESS OF THE PRESIDENT TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

IT is with much misgiving that I endeavor to discharge the traditional duty of the president of a section of the British Association. So many other duties seem to find a natural resting-place with any one who has to reckon at the same time with the immediate requirements of the public, the claims of scientific opinion, and the interests of posterity, that, unless you are content with such contribution towards the advancement of the sciences of mathematics and physics as my daily experience enables me to offer you, I shall find the task impossible.

With a leaning towards periodicity perhaps slightly unorthodox I have looked back to see what they were doing in Section A fifty years ago. Richard Owen was president of the association, William Whewell was president of Section A for the fifth time.

At the meeting of 1858 they must have spent some time over nineteen very substantial reports on researches in science, which included a large section of Mallett's facts and theory of earthquake phenomena, magnetic surveys of Great Britain and of Ireland, and, oddly enough, an account of the self-recording anemometer by Beckley; perhaps a longer time was required for fifty-seven papers contributed to the section, but very little was spent

[1] Dublin, 1908.

over the presidential address, for it only occupies two pages of print. My inclination towards periodicities and another consideration leads me to regard the precedent as a good one. That other consideration is that Section A has always more subjects for discussion than it can properly dispose of; and, in this case, discipline, like charity, might begin at home.

Since the section met last year it has lost its most illustrious member and its most faithful friend. Lord Kelvin made his first contribution to Section A at Cambridge in 1845, on the elementary laws of statical electricity; he was president of the section in 1852 at Belfast for the first of five times. I have looked to see what suggestion I could derive from his first essay in that capacity. I can find no reference to any address in the published volume. I wish I had the courage to follow that great example.

Lord Kelvin's association with Section A was so constant and so intimate that it requires more than a passing word of reference. There is probably no student of mathematics or physics grown into a position of responsibility in this country but keeps among his treasured reminiscences some words of inspiration and of encouragement from Kelvin, spoken in the surroundings which we are once more met to inaugurate. I refer to those unrecorded acts of kindness and help because they were really a striking characteristic of Section A. Their value for the amenity as well as for the advancement of science it would be difficult to over-estimate. I could not, even if time permitted, hope to set before you an adequate appreciation of Kelvin's contributions to science as illustrated by his communications to this section, and in this place it is not necessary. But I can not pass over that feature of his character without notice.

Closely following on the loss of Kelvin came the death of Sir Richard Strachey, a personal loss to which it is difficult to give expression. I am not aware that he had much to do with Section A. I wish, indeed, that the section had seen its way to bring him more closely into touch with its proceedings. He was president of Section E in 1875, and, by appointment of the Royal Society, he was for twenty-two years chairman of the meteorological council. I had the good fortune to be very closely associated with him during the last ten years of his life, and to realize the ideas which lay behind his official actions and to appreciate the reality of his services to science in the past and for the future.

These losses unfortunately do not stand alone. Only last year Sir John Eliot received the congratulations of all his fellow-workers upon the publication of his "Climatological Atlas of India" as representing the most conspicuous achievement of orderly, deliberate, purposeful compilation of meteorological facts for a special area that has yet been seen. He was full of projects for a handbook to accompany the atlas, and of ideas for the prosecution of meteorological research over wide areas by collecting information from all the world and enlisting the active cooperation of the constituent parts of the British empire in using those observations for the advancement of science and the benefit of mankind. He died quite suddenly on March 18, not young as years go, but quite youthful in the deliberate purpose of manifold scientific activities and in his irrepressible faith in the future of the science which he has adorned.

The section will, I hope, forgive me if I put before them some considerations which the careers of these three men suggest. Kelvin, a mathematician, a natural philosopher, a university professor, some part of whose scientific work is known to each one of us. He was possessed with the notion that mathematics and natural philosophy are applicable in every part of the work of daily life, and made good the contention by presenting to the world, besides innumerable theoretical papers, instruments of all degrees of complexity, from the harmonic analyzer to an improved water-tap. It was he who transfigured and transformed the mariner's compass and the lead-line into instruments which have been of the greatest practical service. It was he who, when experimental science was merely a collection of facts or generalizations, conceived the idea of transfiguring every branch of it by the application of the principles of natural philosophy, as Newton had transfigured astronomy. The ambition of Thomson and Tait's "Natural Philosophy," of which only the first volume reached the stage of publication, is a fair index of Kelvin's genius.

Strachey, on the other hand, by profession a military engineer, a great administrator, head of the Public Works Department in India, deeply versed in finance and in all the other constituent parts of administration, by his own natural instinct demanded the assistance of science for every branch of administration. In promoting the development of botany, of meteorology, or geodesy and of mathematics, he was not administering the patronage of a Macænas, but claiming the practical service of science in forestry, in agriculture, in famine relief, in public works, and in finance. You can not gauge Strachey's services to science by the papers which he contributed to scientific societies, if you leave out of account the fact that they were really incidents in the opening of fresh channels of communication between scientific work and the public service.

And Eliot, as meteorological reporter to the government of India, an accomplished mathematician (for he was second wrangler and first Smith's prizeman in 1869), a capable and devoted public servant, the medium by which Strachey's ideas as regards the use of meteorology in administration found expression in the government of India, who caught the true perception of the place of science in the service of the state, and made his office the indispensable handmaid of the Indian administration. These three men together, who have all passed away within a space of three months, are such representative types of scientific workers, complementary and supplementary, that a similar combination is not likely to occur again. All three indispensable, yet not two alike, except in their enthusiasm for the sciences for the advancement of which Section A exists.

To these I might indeed add another type, the private contributor to the physical exploration of the visible universe, of which Ireland furnishes so many noble examples; and in that connection let me give expression to the sense of grievous loss, to this association and to science, occasioned by the premature death of W. E. Wilson, of Daramona, a splendid example of that type.

In the division of the work of advancing the science of mathematics and physics and their application to the service of mankind, I am reminded of Dryden's somewhat lopsided comparison of the relative influence of music and song in his Ode to St. Cecilia's Day. If I may be pardoned for comparing small things with great, the power of Timotheus's music over Alexander's moods was hardly less complete than Kelvin's power to touch every department of the working world with his genius. But I may remind you that, after a prolonged description of the tremendous influence of Timotheus upon the victorious hero, the poet deals in one stanza with his nominal subject:

At last divine Cecilia came,
Inventress of the vocal frame;
The sweet enthusiast, from her sacred store,
Enlarged the former narrow bounds
. . . .
With nature's mother-wit, and arts unknown before.

Let old Timotheus yield the prize,
Or both divide the crown;
He raised a mortal to the skies,
She drew an angel down.

I doubt if any of my hearers who knew Strachey by sight would recognize in him the scientific reincarnation of St. Cecilia, but it is none the less true that he was preeminent among men in inventing the means of drawing angels down and using their service for the attuning of common life to a scientific standard. It may be equally hard for those who knew him to look upon Eliot as a vocal frame, for of all his physical capacities his voice was the least impressive; and yet it is not untrue to say that he was conspicuously a medium by which the celestial harmonies of the physical sciences were brought into touch with the practical life of India through his work, which is represented by a considerable number of the twenty volumes of *Memoirs* of the Indian Meteorological Service.

I do not indulge in this poetic extravagance without some underlying reason. Speaking for the physics of the atmosphere, there is a real distinction between these three sides of scientific work. To some is given the power of the mathematician or the physicist to raise the mortal to the skies, to solve some problem which, if not in itself a meteorological one, still has a bearing, sooner or later to be discovered and developed, upon the working of atmospheric phenomena. It is easy enough to cite illustrious examples: among notable instances there recur to my mind Rayleigh's work on the color of the sky and Pernter's meteorological optics; papers by Ferrel and others on the general circulation of the atmosphere; Kelvin and Rayleigh on the elastic oscillations of the atmosphere; the papers by Hagen, Helmholtz, Oberbeck, Margules, Hertz and Von Bezold on the dynamics and thermodynamics of the atmosphere, collected and translated by Cleveland Abbe; the work on atmospheric absorption by Langley and the theoretical papers on radiation by Poynting; those on condensation nuclei by Aitken and Wilson, and the recent work on atmospheric electricity, including the remarkable paper by Wilson on the quiet transference of electricity from the air to the ground.

But these things are not of themselves applied to the meteorology of every-day life. It is, in a way, a separate sense, given to few, to realize the possibilities that may result from the solution of new theoretical problems, from the invention of new methods—to grasp, in fact, the idea of bringing the angels down. And, in order that the regular workers in such matters may be in a position constantly to reap the advantages which men of genius provide, the vocal frame must have its permanent embodiment. For the advancement of science in this sense we require all three—the professor with academic freedom to illuminate with his genius any phenomenon which he may be pleased to investigate, the administrator, face to face with the practical problems in which science can help, and the living voice which can tune itself in harmony with the advances of science and in sympathy with the needs of the people whom it serves.

The true relations of these matters are not always apparent. Eliot, bringing to the work of the Indian Meteorological Office a mind trained in the mathematical school of which Kelvin was a most conspicuous exponent, achieved a remarkable success, with which perhaps my hearers are not familiar.

In this country there is a widespread idea that meteorology achieves its object if by its means the daily papers can give such trustworthy advice as will enable a cautious man to decide whether to take out his walking-stick or his umbrella. Some of us are accustomed to look upon India as a place of unusual scientific enlightenment, where governments have a worthy appreciation of the claims of science for recognition and support. But Eliot was never tired of telling me that it was the administration of India, and not the advancement of science, that the Indian administrators had in view; and among his achievements the one of which he was most proud was that the conduct of his office upon scientific lines during his tenure had so commended itself to the administrators that his successor was to be allowed three assistants, with special scientific training, in order that the state might have the benefit of their knowledge.

It is, of course, easy to suggest in explanation of this success that the Department of Public Works of India can not afford to be unmindful of the distribution of rainfall, and that there is an obvious connection between Indian finances and Indian droughts; but it is a new fact in British history that the application of scientific considerations to the phenomena of rainfall are of such direct practical importance that meteorological information is a matter of consequence to all government officials, and that meteorological prospects are a factor of finance. Imagine his Majesty's Chancellor of the Exchequer calling at 63 Victoria Street to make inquiries with a view to framing his next budget, or taking his prospects of a realized surplus from the "Daily Weather Report." Yet in India meteorology is to such an extent a public servant that such proceedings would not excite remark.

To have placed a scientific service on such a footing is, indeed, a notable success. Again, I rely upon Eliot when I say that that success is only to be achieved by being constantly on the watch to render service wherever service can be rendered. There is a difference between this attitude and that which has for its object the contribution of an effective paper to a scientific publication; in other words, it must be frankly recognized that the business of the scientific departments of government is not to raise an occasional mortal to the skies, but to draw down as many angels as are within reach. I was much surprised, when Eliot wished to develop a large scheme for meteorological work on a wider scale, that he made his appeal to the British Association as chairman of the Subsection for Cosmical Physics at Cambridge, and thereby to the governments of this country and the colonies. He felt that he could only urge the Indian government to join, and he did so successfully, so far as India would be directly benefited thereby, however important the results might be from a purely scientific point of view. Strange as it may appear to some, it was to this country that he looked for assistance, on the plea of the increase of knowledge for its own sake, or for the sake of mankind at large.

I am disposed, therefore, to carry your thoughts a little further, and rely on your patience while I consider another aspect for the process of drawing down the angels from the mathematical and physical sky, a process which is sufficiently indicative of the functions of a state scientific department. Viewing the world at large, and not merely that part of it with which we are ourselves immediately concerned, such departments deal with celestial physics in astronomy, with the physics of the air in meteorology and atmospheric electricity, with the physics of land and water in physical geography and geology, seismology and terrestrial magnetism, oceanography and hydrography. It is for the practical applications of these sciences to the service of the navigator, the fisherman, the husbandman, the miner, the medical man, the engineer and the general public that there is an obvious public want.

Let me carry you with me in regarding these departments, primarily, as centers for establishing the growth of science by bringing it to bear upon the practical business of life, by a process of regular plantation, and not the occasional importation of an exotic scientific expert. I shall carry you with me also if I say that the gravest danger to such scientific institutions is the tendency to waste. I use the term "waste" not in its narrowest, but in its most liberal sense, to include waste of money, waste of effort, waste of scientific opportunity. I do not regard it as a waste that such a department should be unable to emulate Timotheus's efforts. Any aspiration in that direction is, of course, worthy of every encouragement, but the environment is not generally suitable for such achievements. I do, however, regard it as waste if the divine Cecilia is not properly honored, and if advantage is not taken of the fullest and freest use of the newest and best scientific methods, and their application in the widest manner possible.

I speak for the office with which I am connected when I say its temptations to waste are very numerous and very serious. It is wasteful to collect observations which will never be used; it is equally wasteful to decline to collect observations which in the future may prove to be of vital importance. It is wasteful to discuss observations that are made with inadequate appliances; it is equally wasteful to allow observations to accumulate in useless heaps because you are not sure that the instruments are good enough. It is wasteful to use antiquated methods of computation or discussion; it is equally wasteful to use all the time in making trial of new methods. It is wasteful to make use of researches if they are inaccurate; it is equally wasteful to neglect the results of researches because you have not made up your mind whether they are accurate or not. It is wasteful to work with an inadequate system in such matters as synoptic meteorology; it is equally wasteful to lose heart because you can not get all the facilities which you feel the occasion demands.

It is the business of those responsible for the administration of such an office to keep a nice balance of adjustment between the different sides of activity, so that in the long run the waste is reduced to a minimum. There must in any case be a good deal of routine work which is drudgery; and if one is to look at all beyond the public requirements and public appreciation of the immediate present, there must be a certain amount of enterprise and consequently a certain amount of speculation.

Let me remark by the way that there is a tendency among some of my meteorological friends to consider that a meteorological establishment can be regarded as alive, and even in good health, if it keeps up its regular output of observations in proper order and up to date, and that initiative in discussing the observations is exclusively the duty of a central office. That is a view that I should like to see changed. I do not wish to sacrifice my own privilege of initiative in meteorological speculation, but I have no wish for a monopoly. To me, I confess, the speculation which may be dignified by the name of meteorological research is the part of the office work which makes the drudgery of routine tolerable. For my part, I should like every worker in the office, no matter how humble his position may be, somehow or other to have the opportunity of realizing that he is taking part in the unravelling of the mysteries of the weather; and I do not think that any establishment, or section of an establishment, that depends upon science can be regarded as really alive unless it feels itself in active touch with that speculation which results in the advancement of knowledge. I do not hesitate to apply to other meteorological establishments, and indeed to all scientific institutions that claim an interest in meteorology, the same criterion of life that I apply to my own office. It is contained in the answer to the question, How do you show your interest in the advancement of our knowledge of the atmosphere? The reply that such and such volumes of data and mean values measure the contribution to the stock of knowledge leaves me rather cold and unimpressed.

But to return to the endeavor after the delicate adjustment between speculation and routine, which will reduce the waste of such an institution to a minimum; experience very soon teaches certain rules.

I have said elsewhere that the peculiarity of meteorological work is that an investigator is always dependent upon other people's observations; his own are only applicable in so far as they are compared with those of others. Up to the present time, I have never known any one take up an investigation that involved a reference to accumulated data, without his being hampered and harassed by uncertainties that might have been resolved if they had been taken in time. I shall give you an example presently, but, in the meantime, experience of that kind is so universal that it has now become with us a primary rule that any data collected shall forthwith be critically examined and so far dealt with as to make sure that they are available for scientific purposes—that is, for the purposes of comparison. A second rule is that as public evidence of the completion of this most important task there shall be at least a line of summary in a published report, or a point on a published map, as a primary representation of the results. Such publication is not to be regarded as the ultimate application of the observations, but it is evidence that the observations are there, and are ready for use.

You will find, if you inquire, that at the office we have been gradually lining up these troops of meteorological data into due order, with all their buttons on, until, from the commencement of this year, any one who wishes to do so can hold a general review of the whole meteorological army, in printed order—first order stations, second order stations, rainfall stations, sunshine and wind stations, sea temperatures and other marine observations—on his own study table, within six months of the date of the observations, upon paying to his Majesty's Stationery Office the modest sum of four shillings and sixpence. For all the publications except one the interval between observation and publication is only six weeks, and as that one has overtaken four years of arrears within the last four years, I trust that by the end of this year six weeks will be the full measure of the interval between observation and publication in all departments. This satisfactory state of affairs you owe to the indefatigable care and skill of Captain Hepworth, Mr. Lempfert and Mr. R. H. Curtis, and the members of the staff of the office who work under their superintendence. I need say little about corresponding work in connection with the Daily Weather Report, in which Mr. Brodie is my chief assistant, although it has received and is receiving a great deal of attention. The promptitude with which the daily work is dealt with hardly needs remark from me, though I know the difficulties of it as well as any one. If I spend only one long sentence in mentioning that on July 1, 1908, the morning hour of observation at twenty-seven out of the full number of twenty-nine stations in the British Isles was changed from 8 A.M. to 7 A.M., and the corresponding postoffices, as well as the Meteorological Office, opened at 7:15 A.M. in order to deal with them, so that we may have a strictly synchronous international system for western and central Europe, and thus realize the aspiration of many years, you will not misunderstand me to mean that I estimate the task as an easy one.

The third general rule is that the effectiveness of the data of all kinds, thus collected and ordered, should be tested by the prosecution of some inquiry which makes use of them in summary or in detail. It is here that the stimulating force of speculative inquiry comes in; and it is in the selection and prosecution of these inquiries, which test not only the adequacy and effectiveness of the data collected but also the efficiency of the office as contributing to the advance of knowledge, that the most serious responsibility falls upon the administrators of parliamentary funds.

Scientific Shylocks are not the least exacting of the tribe, and there have been times when I have thought I caught the rumination:

Shy. Three thousand ducats? 'tis a good round sum!

Bas. For the which, as I told you, Antonio shall be bound.

. . . .

Shy. Antonio is a good man?

Bas. Have you heard any imputation to the contrary?

Shy. Oh! no, no, no, no. . . . Yet his means are in supposition: he hath an argosy bound to Tripolis, another to the Indies; I understand, moreover, upon the Rialto, that he hath a third in Mexico, a fourth for England, and other ventures he hath squandered abroad. But ships are but boards, sailors but men. There is the peril of water, winds and rocks. . . . Three thousand ducats.

We at the Meteorological Office are very much in Antonio's position. Our means of research are very much in supposition: four observatories and over four hundred stations of one sort or another in the British Isles; an elaborate installation of wind-measuring apparatus at Holyhead; besides other ventures squandered abroad; an anemometer at Gibraltar, another at St. Helena; a sunshine recorder at the Falkland Isles, half a dozen sets of instruments in British New Guinea, and a couple of hundred on the wide sea. The efforts seem so disconnected that the rumination about the ducats is not unnatural.

And you must remember that we lack an inestimable advantage that belongs to a physical laboratory or a school of mathematics, where the question of the equivalent number of ducats does not arise in quite the same way. The relative disadvantage that I speak of is that in an office the allowance for the use of time and material in practise and training disappears. All the world seems to agree that time or money spent on teaching or learning is well spent. In the course of twenty years' experience at a physical laboratory, and in examinations not a few, I have seen **M** and **N** or the wave-length of sodium light determined in ways that would earn very few ducats on the principle of payment by results; but, having regard to the psychological effect upon the culprit or the examiner, the question of ducats never came in. Wisely or unwisely public opinion has been educated to regard the psychological effect as of infinite value compared with the immediate result obtained. But in an office the marks that an observer or computer gets for showing that he "knew how to do it," when he did not succeed in doing it, do not count towards a "first class," and we have to abide by what we do; we can not rely on what we might have done. Consequently our means in supposition, spread over sea and land, are matters of real solicitude. In such circumstances there might be reason for despondency if one were dependent merely upon one's own ventures and the results achieved thereby. But when one has the advantage of the gradual development of investigations of long standing, it is possible to maintain a show of cheerfulness. When Shylock demands his pound of flesh in the form of an annual report, it is not at all uncommon to find that some argosy that started on its voyage long ago "hath richly come to harbor suddenly." There have been quite a number of such happy arrivals within the last few years.

I will refer quite briefly to the interesting relations between the yield of barley and cool summers, or the yield of wheat and dry autumns, and the antecedent yield of eleven years before, which fell out of the body of statistics collected in the "Weekly Weather Report" since 1878. The accomplished statisticians of the Board of Agriculture have made this work the starting-point for a general investigation of the relation between the weather and the crops, which can not fail to have important practical bearings.

Let me take another example. For more than a full generation meteorological work has been hampered by the want of a definite understanding as to the real meaning in velocity, or force, of the various points of the scale of wind estimates laid down in 1805 by Admiral Beaufort for use at sea, and still handed on as an oral tradition. The prolonged inquiry, which goes back really to the report upon the Beckley anemograph already referred to, issued quite unexpectedly in the simple result that the curve

$$p = .0105B^3$$

(where p is the force in pounds per square foot, and B the arbitrary Beaufort number) runs practically through nine out of the eleven points on a diagram representing the empirical results of a very elaborate investigation. The empirical determinations upon which it is based are certainly not of the highest order of accuracy; they rely upon two separate investigations besides the statistical comparison, viz., the constant of an anemometer and the relation of wind velocity to wind pressure, but no subsequent adjustment of these determinations is at all likely to be outside the limits of an error of an estimate of wind force; and the equation can be used, quite reasonably, as a substitute for the original specification of the Beaufort scale, a specification that has vanished with the passing of ships of the type by which it was defined. This result, combined with the equation $p = .003V^2$, which has been in use in the office for many years, and has recently been confirmed as sufficiently accurate for all practical purposes by Dr. Stanton at the National Physical Laboratory and Monsieur Eiffel at the Eiffel Tower, places us upon a new plane with regard to the whole subject of wind measurement and wind estimation.

Results equally remarkable appear in other lines of investigation. Let me take the relation of observed wind velocity to barometric gradient. You may be aware that in actual experience the observed direction of the wind is more or less along the isobars, with the low pressure on the left of the moving air in the northern hemisphere; and that crowded isobars mean strong winds. Investigations upon this matter go back to the earliest days of the office.

There can be no doubt that the relation, vague as it sometimes appears to be upon a weather chart, is attributable to the effect of the earth's rotation. In order to bring the observed wind velocity into numerical relation with the pressure gradient Guldberg and Mohn assumed a coefficient of surface "friction," interfering with the steady motion. The introduction of this new quantity, not otherwise determinable, left us in doubt as to how far the relation between wind and pressure distribution, deducible from the assumption of steady motion, could be regarded as a really effective hypothesis for meteorological purposes.

Recent investigations in the office of the kinematics of the air in traveling storms, carried out with Mr. Lempfert's assistance, have shown that, so far as one can speak of the velocity of wind at all—that is to say, disregarding the transient variations of velocity of short period and dealing with the average hourly velocity, the velocity of the wind in all ordinary circumstances is effectively steady in regard to the accelerating forces to which it is subject. This view is supported by two conclusions which Mr. Gold has formulated in the course of considering the observations of wind velocity in the upper air, obtained in recent investigations with kites. The first conclusion is that the actual velocity of wind in the upper air agrees with the velocity calculated from the pressure distribution to a degree of accuracy which is remarkable, considering the uncertainties of both measurements; and the second conclusion affords a simple, and I believe practically new, explanation upon a dynamical basis of the marked difference between the observed winds in the central portions of cyclones and anti-cyclones respectively, by showing that, on the hypothesis of steady motion, the difference of sign of the effective acceleration, due to curvature of path and to the earth's rotation respectively, leads to quite a small velocity and small gradient as the limiting values of those quantities near anti-cyclonic centers.

This conclusion is so obviously borne out by the facts that we are now practically in a position to go forward with the considerable simplification which results from regarding the steady state of motion in which pressure gradient is balanced by the effective acceleration due to the rotation of the earth and the curvature of the path, as the normal or ordinary state of the atmosphere.

I can not forbear to add one more instance of an argosy which has richly come to harbor so lately as this summer. You may be aware that Kelvin was of opinion that the method of harmonic analysis was likely to prove a very powerful engine for dealing with the complexities of meteorological phenomena, as it has, in fact, dealt with those of tides. In this view Sir Richard Strachey and the Meteorological Council concurred, and an harmonic analyzer was installed in the office in 1879, but subsequently numerical calculation was used instead. A considerable amount of labor has been spent over the computation of Fourier coefficients. Not many great generalizations have flowed from this method up to the present time. I have no doubt that there is much to be done in the way of classifying temperature conditions, for climatic purposes, by the analysis of the seasonal variations. A beginning was made in a paper which was brought to the notice of the association at Glasgow. The most striking result of the Fourier analysis we owe to Hann, who has shown that, if we confine our attention to the second Fourier coefficient of the diurnal variation of pressure—that is, to the component of twelve-hour period—we get a variation very marked in inter-tropical regions, and gradually diminishing poleward in both hemispheres, but synchronous in phase throughout the 360 degrees of a meridian. The maximum occurs along all meridians in turn about 10 A.M. and 10 P.M. local time. This semi-diurnal variation with its regular recurrence is well known to mariners, and we have recently detected it, true to its proper phase, in the observations at the winter quarters of the *Discovery;* small in amplitude indeed—about a thousandth of an inch of mercury—but certainly identifiable.

The reality of this variation of pressure, common to the whole earth, can not be doubted, and, so far as it goes, we may represent it (if indeed we may represent pressure differences as differences in vertical heights of atmosphere) as the deformation of a spherical atmosphere into an ellipsoid, with its longest axis in the equator pointing permanently 30° to the west of the sun. Its shortest axis would also be in the equator, and its middle axis would be along the polar axis of the earth. Somehow or other this protuberance remains fixed in direction with regard to the sun, while the solid earth revolves beneath it. Whatever may be the cause of this effect, obviously cosmical, and attributable to the sun, at which it indirectly points, its existence has long been recognized, and further investigation only confirms the generalization. It is now accepted as one of the fundamental general facts of meteorology.

Professor Schuster, for whose absence from this meeting I may venture to express a regret which will be unanimous, has already contributed a paper to the Royal Society pointing out the possible relations between the diurnal variations of pressure and those of terrestrial magnetic force. Going back again to the ubiquity of the application of the relation of pressure and wind, in accordance with the dynamical explanation of Buys Ballot's law, we should expect the effect of a pressure variation that has its counterpart in that of terrestrial magnetism to be traceable also in wind observation.

Mr. J. S. Dines has just given me particulars of the discovery of that effect in the great air-current, the variations of which I have called the pulse of the atmospheric circulation—I mean the southeast trade wind, the most persistent atmospheric current in the world. It is difficult as a rule to get observers to pay much attention to that current, because it is so steady; but in 1891 the Meteorological Council set up an anemometer at St. Helena, in the very heart of the current, and we have just got out the results of the hourly tabulations. When the observations for the hours 1 to 24 are grouped separately for months, so as to give the vector resultants for each hour and for each month, it appears that there is a conspicuous semi-diurnal variation in the current, which shows itself as a closed polygon of vector variations from the mean of the day.

The month of April gives the most striking diagram of the twelve. It displays the superposition of two practically complete dodekagons, one a large one, completing its cycle from 6 A.M. to 6 P.M., the other a small one, for 6 P.M. to 6 A.M. The resultant wind for the whole day is very nearly southeast, and practically remains so for all the months of the year, the monthly variation of resultant wind being confined to a change of velocity from about fourteen miles per hour in May to about twenty-one miles per hour in September.

If, instead of combining the south and east components to form a vector diagram, we plot their variations separately, the semi-diurnal variation in each is plainly marked; and the calculation of its constants shows that its amplitude is about three quarters of a mile per hour both in the south and rather less in the east component. The easterly increment has its maxima at 10 A.M. and 10 P.M., and at these hours the phase of the variation of the southerly component is nearly opposite. Thus, to correspond with the semi-diurnal variation of pressure, there is a semi-diurnal variation in the trade wind at St. Helena, which is equivalent to the superposition upon the resultant wind of a northeasterly component of about one mile per hour amplitude, with maxima at 10 A.M. and 10 P.M., the hours when the ellipsoidal deformation of the spherical atmosphere is passing over the locality.

I have only dealt with one month. I believe that when all the results that flow from this simple statement can be put before you, you will agree with me that the argosy which the Meteorological Council sent out in 1891 has indeed richly come to harbor.

Let me digress to say a word in illustration of the principle I laid down that, if one would avoid waste in meteorological work, the observations must be examined forthwith and so far discussed that any ambiguities may be cleared up.

After some years of wear at St. Helena the persistent rubbing of the southeast part of the spiral metallic pencil upon the metallic paper wore away the metal and left a flat place. This got so bad that the instrument had to come home for repairs, and when it was set up again, after a year's absence, the average direction of the trade wind differed by two points from the averages of most, but not of all, of the previous years. So far as we know, the orientation has been attended to, as before, and yet it is hardly possible to resist the suggestion that the anemometer has been set slightly differently. We are now making very careful inquiries from the observer; but, in the meantime, it seems to me that there is a great opportunity for a competent mathematical physicist to help us. Dynamical explanations of the trade winds have been given from the time of Halley. Let me offer as a simple question in the mathematical physics of the atmosphere whether a variation of two points in the direction of the southeast trade wind between the years 1903 and 1905 can be regarded as real, and, if not, which of the two recorded directions is the correct one?

It would be appropriate for me to add some words about the results of last year's work upon the upper air, in which we have had the valuable cooperation of the University of Manchester. These results have disclosed a number of points of unusual interest. But we are to have an opportunity of considering that subject in a discussion before the section, and I need not deal with it here. I must, however, pause to give expression of the thanks of all meteorologists to Professor Schuster for his support of the Manchester University station at Glossop Moor. I may remind you that this generous contribution for the advancement of science on the part of Professor Schuster is in addition to the foundation of a readership in mathematical physics at Manchester and a readership in dynamical meteorology, now held by Mr. Gold at Cambridge.

I have said enough to show that the speculative ventures of official meteorologists are not all failures, and I will only add that if any mathematician or physicist would like to take his luck on a meteorological argosy he will be heartily welcomed. Part of the work will be drudgery; he must be prepared to face that; but the prospects of reaching port are reasonably good, so much so, indeed, that such a voyage might fairly lead to a claim for one of the higher academical degrees.

Up to now I have been dealing with the adjustment of official scientific work to reduce waste to a minimum, in so far as it lies within the control of those responsible for an office. I turn now to an aspect of the matter in which we require the assistance of others, particularly of the British Association.

The most serious danger of waste in a busy office is that it should carry on its work without an adequate knowledge of what is being done in advancing science and improving methods elsewhere. I speak myself for the Meteorological Office alone, but I believe that the responsible officials of any scientific government department will agree with what I say.

Year by year some Timotheus "with his sounding flute and tuneful lyre" performs some miracle by the application of reasoning to the phenomena of nature. Only last year you heard Professor Love in his presidential address treat of the mundane question of the shape of the earth and etherealize the grim actualities with the magic of his spherical harmonics. Year by year, in every one of the subjects in which the practical world is immediately interested, active students, whether public officials, academic officials, or private enthusiasts, not only keep alight the sacred flame but occasionally add to its brilliance; and all the new knowledge, from whencesoever it comes, ought to be applied to the service of the state.

The actual volume of original contributions on these subjects is by no means inconsiderable. You are all aware that, some years ago, the Royal Society initiated a great international enterprise for the compilation of a catalogue of scientific literature. I have been looking at the fifth annual issue of the volume on "Meteorology," including "Terrestrial Magnetism." I may remark that the catalogue is quite incomprehensibly eclectic as regards official literature, but let that pass. I find that, in the year that closed with July, 1907, 1,042 authors (not counting officers and institutions as such) presented to the world 2,131 papers on meteorology, 229 on atmospheric electricity, and 180 on terrestrial magnetism. This will give some idea of the annual growth in these subjects, and may convince you that, after all allowance is made for duplicate titles, for papers of no importance, and for mere sheets of figures published for purposes of reference, there remains a bulk of literature too large for any single individual to cope with if he has anything else to do.

If instead of confining ourselves to what can be included in meteorology alone we extend our view over the other allied sciences, it would be necessary to take in other volumes of the international catalogue, and there would be some overlapping. I have taken instead the volume of the *Fortschritte der Physik* for 1906, which deals with "Kosmische Physik." It is edited by Professor Assmann, who adds to his distinction as head of the Royal Prussian Aeronautical Observatory of Lindenberg that of an accomplished bibliographer. In this volume are given abstracts or titles of the papers published during the year which can be regarded as worthy of the attention of a physicist. An examination of the volume gives the following numbers of the papers in the different sections:

		Papers
Astrophysics		222
Meteorology		1,122
Atmospheric electricity		135
Geophysics:		
Geodetics	105	
Seismology and volcanic phenomena	256	
Terrestrial magnetism and aurora	108	
Currents, tides and waves	46	
Inland hydrography	117	
Ice, glaciers and ice age	139	
Other papers	126	
		897
Total		2,376

I need hardly say that these 2,376 papers are not all English; in some of the sections few of them are in that language, and fewer still are British. If British students, official and unofficial, are to make the most of the operation of drawing the angels down, they need help and cooperation in dealing with this mass of literature, in winnowing the important from the unimportant, and in assimilating that which makes for the real progress of the practical application of science. This is the more necessary for these subjects because there is no organized system of academic teaching, with its attendant system of text-books. In a subject which has many university teachers it might reasonably be supposed that any important contribution would find its way into the text-books, which are constantly revised for the use of students; and yet, in his presidential address to the Royal Society in the November of last year, Lord Rayleigh felt constrained to point out that, for the advance of science, although the main requirement is original work of a high standard, that alone is not sufficient. "The advances made must be secured, and this can hardly be unless they are appreciated by the scientific public." He adds that "the history of science shows that important original work is liable to be overlooked and is, perhaps, the more liable the higher the degree of originality. The names of T. Young, Mayer, Carnot, Waterston and B. Stewart will suggest themselves to the physicist, and in other branches, doubtless, similar lists might be made of workers whose labors remained neglected for a shorter or longer time."

If this is true of physics how deplorably true it is of meteorology. If I allow a liberal discount of over 50 per cent. from the numbers that I have given, and estimate the number of effective contributions to meteorology as recognized by the "International Catalogue" at a thousand, which agrees pretty well with that given by the *Fortschritte der Physik,* and if I were to ask round this room the number of these papers read by any one here present, I am afraid the result would be disheartening. Many of us have views as to the way in which the study of meteorology ought to be pursued, but the views are not always based on an exhaustive examination of the writings of meteorologists. Few of us could give, I think, any reasonable idea of the way in which it is being pursued by the various institutions devoted to its application, and of the progress which is being secured therein. Meteorological papers are written by the hundred, and, whether they are important or unimportant, they often disregard what has been already written in the same or some other language, and are themselves in turn disregarded. I do not think I should be doing any injustice if I applied similar remarks to some of the other subjects included in the table which I have quoted. How many readers are there in this country for an author in terrestrial magnetism, atmospheric electricity, limnology or physical oceanography? But, if the papers are not read and assimilated, the advancement of science is not achieved, however original the researches may be.

By way of remedy for the neglect of important papers in physics Lord Rayleigh suggests that teachers of authority, who, from advancing years or from some other reason, find themselves unable to do much more work in the direction of making original contributions, should make a point of helping to spread the knowledge of the work done by others. But what of those subjects in which there are no recognized teachers? and in this country this is practically the case with the subjects which I have mentioned. It is true that many of them are made the occasion of international assemblies, at which delegates or representatives meet. But such international assemblies are of necessity devoted, for the most part, to the elaboration of the details of international organization, and not to the discussion of scientific achievements. The numbers attending are, equally of necessity, very restricted.

The want of opportunity for the discussion of progress in these sciences is specially lamentable, because in its absence they lose the valuable assistance of amateur workers, who might be an effective substitute for the students of an academic study. In no subject are there more volunteers, who take an active part in observing, than in meteorology; but how few of them carry their work beyond the stage of recording observations and taking means. The reason is not lightly to be assigned to their want of capacity to carry on an investigation, but far more, I believe, to the want of knowledge of the objects of investigation and of the means of pursuing them.

Among the agencies which in the past have fostered the knowledge of these subjects, and stimulated its pursuit, there stand out prominently the annual meetings of this association. It was the British Association which in 1842 re-founded the Kew Observatory for the study of the physics of the atmosphere, the earth, and the sun. It was the British Association which promoted the establishment of magnetic observatories in many parts of the earth, and in the early sixties secured the most brilliant achievements in the investigation of the atmosphere by means of balloons. I know of no other opportunity of anything like the same potentialities for the writers of papers to meet with the readers, and to confer together about the progress of the sciences in which they are interested. But its potentialities are not realized. Those of us who are most anxious for the spread of the application of mathematics and physics to the phenomena of astronomy, meteorology and geophysics have thought that this opportunity could not properly be utilized by crowding together all the papers that deal with such subjects into one day, or possibly two days, so that they can be polished off with the rapidity of an oriental execution. In fact, the opportunity to be polished off is precisely not the opportunity that is wanted. There are some of us who think that a British Association week is not too long for the consideration of the subjects of which a year's abstracts occupy a volume of six hundred pages, and that, if we could extend the opportunity for the consideration of these questions from one or two days to a week, and let those members who are interested form a separate committee to develop and extend these subjects, the British Association, the country and science would all gain thereby. I venture from this place, in the name of the advancement of science, to make an appeal for the favorable consideration of this suggestion. It is not based upon the depreciation, but upon the highest appreciation of the service which mathematics and physics have rendered, and can still render, to the observational sciences, and upon the well-tried principle that close family ties are strengthened, and not weakened, by making allowance for natural development.

The plea seems to me so natural, and the alternatives so detrimental to the advancement of science in this country, that I can not believe the association will turn to it a deaf ear.

W. N. Shaw

GRAPHIC ART IN SCIENCE[1]

As a beginning I wish to thank this society for the privilege granted me to address it. That a strong personal pleasure is felt at this opportunity, I shall not attempt to deny; but I have a greater satisfaction than this, and that is that I am allowed to present a subject which has been too seldom publicly discussed in the presence of investigators and students, viz.: the part played by graphic art in science.

This subject is one of growing importance, and I trust I shall live to see the day

[1] Read before the Harvey Club, University of California, November 7, 1907.

when every student of the natural sciences will be obliged to take a thorough course in drawing as adapted to his own special requirements. And I hope, as well that this course will be so arranged that the student will understand at least the *theory* of the several processes by which the printer reproduces a drawing. In fact, I wish this address to be considered as a stroke toward that end.

Just when the first drawing was made to illustrate an idea, of course, can not be determined. Perhaps it was nothing more pretentious than a simple sketch, fashioned with a sharpened twig upon some smooth bit of sand. From such a small beginning, however, graphic art has developed prodigiously, and to-day it forms a large integer in nearly every branch of science. In view of this, almost every university of repute, both in this country and abroad, employs a salaried scientific artist. At Johns Hopkins, in Baltimore, where is situated perhaps our best medical college, an actual corps of expert artists is kept busily employed in illustrating scientific articles there produced.

But this growth has not been unattended with set-backs. Graphic art has not won its place in scientific work without many a bitter struggle. In truth, even at this late date there are, unfortunately, many investigators doing exceptionally good work, who do not appreciate the highest type of drawing, and actually refuse to include it in their publications.

This folly can not be attributed to any personal aversion entertained towards fine art, it is simply the result of ignorance. These individuals have not been properly trained to see the good points in realistic drawing, and, not being by nature of an artistic trend, they simply refrain from adopting something they can not understand. As an example of this occasional "tiff" between realistic and diagrammatic representation of scientific work, the following experience of a student with a "hard-headed man of science" might be cited:

All the drawings made in the zoological laboratory of this particular school were being done in black-and-white, but the student felt that if drawing has any value at all in the study of zoology, it should be to direct the observer's attention to *all* the features of the object examined—its *color* as well as its *morphological* characteristics. Accordingly, he brought a color box with him one day into the laboratory, and started to draw a certain preparation with as near the same color-variations presented as his talent permitted. This drawing soon attracted admiring glances from the other students engaged in the laboratory. When it was about completed, the principal of the school, the "hard-headed man of science" approached the "realist," and said with some asperity: "This is not an art-academy, this is a zoological laboratory. You had better make your drawings in simple black-and-white." Had the astonished student been behind in his work, had his respect for realism produced a bad effect on the decorum of the class, or had his drawing not been the best in the laboratory, I think he would have been honest enough to have taken the principal's advice. But none of these things were so. In consequence he thought the excellencies of his product sufficient justification for its novelity, and, without laying down his brush, he answered respectfully but firmly: "If science does not approve at present of life-like illustrations, the day *must* come when it will!" The principal made no reply and walked away with a frown. The student found out afterwards, however, that he was no innovator, as very excellent scientific drawings in color had been made a good hundred years before that old fellow was born. But the old man has never changed his view-point, and to this day a schematic drawing, done in sober black-and-white, remains the only kind of scientific illustration that he can tolerate. And yet he has done some very good investigative work, is an excellent educator of considerable reputation and has been successful in the financial side of life. So, he can not be counted below par in mental attributes. He was simply not properly trained to appreciate the value of realistic drawing. Let us guard against such a poverty of understanding in ourselves, and, by word and example, help root it out of others with whom we come in contact.

It is hardly necessary to defend the practise of drawing as an adjunct toward explaining an idea, as surely every one here has convinced himself of that fact long ago, even while reading an ordinary daily newspaper. And much more welcome is an illustration in some complex scientific discussion, where words alone so often fail completely to tell the story, or merely give a faint outline of what the observer wishes to convey. But, until quite recently, the practise of drawing was not accorded its deserved recognition in the *teaching* of scientific subjects. What physician of fifty years ago was obliged to systematically draw the bones he studied? Or, what one of thirty years ago was obliged to draw the preparations he investigated with the help of high-power lenses? Comparatively, they were good men, it is true, but one can always improve, and at this time there is hardly a medical school of any merit where drawing is neglected as part of the routine laboratory work, and this is a very happy condition, indeed, for it exacts the closest scrutiny of objects examined by the student. His attempt to picture on paper some particular object reveals characteristics of that object which would assuredly have escaped his observation if its graphic illustration were not exacted.

But, in spite of this general recognition accorded to drawing as a teaching method, as far as I can learn, there is not a single text-book or laboratory guide of any practical completeness in microscopical drawing, and this is only one division of graphic art as employed in the scientific world. Students in the laboratory are told to get this pen or that, this grade of pencil, such and such a kind of ink and paper. Perhaps blenders, erasers and thumb-tacks are alluded to. But, aside from this, the beginner seldom receives further instruction as to how he is to go about the difficult task of drawing what he sees through the microscope. His looks and actions often show how much he would welcome any advice concerning a method of approaching this new work. He is alone in a strange country without a road in sight.

Feeling that something should be done to contend against this unfortunate state of affairs, I determined to prepare a short description of some materials and methods commonly used in the drawing of microscopical preparations, and Professor Hardesty has thought this sufficiently worthy to give it a place in his "Laboratory Guide in Histology."

The condition should prevail, however, that when a student has brought his career so far forward as to be admitted to the study of medicine, he should then be trained already in microscopical drawing. He has so much to do in this highly complex problem that the extra time spent in acquiring an illustrative technic is given at the expense of more important matters.

Let us now drop the student and his troubles for a time, and turn to the field where graphic art finds its most dignified and important employment in the sciences, that is, in the illustration of investigative and teaching publications.

For its practise in these spheres, allow me to emphasize that no one should be chosen except talented and well-trained artists. It is to be lamented that such artists are not made use of to any great extent to-day. A merely superficial acquaintance with some otherwise very good modern text-books and current scientific literature is quite sufficient to prove this statement. And, at a glance, it is rather difficult to understand why such should be the case. In fact, a number of obstinate conditions contribute to the matter. First of all, only in rare instances has the investigator the adequate financial support at his disposal to pay for the services of first-rate artists. Secondly, under the existing conditions first-rate artists can not be supplied in fitting numbers to fill even the available positions. And thirdly, the investigator is too often one who underrates, or does not appreciate, the value of realistic drawing.

Of these obstacles perhaps the financial one is the most common and difficult to contend against. Scientific text-books are used by such a comparatively small public that the publisher is compelled to cut down the expenses of their production to the lowest allowable figure. Otherwise his limited profit would be lost. And, with this economy, the illustration of text-books is very likely to suffer most. Good artists must be fairly well paid, and, to retain the merits of good drawing, somewhat expensive methods and a fine grade of paper are necessary in the reproduction by the printer. To raise the price of a book to any considerable degree, because of the extra expense its illustration has entailed, is apt to be risky, for already the student and investigator groan aloud under the price they are obliged to pay for additions to their professional libraries. And yet, knotty as it seems, much can be done towards solving this problem, and the best way to commence the task is by employing only *competent* artists. A skilful artist can tell a story more convincingly with fewer illustrations, and in a technic which will allow a cheaper method of reproduction, than an artist whose talent is but moderate and whose training has been mediocre. A second-rate artist is apt, as well, to be a slow one. Not alone does he waste time in the actual drawing of the object, but it is only too often the case that the investigator or editor is forced to spend considerable valuable time in explanation before an inferior artist grasps the idea to be conveyed by an illustration. Occasionally, even then one is not through with this type of artist, for, while he may have seemed to understand what was wanted, he will return with a drawing that is entirely erroneous, and the whole trying performance must be gone through with again. Thus, economy in the matter of artists frequently amounts to nothing but unpardonable extravagance.

Leaving text-books and their problems, let us turn attention to the vehicles through which investigators disseminate their findings. These journals are, for the most part, conducted by scientists, and there is seldom the hope among them that the journal will bring in more than enough to pay for its publication. So, profit falls out of the argument entirely, with sometimes a consequent increase in the facilities for elaborate illustration. It is only now and then the case that an editorial staff of such a journal will balk at any reasonable expense necessary to reproduce the drawings explanatory of the text in a piece of research. Accordingly, aside from the limited funds at the investigator's command, there is hardly any reason left why the very best artist should not be employed to illustrate his work. Most of the institutions, which exist merely for the furtherance of science, though running at about the utmost limit of their financial resources, consider the occasional use of an artist, perforce, as a sort of necessary evil. But the little money at disposal for his pay oftentimes precludes the services of a capable and experienced man. Yet, if the employment of inferior artists in the production of text-books is, in the end, a form of extravagance, it is doubly so in the illustration of purely investigative labor. The very fact that the observer so frequently calls in graphic art to assist in his presentation of a study, proves that he feels there are certain clefts in the description of this study which words can not bridge over. He needs an *optical* picture. If this optical picture is not just as he sees it in his preparations, there is bound to be a conflict between it and his text, which is bound to confuse rather than enlighten the reader. Therefore, the *best* drawing should be utilized, and *only* the best. But again comes the discouraging complaint: "How is the best drawing to be obtained when sufficient funds are not at hand to employ a good artist, and with hardly enough for a poor one?" This condition will exist until the investigator throws aside his lukewarm attitude in the matter, and takes up an earnest campaign towards furnishing the necessary money for the employment of his indispensable ally, viz.: the finished scientific artist.

I can recall instance after instance where an investigator has worried through weeks and even months of vexation with an inferior artist, and, as soon as the illustrative work was completed, forgotten all about his trials until it became necessary to call upon the illustrator for the needs of another publication. In the period of suspended graphic activity no attempt was made by the investigator, or at best, only a feeble, abortive one, to supply a competent artist. Every facility, on the other hand, would be called into play to supply the laboratory paraphernalia requisite to the proper pursuance of investigative procedures, but the artist, secondary only to the text in the publishing of this investigation, had been almost completely overlooked. Now who is to know about this desired help if the individual who needs it most does not give it expression? A faculty is not to be censured if it does not take steps towards allowing each research laboratory under its dominion the financial means to emply a capable artist, if the director of that laboratory has not vigorously presented his need of one. Granting that the available funds of an institution are not plentiful enough to allow the installation of a trained scientific artist in any one or in the different departments of investigation, the heads of the departments should see to it then that no opportunity passes to bring this keenly felt want before the consideration of wealthy, public-spirited individuals who are able to contribute towards its dissipation.

With the establishment of paying positions, and schools for their proper training, to be described later, there can be no doubt that the number of skilled, scientific artists would rapidly increase. Further, the number of scientific artists who, at present, do not understand the immense advantages offered by a high type of realistic graphic art would speedily diminish by the coming in contact with those who are able and determined to practise it.

In the preceding remarks, frequent reference has been made to realistic graphic art, or realistic drawing. These terms should be self-explanatory, but, not wishing any confusion to arise, a fairly exhaustive discussion of them will be hardly superfluous.

Let us suppose that nothing more complex is to be represented than an ordinary bottle, standing on a table and at some distance from, although in, the unobstructed light of a window. It is quite true that any one would know what sort of an object the artist intended to picture, if only the correct, bare outlines of this bottle were drawn. These outlines would suggest a bottle, nothing but a bottle, yet with very little of its special characteristics. But an outline drawing of it would not be a type of realistic drawing, for even the most imaginative person could not find any similarity between the bottle and the drawing, save in the outline. Now suppose that the outline drawing be filled in with the proper shading to give it the appearance of being round, a step towards realism would therewith have been taken; but, in spite of that, the drawing is still far from being a good example of graphic art. Comparing it with the bottle in a critical way, one could not honestly and irrefutably identify one with the other, for, as example, this shading, directed alone towards showing that the bottle is round, does not develop the fact that the bottle's surface is highly polished and hence *reflective*. Continuing, however, the subtleties of shading to the degree where the light reflected from the table on to the bottle, and *vice versa*, is shown, to where the source of light, namely, the window, with its typical cross sashes, is seen in miniature upon the smooth glass, and to where other characteristics have been added, the drawing has at last reached the fullness of realism, it has become, in a manner, a *portrait*. Any one now would recognize at a glance what *particular* bottle the drawing was intended to represent, providing, of course, that one compared it with the bottle under the same conditions of position and lighting.

This very humble subject, a smooth, highly polished bottle, has been taken to illustrate realistic drawing, since its characteristic of reflection is shared by some forms of laboratory specimens subjected to certain conditions. Yet, the greatest scientific artist in this country has been severely criticized by some investigators because, at times, he allows his source of light, a near-by window, to appear in his drawings, as it clearly did on the reflective surfaces of the objects drawn.

There is a common enough belief in scientific circles that any feature of a drawing not directly contributing to the main idea which an investigator wishes to express, must be looked upon as a blemish. And this is true to some extent. But the main idea seldom exists severely alone, unsupported by secondary ones. As a matter of fact, in nearly all instances, a main idea might be considered as an accumulation of associating secondary ideas. The particular artist mentioned above realizes this truth, and for those who share his belief, the delineation of secondary ideas never disturbs, but, on the contrary, markedly assists in his forcible expression of the central thought. To cite an example:

Turning to a certain page of a recent, scientific text-book, we find a drawing of a cyst by this particular artist whose realism has been, as remarked, criticized by a number of competent investigators. In the text describing the cyst, from which this drawing was made, the author states that its surface was very smooth and moist. For the benefit of those who do not know what a cyst is, it might be generally described as a closed sack, more or less globular in form, its walls consisting of organic matter, and filled with more or less fluid contents. Any surface, whether organic or inorganic, if it be *very smooth* and *moist*, is bound to be *reflective*. Now, whether this surface reflect the source of light, to which it is subjected while being drawn, or some feature of the plane upon which it rests, or some other near or distant object, is quite a matter of choice; but some recognizable thing must be pictured on the surface to show that it is reflective, if in a high degree. This was the case with the cyst described by this particular author and drawn by this particular artist. Now why should the artist be criticized because he chose his source of light, the window, as the object reflected, providing, of course, that it did not obscure any structural detail described by the author? In this instance it did not obscure. By drawing in his source of light, the window, since he had to do with a highly reflective surface, he simply introduced a secondary fact which largely contributed to, without detracting from, the main idea, and he added thereby only a touch of *realism* to his picture.

Now you may ask why has so much stress been laid upon this *realism* as applied to graphic art in science? The answer to that question may be begun with another question—Why is there such a pursuit as scientific investigation? Surely one of its chief reasons for existence is to dispel the mystery that often overclouds even the simplest phenomena of life, and to lead us, if not into the full, white light of complete understanding, at least, into the light of partial comprehension. And often when one seeks to describe some findings that have resulted from his exploration into the unknown, he finds that his words are too vague and inadequate to present the complete and correct description. He desires to convey to others a delicately accurate idea of the object as he sees it, and naturally must turn to the use of a picture. Therefore, an investigator should never tolerate a drawing illustrative of his text that does not vividly contribute to express, in an optical sense, completely and truthfully, the object described.

But, even realism can be carried too far in the drawing of scientific subjects, and to avoid this a fine discrimination is necessary: a discrimination that the artist can not be expected to exercise if he does not know *what* he is drawing, and, more important, the *purpose* of the drawing. This leads us to what I consider the most momentous matter in this address, and that is a discussion of the ideal relationship which *should* exist between scientist and artist, and the means by which this might be effected. At present it is only too common that inharmonious relations exist between scientist and artist.

In the first place, an individual whose nature has led him into a life devoted to investigation is seldom an adept in the use of tools employed in the practise of graphic art. At times it seems that investigative talent, and the talent necessary to worthily render anything in a graphic way, are natural antagonists, so rarely are they found inculcated in the same person. But there are very few good scientists who, if they choose and have the opportunity, can not become excellent critics of the good and bad points in a drawing or painting, especially when it is used to illustrate subjects with which their business in life has made them thoroughly familiar.

And, on the other hand, very few artists display any taste for or merit in work of a purely investigative character. Most of them are loath to believe that any high art can be worked into subjects that present a pattern of almost infinite detail. But this is not all. Without the proper guidance, even an eager, capable artist set upon the task of drawing some scientific subject, would be, in nearly every instance, sure to give some important feature of the same only an indifferent expression, or omit it entirely, while another one, perhaps an artifact, something that a horde of accidental conditions might produce and which is entirely foreign to the subject in its natural state, would be painstaking and conspicuously copied, thus rendering his production absolutely useless to the scientist. So the scientist with little artistic talent, and the artist with no scientific training, clash together again and again, leading to a loss of precious time, and a severe straining of patience on both sides. This thundercloud hangs over both until, by constant rubbing together, each takes on some of the other's particular efficiency. Under the conditions existing to-day, this is a slow and laborious process, and frequently attended with exhibitions of the most fretful behavior on the part of both principals. The scientist gets angry with the artist, and *vice versa,* each consoling himself with the firm conviction that the other is a microcephalic egotist. And this is not so strange as at first appears when we look at the methods by which each has attained his smattering of the other's specialty. The scientist, in the course of his career, because of the demands laid upon him by the publishing of his work, is, from time to time, brought into brief and, as a rule, imperfect contact with the processes by which a drawing or painting is reproduced in printed literature. He hears about light and shade, color and tone values, contour and perspective, half-tone and auto-type, etc., until he has learned them by heart, and only with a ghost of an idea what they all mean. Hence, he can not be a judge of what particular process of illustration best adapts itself to the subject described, and when a skilled artist points out the respective merits of different processes of delineation and reproduction, he finds that his words fall on, at best, only partially comprehending ears. Yet the artist may be just as far in arrears in his scientific obligations. It is a long, hard struggle for him to suppress his realism to the interest of the scientific purpose of an illustration. Time and time again he spends fond hours with some particular thing he sees in the preparation, only to have it ruthlessly cut out by the investigator as a positively unnecessary and confusing feature in the drawing. And it is no uncommon occurrence to see an artist presenting himself for service in scientific circles, boasting of nothing more than a bowing acquaintance with the microscope. He looks into it with a squint, sends the oil-immersion lens down through the cover-glass, and carries the instrument about by its delicate adjusting-mechanism.

Coming to the question of what should be done to improve the relations existing between scientist and artist, the terse advice of Max Brödel sums up the whole problem—"Teach the scientist more art and the artist more science." And how is this to be done? I can see but one logical way, and that is by modifying and establishing courses where both scientist and artist may be trained in a proper and thorough manner concerning what each should know of the other's occupation. From the best available sources of information I am told that such a school is nowhere in existence to-day. Here is an opportunity for this university to take up an initiative which it would never need to regret. For, with the proper management, I am sure that such a course of instruction would be nearly, if not quite, self-supporting, and the good results to be obtained from it would earn the hearty thanks of every branch of scientific work coming within the pale of its influence. This is not the time or place to discuss the equipment or conduction of such a course of study. Suffice it to say that neither would demand heavy financial expenditure. While the mature scientist and mature artist would have, naturally, recourse to the training here offered, the greatest bulk of its attendance would be from the ranks of the beginners in both pursuits. The students of natural sciences could be here enrolled in their several classes, and instructed in the graphic arts as demanded by their own special needs. And individuals of graphic talent, those intending to follow the illustration of scientific subjects as a life-work, could be here instructed in a manner calculated to amply fit them for the graphic execution of any subject in any branch of scientific investigation. At least two courses, experimental and didactic, would be attended by both sections of workers, viz.: reproductive methods, that is, the various processes by which a drawing or painting is published, and a systematized explanation of that ideal relationship which *must* exist between scientist and artist to insure the best results. The mere mention of these two courses calls up to mind a generous number of subjects embraced by them, each one of which, if anything like justice were done it, would require more time than is allowed to any single period of discussion. But, and I have no doubt at all as to the truth of this assertion, every one, be his help great or small, who assists towards raising the institution from the *suggested* to the *realized* will have done every form of scientific work a great service.

In closing this effort towards bringing art and science into closer, more effective affiliation, I could hardly find a higher sentiment, or an example of nobler support of this cause, than that expressed in a recent personal communication from Mr. Max Brödel, the most capable of all the artists engaged in illustrating American science to-day. They run as follows:

> The only course on the subject of medical illustration is given by myself, and is limited to a few individuals. I don't wish to leave this world without having done some good, and I believe I can help the beginner in the study of medical illustrations to avoid a great many pitfalls and disappointments. There is not a penny in it for me, but I do it because I think it is my duty towards the medical profession.

A. W. Lee

University of California

THE MARINE BIOLOGICAL STATION OF ROSCOFF. ANNEX OF THE UNIVERSITY OF PARIS

A circular received some time ago from Professor Delage concerning the Marine Laboratory at Roscoff, seems worthy of reproduction in Science in order that the advantages of the station may be brought to the attention of American students who may be intending to pursue zoological studies abroad.

J. Playfair McMurrich

Founded in 1872 by H. de Lacaze-Duthiers, this station had at its beginning only a rudimentary equipment. But the judicious selection of its site was a certain guarantee of its ultimate development, for in its immediate neighborhood all varieties of sea bottom are to be found, with the fauna and flora characteristic of each; indeed, there are few points, either in France or abroad, that can compare with it in the richness and variety of their fauna. In addition the tides are very high (almost 10 meters) and expose a large extent of shore, so that the collection of quantities of material is very easy.

The progress of the station has been continuous and to-day it is a vast establishment whose buildings cover the extent of a demi-hectare and comprise a large aquarium with 300 square meters of floor-space and containing 20 aquaria and 2 large basins, all supplied with a constant circulation of sea water; an aquarium of nearly 1,000 square meters of surface and 4 meters in depth, supplied by the tide; elevated tanks of 180,000 liters capacity for the supply of the large aquaria and the smaller ones in the work-rooms; 22 work-rooms for students carrying on original researches; a museum containing examples of all the animal forms of the region, identified by specialists; a large hall for students, in which two courses of lectures and laboratory work, each consisting of thirty sessions, are conducted; a library; a physical laboratory; a chemical laboratory; two photographic rooms; an engine room; a workshop; and twenty living rooms for investigators who may find it necessary to live in close proximity to their work.

The equipment also includes several small sail-boats and a motor boat of eighteen tons, in which excursions may be made as far as the English coast.

The number of workers in attendance at the station, which in former years has varied between thirty and forty, has doubled, and it has been found necessary to make considerable enlargements in order to accommodate all those who request the hospitality of the station.

The aquarium and the old work-rooms have been pulled down and reconstructed on better plans, and 24 new rooms have been added, all lighted by large windows and supplied with all the scientific equipment which modern technique demands. These rooms are intended as private laboratories and are placed at the disposal of students from abroad at an annual rental of 1,500 frs., payable to the faculty of sciences of the University of Paris. This charge is notably less than that made by the Zoological Station at Naples. It must be understood, however, that the Roscoff Station makes no pretensions of duplicating that at Naples. Situated as it is on the shore of a tidal sea, whose fauna is quite different from that of the Mediterranean, it is, on the contrary, a natural complement to the more southern station.

THE BOGOSLOF ISLANDS

The following notes have been received from the North American Commercial Company, of San Francisco, under date of June 30, 1908:

Our Dutch Harbor log contains the following: "Wednesday, June 17th, 1908: The *Rush* passed here for Unalaska at three P.M. from the Seal Islands. Captain Munger returned on the *Rush*. He went up to the islands on the *McCullock*. On the way down the *Rush* had intended doing a little surveying around Bogoslov, but the navigating officer could not find the islands." The company's letter of the 17th instant from St. Paul Island says: "The *McCullock*, returning from Bogoslov, reports the disappearance of McCullock and Perry peaks. A reef adjoining Castle Rock now forms a small bay. We are not in possession of all the facts."

It will be remembered that the Bogoslofs are a group of three small volcanic islands in the southern part of Bering Sea and thirty-seven miles northwest of the island of Unalaska. One of these islands, Castle Rock, has been known since 1796, Fire Island has been known since 1883, while the third one, Perry Island, rose from the sea about the time of the San Francisco earthquake in 1906.

There is a brief account and photographs of these islands published by Dr. Jordan and Mr. G. A. Clark in the *Popular Science Monthly* for December, 1906, pp. 481–489.

J. C. Branner

Stanford University, Cal.,
September 17, 1908

SCIENTIFIC NOTES AND NEWS

The Academy of Sciences at Turin has awarded its Riberi prize of the value of $4,000 to Professor Bosio, of Turin, for his discoveries in relation to the biological reactions to arsenic, tellurium and selenium.

Sir James Dewar, Fullerian professor of chemistry at the Royal Institution, London, and Professor O. D. Chvolson, professor of mathematical physics at St. Petersburg, have been elected foreign members of the Belgian Academy of Sciences.

Mr. Wilbur Wright, as has been fully reported in the daily press, has made with his aeroplane at Le Mans a flight lasting one hour, thirty-one minutes and thirty-five seconds and covering 66.6 kilometers. He has also made a flight with a passenger lasting 55 minutes and 30 seconds and covering 58 kilometers.

Dr. Luthur H. Gulick has resigned the directorship of physical training in the New York public schools to become secretary of the Physical Training Department of the National Young Men's Christian Association.

Dr. S. Tscherny, of Kiev, has been appointed director of the university observatory in Warsaw.

Mr. Robert Nelson has been appointed to the newly created post of electrical inspector of mines in Great Britain.

Professor L. H. Bailey has been given leave of absence from the directorship of the College of Agriculture of Cornell University to devote his time to the chairmanship of the commission appointed by President Roosevelt to investigate the conditions of rural life. He expects to be at Ithaca during the present month and in Washington during November and December. The other members of the commission are: Henry Wallace, of *Wallace's Farmer,* Des Moines, Ia.; President Kenyon L. Butterfield, of the Massachusetts Agricultural College; Gifford Pinchot, chief of the Forest Service, and Walter H. Page, editor of the *World's Work.*

Dr. N. L. Britton, director-in-chief of the New York Botanical Garden, and Mrs. Britton have returned from a fourth trip of botanical exploration of the island of Jamaica.

Professor H. E. Crampton has returned to Columbia University from zoological explorations in the Society Islands.

Dr. George N. Stewart, professor of experimental medicine in Western Reserve University, who has been abroad on leave of absence for the past year, has returned.

Professor J. H. Comstock has returned to Cornell University after a year abroad.

Dr. William Osler has received leave of absence from Oxford University for one year, which he will spend on the continent.

Professor Henry A. Perkins, of Trinity College, will spend the coming year in physical research at the University of Paris.

Dr. Lyman B. Hall, professor of chemistry in Haverford College, has been given leave of absence for the present academic year.

The expedition under Professor Baron Gerard de Geer, of Stockholm University, which has been exploring the Spitsbergen group of islands, has returned.

Professor Edward L. Nichols, head of the department of physics of Cornell University, will represent the university at the inauguration of C. A. Duniway as president of the University of Montana.

Professor George Trumbull Ladd is now giving a course of fifteen lectures upon certain psychological aspects of education at the College for Women of Western Reserve University.

Professor Charles Baskerville began on October 3 a series of six lectures on the chemistry of existence, to be given at the American Museum of Natural History on successive Saturday evenings.

The Rev. Edmund Ledger, M.A., has resigned the Gresham lectureship in astronomy in Gresham College, London, which he has held since 1875.

There was quoted in the last issue of Science an editorial article from the New York *Evening Post* discussing academic freedom in America, which was based on the alleged call of Professor George A. Coe to the Union Theological Seminary. This article, it appears, was incorrect, both in regard to Professor Coe's call to the seminary and in regard to the alleged objections to his views at Northwestern University.

The Royal Society of Victoria is collecting a fund to establish a medal in honor of the late Dr. A. W. Howitt, to be awarded for work in Australian natural science.

Dr. Homer Taylor Fuller, president of the Worcester Polytechnic Institute from 1882 to 1894, member of the Geological Society of America and fellow of the American Association for the Advancement of Science, has died at the age of seventy years.

Professor Ernest F. Fenellosa, curator of the department of oriental art in the Boston Museum of Fine Arts, at one time professor of philosophy in the University of Tokyo, and an authority on oriental archeology, art and philosophy, has died in London at the age of fifty-five years.

The deaths are also announced of Dr. Theodor Peters, director of the Society of German Engineers, and of Mr. George Nicholson, formerly curator of the Royal Gardens, Kew.

There will be a New York State Civil Service Examination to fill the position of associate in clinical pathology in the Pathological Institute at a salary of $2,000; of director's assistant in the State Library at a salary of $2,100, and of junior statistician for the Public Service Commission at a salary of from $1,200 to $1,500.

Director George Otis Smith, of the U. S. Geological Survey, has invited officers of the leading railroads of the country to a conference on the amount of water flowing in the rivers of the country under certain conditions and in different periods of the year. The

National Conservation Commission has been advised of the proposed plan and whatever results come from it will undoubtedly be considered by the commission at its joint meeting with the governors of the states, or their representatives, to be held in Washington next December.

An Australian Institute of Tropical Medicine has been established at Townsville, North Queensland. It receives subsidies of £450 from the commonwealth government; £250 from the Queensland government, and £400 from the British Colonial Office. The nomination of the first director has been delegated to the Royal Society and to the London and Liverpool Schools of Tropical Medicine.

The Virginia Geological Survey, recently established by the General Assembly of Virginia, with headquarters at the University of Virginia, is under the direction of a commission composed of Governor Swanson (chairman), President Alderman, of the University of Virginia; President Barringer, of the Virginia Polytechnic Institute; Superintendent Nichols, of the Virginia Military Institute, and Hon. A. M. Bowman, of Salem, Va. At a recent meeting of the commission Dr. Thomas L. Watson, professor of economic geology in the University of Virginia, was elected director of the survey. Dr. J. S. Grasty, of the Maryland Geological Survey, was appointed assistant geologist, and Mr. Wm. M. Thornton, Jr., of the University of Virginia, chemist. Work is in progress on the geology of the coastal plain region, including the underground water resources; cement and cement materials; topography and geology of the Virgilina copper district; geology of the rutile deposits; and building and ornamental stones. The studies of the coastal plain geology and topographic mapping of the Virgilina district are in cooperation with the United States Geological Survey.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. and Mrs. E. W. Clark, of Philadelphia, have given $10,000 to Harvard University for the establishment of two freshman scholarships.

Columbia University has received $10,000 from Mr. and Mrs. Henry F. Shoemaker, the income to be used in aiding poor students.

Among the alumni of Haverford College a fund is being raised for a science hall.

With the opening of the college year on September 24, the University of Wisconsin College of Agriculture inaugurated a new course known as the middle course, which may be completed in two full years. This course is designed to meet the needs of those students who have had a high school training and are prepared for university work, but can not spend more than two years at the university. The studies include practically all the work of the first two years of the long, or four years' course, with the exception that foreign languages and mathematics are replaced by more practical subjects. The aim is to give the students as thorough training in the sciences and technical agriculture as is possible in two years time.

The Rev. W. W. Guth, A.B. (Stanford), S.T.D. (Boston), Ph.D. (Halle), pastor of Epworth Methodist Episcopal Church, Cambridge, Mass., has accepted the call of the corporation of the University of the Pacific to the presidency of that institution.

Professor H. Wade Hibbard, head of the department of railway mechanical engineering at Cornell University for the last ten years, has been appointed director of the college of mechanical engineering at the University of Missouri. He will take up his new duties the first of the new year.

Dr. Howard S. Reed, expert in soil fertility in the Bureau of Soils of the United States Department of Agriculture, has been elected professor of plant pathology in the Virginia Polytechnic Institute, and plant pathologist in the Virginia Agricultural Experiment Station at Blacksburg, Va. He entered upon his new duties at the opening of the academic year.

At Western Reserve University, Mr. Carl B. James has been promoted to be assistant professor of biology in Adelbert College. In the Medical School, Dr. Maulsby W. Blackman, instructor in histology and embryology has been promoted to be lecturer in histology and embryology, and Dr. Roger C. Perkins, assistant professor of pathology and bacteriology to be associate professor of pathology and hygiene.

Mr. Charles H. Danforth, who has been engaged in comparative anatomical investigation at Tufts College, has been appointed instructor in anatomy in the Medical Department of Washington University.

At Northwestern University David R. Whitney, Ph.D., Columbia, has been appointed assistant in biology, and J. W. Turrentine assistant in chemistry.

At Williams College, Mr. Charles Packard has been appointed instructor in biology; Mr. R. S. Corein assistant in geology; and Mr. L. B. Mears assistant in chemistry.

At Amherst College, Mr. Gordon Pulcher has been appointed instructor in physics; Mr. Charles W. Cobb, instructor in mathematics, and Mr. Arthur L. Kimball, Jr., assistant in geology.

Edward E. Wildman, M.S. (Pennsylvania, 1908), has resigned a fellowship in biology at Princeton on account of his election to a professorship in biology at the Central High School, Philadelphia.

Mr. P. L. Gainey, a recent graduate of the North Carolina College of Agricultural and Mechanical Arts, has been appointed assistant in botany in that institution.

Dr. Jesse H. White, Ph.D. (Clark), has charge of the work in psychology and education in Pittsburgh University, during the absence of Professor Edmund B. Huey, who is spending the year in Paris.

Professor M. Stuart Macdonald, of the University of Fredericton, N. B., has been invited to give assistance to the department of philosophy until the board fills the vacancy made by the resignation of Professor Taylor.

DISCUSSION AND CORRESPONDENCE

THE ADMINISTRATION AT THE UNIVERSITY OF ILLINOIS

The abominable state of affairs which exists at some of our universities in America could not last long if the true conditions were known outside. The faculties are powerless to correct them, for the very places where reform is most needed are the ones in which the professor is so shorn of his power as to be practically helpless. If public opinion is once aroused on the seriousness of this question, it will not take long to remedy the evil.

Those who are interested in the movement for putting our American universities on a true university basis will find some valuable material in the contents of this article.

I agree with the editorial in the *Popular Science Monthly*, for July, 1908, that Dean Kent did a public service when he exposed the administration of Chancellor Day at Syracuse University. I have heard that this is already producing a better atmosphere at Syracuse—as one might have expected.

For the same reasons I propose to give an account of a case at the University of Illinois, and in doing so I have no apology to make to any one; least of all to my fellow citizens of the state or to the alumni of the university. They are the ones who are most interested, and I believe that the vast majority of them will see at once that they will be benefited.

I am trying to clean up a condition which could not exist in the light, and which will spread its poison if allowed to persist in the dark. The university is too strong, the alumni too loyal, and the state, as a whole, too intelligent to allow the recurrence of such acts as have recently been perpetrated by the president of the university, supported, in part at least, by the governor of the state.

Those who are interested in academic freedom will be edified in seeing how the president of an American university handled a professor's case when he appealed it to the supreme court of the university—that is, the trustees.

Without going into the details of the case appealed, I will simply say that when President James came to the University of Illinois, I had completed seven years as full professor and head of the department of physiology. During this entire time I had had no friction with the former president, nor with any one else.

With President James's administration I began to bump over a corduroy road that led me to believe there was something wrong under the surface. I felt that I had been compromised, in several particulars, in my dignity as a professor, and finally, having failed to get a satisfactory explanation, at the end of three years of friction, I wrote to the president suggesting that he ask my resignation rather than to keep things going as they were. I knew, and the president knew, that if he asked my resignation I could request a hearing before the trustees, and he would have to show grounds for his request. As he would do nothing, I finally asked the board of trustees to court-martial me. I was conscious of a clean record, and did not fear a fair trial. I quote the first paragraph of my letter to the board:

When an officer in the army, by the act of a superior, is placed in a position which compromises his reputation, he may apply for a court-martial. In this spirit, I request an investigation by your honorable body.

The letter was addressed directly to the board, and was forwarded through the dean of the College of Science, and the president of the university. As evidence that I had not appealed to the board before exhausting every resource with the president, I presented to the board, at the first meeting on which the case was called, copies of two letters which I had sent to the president—one of the date of September 7, 1906; the other February 14, 1908; and I gave copies of these letters to each member who was present at that meeting. I quote from said letter of September 7, 1906, as follows:

Although I have headed this letter "unofficial" and have marked the envelope "personal" so that it will reach you without passing through clerical hands, it will contain nothing which I wish to be guarded by the seal of privacy, and I expect you to use its contents freely: especially with others whom it may concern. I intend it for an informal discussion: a friendly *pour-parler*, so to speak; preceding official action, if such action must be taken.

I am in doubt as to your attitude toward me and my department, and I wish to go straight to you for information. . . . I know of no reason to justify any action that would insinuate that I was inferior to my colleagues; and if you have any such reason in mind, I wish you would bring it up and let us have it out, fairly, fully, and finally. . . .

I believe I have every moral right to remain here, and share all the benefits, in the growth of the institution to which a long term of efficient service (with many extras) would entitle me. On the other hand, if my position is to be compromised, in its dignity, either as to salary, amount of work, or responsibility, I would not be willing to retain it.

After such words as these, in a *pour-parler*, and even much more vigorous ones in an official letter, later, there was no excuse for the president to refuse to clear things up one way or the other, and the only higher court I could appeal to was the board of trustees.

When my case was called, I appeared before the board and made a brief preliminary statement, to the effect that I wished a clean slate, but that I did not wish to make a personal attack on any one, and would regret it if any personal questions arose. *I also stated that I hoped the case would reveal certain defects in our organization that I knew existed, and that I hoped the board would see and correct them.*

I was then excused, with the understanding that I would be called later. As I left the room I told where I would be, and how I could be back in three minutes if they telephoned to me.

The vice-president, the former dean and the present dean were then called. They were questioned by President James, and their testimony was taken in my absence. No record was kept.

If the president brought in these gentlemen, expecting that they would condemn me, their testimony must have been a sort of a Baalam's blessing; for at least two members of the board, who stuck by the president through thick and thin, told me that the evidence was so much in my favor, that if I would withdraw the case, I could do so without prejudice to my reputation for anything that had been said.

The board took a recess for lunch, after which they transacted other business and then adjourned without taking up the case again. This was March 10; the meeting was at the university.

The next meeting of the board was held April 3, in Chicago. I was not notified and so was not present.

The next meeting was April 23, also in Chicago. I was notified and was present. The president of the board asked me what I had to say. I replied that I did not know what I would have to say until I was informed as to what had been done in my absence. I then said: "First, I should like to ask, 'Are there any charges against me?'" The president of the board gave me the official answer, "No." I then said, "This gives me a clean slate and leaves nothing for me to defend; but I have some witnesses who can tell of the difficulties I have had in the development of my department. I have brought these witnesses here at my own expense, and if you care to use this opportunity to learn of the conditions under which some of us have to work, I offer you their testimony." They were called in, and I voluntarily left the room to allow them to speak without the slightest restraint. They were questioned by different members of the board. Finally, the president of the board, in a genuinely courteous way, gave me ten minutes to "*close the case*"—these were his words. After I had left the room, President James, who had been present all the time, read from a nineteen-page typewritten memorandum in which he reflected on me both personally and professionally.

A resolution was then put to a vote, that the "board of trustees do not recognize that Professor Kemp has any just cause for grievance against the administration of the university." This was lost on a tie vote. Then occurred an accident which gave me the first tangible thing I could get from anybody. The president had taken the seat which I vacated when I left the room. I had left a whole stack of reports, etc., on the table; for I did not know what I might have been called on to prove, and I was prepared to show, if necessary, that my recommendations had not been carried out. After the vote went against him, the president left his memorandum mixed in with my papers, and when I gathered these up, after the meeting, I found it.

Here I had incontestable proof of the president's unfairness. He had presented this paper behind my back, and it was full of misleading statements—especially half truths, very adroitly presented. Indeed I must give the president credit (*sic*) for the way in which he put some of it together. He attacked me on practically every point which is essential to the head of a department, viz., as an administrator, as a teacher, as a man of science, and in my relation to my colleagues. Everything was general—not a specific act was alleged. Here is a sample:

> I do not think that Dr. Kemp's salary should be increased at the present time, or at all, until we get an entirely different atmosphere in the department, and particularly in the relations of the department to the other departments in the university.

If the president had said this to my face, I should have asked to which departments he referred; and what was wrong. If this *were* true, both the president and the dean had been guilty of flagrant dereliction in their duty, for not having called my attention to it. The same would apply to the head of any department making such a complaint.

I have received disciplinary letters from the (former) dean, on meeting a class out of schedule hours[1] and on "smoking in university buildings." If such trivial things as these could be put in writing, there is no excuse for secret action on one of the most serious accusations that could be brought against a professor.

Speaking of atmosphere, I believe I can say that my department has always contained as much university oxygen as any about the place, and my students who have breathed this "atmosphere" have gone out loyal, strong and true university men and women, who have made a record of which any professor may be proud. *That* is the *real* test.

Later in the day, I came upon a group of the trustees who were discussing the meeting. The reading of the memorandum behind my

[1] This was done by unanimous request of the class and involved no conflict with other classes.

back had been objected to, but the objection was not sustained. The group that I met were all indignant at the whole procedure and their talk drifted back to the meeting of April 3, for which I had received no notice.

It seems that at that meeting the governor was present, as were all the ex-officio members. The governor almost never attends even the *regular* board meetings, but he was at that *special* one. He presented a set of laudatory resolutions on the president and spoke so pointedly, on his wish that the board should back up the president, that it excited comment at the time. Shortly thereafter my case was called, and discussed in my absence. The president attacked me, then, behind my back; and tried to get the board to pass resolutions which would have led to my resignation in self-respect. Action was only deferred by the vigorous protests of some who insisted that I had been promised a *hearing;* that up to that time I had had no chance to reply to anything that had been said, and had not even heard it.

After I was sure that there was no doubt on this point, I showed those members my file of the president's letters containing this one:

University of Illinois
president's office

Dr. G. T. Kemp, April 11, 1908.
Natural History Building

My dear Doctor,

The board of trustees at its last meeting on Friday April 3 in the city of Chicago considered at much length your communications to the president of the university and the president of the board. Through some misunderstanding it seems you did not receive notice of the meeting. I urged that action be deferred until you could be heard if you care to be.

Faithfully yours,
(Signed) Edmund J. James.

As will be seen, in my resignation, I accepted the version of the trustees—not that of the president. There is not a member of the board from the governor down who can plead ignorance after this.

There is another thing which happened at the meeting, on April 3, which has a very ugly look. I was not there and did not hear what the president said, but he certainly gave some of the trustees the impression that I had referred him to three men at Johns Hopkins, that he had seen these men, and that all three had spoken unfavorably of me. He did go to Baltimore, and if he was as misleading there, with those whom he saw, as he was in his "secret report" to the trustees, I do not know what sort of impression he created. As a matter of fact, I knew nothing of his intended visit to Johns Hopkins, and did not refer him to anybody. If I had done so I should have given him my card.[2]

The rest is soon told. The president's actions had made the whole affair a burlesque on justice; the governor had aided and abetted him, and was evidently keeping his influence active. The sense of decency of about half the board was outraged, and the others were likely to stand pat. It was disagreeable for everybody. I was disgusted and willing to sacrifice my "job" for the dignity of my profession. A university professor is entitled to more respect than to be subjected to such a farce of a hearing.

I was prepared to resign, but before I did so, the president contributed one more serio-comic feature, in the shape of a letter. It was serious, because it came from a man in his position; it was comic because of its form, and because I received a letter of the *same date,* from another official, and it would take a pretty clever casuist to make the two agree. The one letter was from the secretary of the board of trustees giving me the words of the president's resolution, which had been lost at the last meeting, and also the vote. This resolution has been quoted above. The president's letter, on the same date, is as follows:

[2] I can not pass this by, without expressing a thought which will appeal to more than one reader of Science. I have known men to have injustice done them when it was never so intended. In judging the speed of a horse, you must see if there is a handicap. A horse that can trot a mile in 3:50, carrying weight over a heavy and broken road, may have just as good stuff in him as one that can make it in 2:25 on a good track in a proper rig; and the fact that the 3:50 animal has never quit, and refuses to have his racing-spirit broken is not such a bad recommendation for his old stable.

University of Illinois
president's office
April 28, 1908

Dr. G. T. Kemp,
Natural History Building
My dear Doctor Kemp,

The board of trustees after a long discussion over the matter did nothing in regard to the subject matter of the communications which you have forwarded to them. They will have another meeting on next Saturday at nine o'clock at the Palmer House in Chicago. If you desire to make any further statement or appear again before the board at that time I shall be very glad to ask that permission be accorded you.

Faithfully yours,
(Signed) Edmund J. James.

I do not see how the action of the board could have been more to the point. I asked a court-martial on the ground that I had been compromised by a superior. The board told me, through its president, that there were no charges against me, and put it on record. They then refused to say that I had no just cause for grievance against the administration of the university. That was as complete a vindication as any man could wish. Everybody was tired of the thing, and I felt outraged and disgusted, so I sent the president the following letter, with my resignation enclosed:

University of Illinois
department of physiology
May 1, 1908.

President E. J. James,
University of Illinois.
My dear President James,

Following my letter of yesterday, I now enclose you my resignation, as the only communication I have to make to the board of trustees for their meeting to-morrow.

This settles the case so far as I am concerned, but if the board wishes me to appear, for any reason, I shall, of course, do so.

The reasons for my resigning, as I am now doing, are set forth in the preamble to the resignation. A further discussion seems superfluous.

Very respectfully yours,
(Signed) Geo. T. Kemp.

To the Honorable Board of Trustees
Of the University of Illinois
Ladies and Gentlemen:

Whereas, The Board of trustees has taken much of its valuable time in discussing matters arising from my communication, of March seventh, to the board, and

Whereas, The action of the board was to refuse, by a tie vote, to pass a resolution, emanating from the president of the university, to the effect that I had no grievance, and

Whereas, I feel that I am sufficiently vindicated, by this action of the board, to resign without compromise of my reputation, and,

Whereas, I do not wish to give the board any further trouble with the case, and

Whereas, At a meeting of the board, on April third, the president of the university urged the passage of resolutions reflecting to my discredit, and

Whereas, I was absent from said meeting, and, at the time the president of the university urged such action, I had been given no chance to reply to anything that had been said about me, and

Whereas, At the next meeting of the board, to wit, April 23, I asked the question: "Are there any charges against me?" and

Whereas, The president of the board gave me the official answer: "No," and

Whereas, I then said "May I ask that this be made a matter of record?" and

Whereas, The president of the board said: "If there is no objection, it is so ordered" (or words to that effect), and

Whereas, The president of the university was present and interposed no objection, and

Whereas, After the case was supposed to be closed, and I had left the room, the president of the university read from a lengthy typewritten memorandum, and made statements which reflected to my discredit both personally and professionally, and

Whereas, My confidence in the administration of the university is now so shaken that I think it best to resign,

Therefore: I hereby tender my resignation, as a member of the faculty of the University of Illinois, to take effect September 1, 1908.

Very respectfully yours,
(Signed) Geo. T. Kemp.

In conclusion, I wish to quote again from the president's secret memorandum:

Dr. Kemp makes certain definite charges involving the good faith and honesty of the university administration. I shall dismiss these with this reference, as I do not consider that it is necessary to enter into this subject at all. I call attention to it simply as an evidence of the difficulty which Dr. Kemp has in taking a proper view of university questions. Everything is so bound up with his own personal view as to what is due him and his particular department, as to make it temperamentally impossible for him to take any other but a false view of this particular phase of the subject.

In my letter to the board, I tried to avoid anything personal, and when I appeared before the board, to make my preliminary statement, I laid special emphasis on this. In fact, I gave it as my reason, for appealing to the board, that I could not locate where the trouble lay. The dean referred me to the president, and the president laid the responsibility on the former dean, the present dean, and the vice-president. I felt that I was being shot at from ambush, and when I stopped, like a man, and challenged, the president would not bring us together, but said the reports were confidential.[3]

When I found the president with his secret memorandum, I had something definite. It is the irony of fate, that in making the very flourish with which he dismissed these *alleged* charges, he dropped a paper which proved most serious things on himself in stern reality. I frankly admit that I am temperamentally so constructed that I can not regard it as either "fair or honest" for a university president to make an attack on a professor behind his back that he would not make to his face. Furthermore, the same temperamental construction forces me to feel that a man who would not look upon such an act as disgraceful does not "take a proper view of university questions," and is not the best type of man to intrust with the instruction of the youth of a nation. I do not mean these for words of passing sarcasm. The idea which they convey is of serious import to the educational interests of the country. One of the most famous educators of the past generation has said:

> No educational system can have a claim to permanence, unless it recognizes the truth that education has two great ends to which everything else must be subordinated. The one of these is to increase knowledge; the other is develop the love of right and the hatred of wrong.

If we wish our system of state education to endure, we dare not condone a serious infringement of either of these fundamental principles, for a recognized amount of ability in the money-getting or in the advertising line. The State of Illinois, for instance, is not giving nearly $1,000,000 a year in order that any man shall rear a showy structure, and say, "Behold the great Babylon which I have built." The people who furnish the money have a right to demand—and will demand—a clean administration, and a healthy atmosphere from the president's office to the athletic field. If anything half as bad as the president's attack in the dark had happened in connection with the management of the football team, there would have been a tremendous cry of "dirty athletics," and a storm of righteous indignation would have broken loose. The higher up we go, the harder it is to correct abuses—but the more important it is that these abuses should be corrected.

Geo. T. Kemp

Hotel Beardsley,
Champaign, Illinois

[3] There is food for thought here. I have some excellent friends, for whose opinions I have genuine respect, who believe that a democratic form of university government would seriously upset faculty discipline. Here we have a typical monarchical form; and what could be more subversive of faculty discipline, and of confidence, than what I have just described? I finally came to fear that the president had ulterior motives which he did not care to allege; and that he was seeking cover behind which to fight.

QUOTATIONS

AT THE UNIVERSITY OF OKLAHOMA

A third according to our informant, a fifth according to Mr. Cruce, of the faculty have been removed. They were removed with practically no notice; so late in the season that it is really a remarkable testimony to their ability that so many of them have already obtained appointments in colleges of standing not unequal to that of Oklahoma University. Accompanying this removal, without previous notice, was a refusal to pay the last two months' salary of the year for which they were appointed. What legal justification there was for this refusal we do not know; the question is now before the courts of the state in a suit by the professors for the withheld salary. Legal or illegal, it certainly was not just. We shall require a great deal of evidence to convince us that the people of Oklahoma wish their faithful and efficient teachers treated in this fashion. For there is no pretense that they were not faithful and efficient. It is too late now to interpose charges, even if one wished to do so. Nor is it pretended that their successors are abler scholars or likely to be more efficient teachers. The value of a degree in America depends on the college or university which grants it. The men removed represent degrees from Harvard, Columbia, Johns Hopkins, Michigan and Chicago Universities. The men appointed in their place represent degrees from Harvard and Texas Universities and Coronal Institute.

No reason for the discharge of this one third or one fifth of the faculty is even hinted at by the president of the board of regents. The fact that two out of the seven members of the board present when this dismissal was voted were Republicans does not indicate that the object of the removal was not political. We do not know how those two voted; Mr. Cruce tells us that one of the two members voted against the dismissal. The fact that the Republican members voted for Mr. Evans after Dr. Boyd was removed does not indicate that Dr. Boyd's removal was not political. Dr. Boyd having been removed, Mr. Evans may have been, for aught we know, the best candidate, or the only candidate, in sight. The one essential fact that appears in this whole miserable business is that the president and a large proportion of the faculty have been summarily removed from office, and that there is no pretense that any question of their scholarly attainments or their competence to teach was involved in the removal. To the charge that the reasons for the removal were political, ecclesiastical and personal favoritism, only one answer is possible. That answer is a clear statement of some other reason; and no other reason is even suggested. —*The Outlook*.

SCIENTIFIC BOOKS

Introduction to Metallography. By Paul Goerens, Docent in Physical Metallurgy at the Royal Technical High School, Aachen. Translated by Fred Ibbotson, Lecturer in Metallurgy, The University, Sheffield. London, Longmans, Green and Co. 1908. Pp. x + 214.

The applications of physical chemistry to the solution of industrial problems have been many, but it is doubtful whether any field has yielded such important results as in the study of metallic alloys. Empirically established facts have been placed upon a distinctly scientific basis and fortuitous experimentation has been replaced to a very great extent by accurate prediction. Perhaps in no other field of chemistry or physics has there been such an accumulation of unsystematized observations. This information is now being carefully classified by the results of metallographic study. The methods used are thermal and microscopic—the study of freezing-point curves and the microscopic examination of alloys of varying concentration. The author of this treatise has rendered a distinct service to those interested in the study of the properties of metals. The information has been widely distributed and unavailable to many, and it is now brought together in compact form. The book is simply and clearly written and is an excellent guide to the study of metallography. The exposition of the theoretical side of the subject is not as complete as it might have been but it will give the beginner an excellent idea of equilibrium phenomena. The explanations of the freezing-point diagrams have been duplicated unnecessarily, perhaps not for the beginner, but certainly for those using the book for reference. For the latter class of readers there is too much detail.

The volume treats of the methods employed in the establishments of cooling curves, the interpretations of these curves with chapters on the analogies between aqueous solutions, fused salts and alloys; the practical microscopy and photography of metallic sections; and a special chapter on the iron-carbon system. In the translation this chapter has been completely rewritten.

The author has, in a number of cases, without any apparent reason given the older freezing-point diagrams of Gautier, and Roland-Gosselin along with the more correctly established diagrams of later workers. This arrangement occupies space at the expense of clearness. The placing of the diagram on the page might also have been done to better advantage. As an example, on page 110 the copper-nickel diagram is given under the paragraph heading silver-zinc, and the diagram for this pair of metals is given on the following page under copper-tin.

In the explanation of those diagrams in which a concealed maximum exists, the changes in concentration are not clearly followed and in at least one case inaccurately given.

The chapter on iron-carbon alloys is clear, concise and well illustrated with excellent reproductions of photomicrographs.

Henry Fay

SCIENTIFIC JOURNALS AND ARTICLES

The contents of *Terrestrial Magnetism and Atmospheric Electricity* for September are: "Pocket Compass Sun-Dial of 1451" (frontispiece); "The Earliest Values of the Magnetic Declination," by L. A. Bauer; "On the Distribution of Magnetism over the Earth's Surface," by P. T. Passalskij, translated by Paul Wernicke; "Report on the Atmospheric Electricity Observations made on the Magnetic Survey Yacht, *Galilee*, 1907–8," by P. H. Dike; Letters to Editor; Notes; Abstracts and Reviews; List of Recent Publications.

THE RULE OF PRIORITY IN ZOOLOGICAL NOMENCLATURE[1]

Disapproval was expressed of the extreme application of the rule of priority, which in the author's opinion had brought about much mischief under pretence of aiming at ultimate uniformity. The author protested against the abuse to which this otherwise excellent rule had been put by some recent workers, encouraged as they were by the decision of several committees who had undertaken to revise the Stricklandian Code, elaborated under the auspices of the British Association in 1842. The worst feature of this abuse is not so much the bestowal of unknown names on well-known creatures as the transfer of names from one to another, as we have seen in the case of *Astacus, Torpedo, Holothuria, Simia, Cynocephalus,* and many others which must be present to the mind of every systematist.

The names that were used uniformly by Cuvier, Johannes Müller, Owen, Agassiz, Darwin, Huxley, Gegenbaur, would no longer convey any meaning, very often they would be misunderstood; in fact the very object for which Latin or Latinized names were introduced would be defeated. It is all very well to talk of uniformity in the future, but surely we must have some consideration for the past. Names with which all general zoologists anatomists and physiologists are familiar should be respected, should be excepted from the rule in virtue of what may be termed the privilege prescription.

If biologists would agree to make that one exception to the law of priority in nomenclature things would adjust themselves well enough, and we might hope to see realized some day what we all desire, fixity in names, that we may readily understand the meaning of all writers, not only over the whole civilized world, at the present day and in the future, but back into the last century, which has marked so great an advance in zoological science. Such a result would be attained by protecting time-honored names of well-known animals from the attacks of the revisers of nomenclature. For this purpose future committees that may be convened to discuss these topics might confer a real and lasting benefit on zoology by determining group by group, which names are entitled to respect, not, of course, on the ground of their earliest date or their correct application in the past, but as having been universally used in a definite sense.

This suggestion is not a new one. As far back as 1896, in a discussion which took place at the Zoological Society of London, Sir Ray

[1] Abstract of a paper by G. A. Boulenger, F.R.S., presented at the Dublin meeting of the British Association.

Lankester, protesting against the digging up of old names, suggested that an international committee should be formed, not to draw up a code of rules, but "to produce an authoritative list of names—once and for all—about which no lawyer-like haggling should hereafter be permitted. Twelve years have elapsed, and nothing of the kind has been arranged. On the contrary; the various committees that have legislated since have insisted on absolute priority, and we often read that such a decision has been arrived at by international agreement. It is not so, a great body of zoologists in this country protest, and hope that something will be done towards carrying out the proposal here briefly set forth, which seems to be the only proper step to take in order to prevent the confusion with which we are menaced.

SPECIAL ARTICLES

SOME RESULTS OF A SERIES OF TESTS MADE BY THE WIRE-BASKET METHOD FOR DETERMINING THE MANURIAL REQUIREMENTS OF SOILS

A number of methods for determining the manurial requirements of any given piece of land have been proposed from time to time, since it is well known that the mere chemical analysis of a soil often fails to be of real value in this connection.

One of the most reliable methods consists in making actual field tests with various fertilizers applied in definite amounts to plots of land of equal size, one or more of the plots being left untreated to serve as a check. The effect of the various manures applied is measured in terms of the crop harvested, and thus the requirements of the soil for specific forms of plant food is made evident. The chief objection to this method is that climatic conditions are not always favorable for the best results in any one season, in addition plant diseases and insect pests may be active, hence it often happens that it becomes necessary to conduct the field experiments for a number of years before definite conclusions can be reached.

During the year 1904, the Bureau of Soils of the United States Department of Agriculture, devised a promising method for ascertaining the manurial requirements of soils. This has been published as Circular 18, Bureau of Soils, "The Wire-Basket Method for Determining the Manurial Requirements of Soils." Briefly, it consists in treating samples of the soils in question with definite amounts of various fertilizers, and placing the treated soil samples in wire-baskets which are then coated with melted paraffin, and growing wheat in the soil in these baskets for short periods of time. The amount of water transpired by and the green weight of the plants are taken as indicative of the requirements of the soil for specific manurial constituents. The value of the method consists largely in the fact that results can be obtained in a period of two or three weeks.

In the early part of 1908 the writer was requested to make a series of wire-basket tests of soil samples from Boydton, Va.; these samples were taken on a farm, the property of the Boydton Institute. The soil of this region is characterized by one who has worked it for a number of years, "as having tilling qualities of about the average for a heavy clay soil . . . if plowed at the proper time, subsoiled and kept stirred it presents no unusual difficulties." The two soils represented by the following samples are undoubtedly of the same character, and differ from each other mainly through the different treatment which each has received.

A rough mechanical analysis of one of the samples (*a*) by the beaker method, made in this laboratory, gave the following result: Sand 29 per cent., clay 18 per cent., silt 53 per cent. A deficiency of humus was shown by the small amount of volatile matter present (4.76 per cent.) and by the absence of a dark color in the soil. By actual determination the amount of humus was found to be 1.40 per cent. The gravel was found to be composed mainly of quartz.

Two samples of soil were used in making these tests, designated as (a) and (j), having the following history: (*a*) "East end of corn lot on the 300-acre tract. Cleared about

1887. Cropped with corn and oats (poorly) every second or third year and idle between. Fertilized 1907 with a cheap corn fertilizer. Yield 10 to 12 bushels of corn per acre."

(j) "Cherry tree lot, west of campus. Probably cropped since 1894. Was once part of the campus. Cropped with corn and potatoes, alternately, clover and oats also planted twice, potatoes in 1906, millet in 1907, but failed because of drought. Some sweet potatoes planted there in 1907 but were also poor because of the dry season. Corn yielded there about 40 bushels to the acre. None of this land has been fertilized more than twice in thirty years and then with wood ashes or a cheap commercial fertilizer."

These soil samples were subjected to the following treatment: The air-dry soil was rolled with a small wooden roller to crush the lumps and sifted through a sieve having meshes of 2 mm. Three-pound portions of the pulverized soil were each placed in a separate tray moistened with distilled water and treated with various fertilizers.

In the case of sample (a) to portion I. was added nitrogen, as nitrate of soda, at the rate of 200 lbs. to the acre; and phosphorus, as acid phosphate (containing 14 per cent. of soluble phosphoric acid) at the rate of 600 lbs. to the acre. Portion number II. received nitrogen, as sodium nitrate, at the rate of 200 lbs. per acre, and potassium, as sulphate of potash at the rate of 200 lbs. to the acre. Number III. received phosphorus, as acid phosphate (14 per cent. soluble phosphoric acid), at the rate of 600 lbs. to the acre; and potassium, as sulphate of potash, at the rate of 200 lbs. to the acre. Number IV. received nitrogen, as nitrate of soda, 200 lbs. to the acre; phosphorus, as acid phosphate (14 per cent.), 600 lbs. per acre; and potassium, as sulphate of potash, 200 lbs. per acre. Number V. received the same treatment as number IV., and in addition calcium, in the form of slaked lime, at the rate of 2,000 lbs. per acre. Number VII. received nothing and served as a check.

Soil sample (j) was divided into five three-pound, portions. Numbers I., II., III. and IV. received precisely the same treatment as did numbers I., II., III. and IV. of sample (a). Number V. served as a check and was left untreated.

All of these various portions were allowed to remain in their respective dishes for several days, with occasional stirring and moistening in order to thoroughly distribute the fertilizers. Then, as nearly as could be judged, enough distilled water was added to each portion to supply the optimum or most favorable moisture content for plant growth, which according to Hilgard, is equivalent to from 40 per cent. to 60 per cent. of the water capacity of a soil. Each portion was divided into three approximately equal parts, and each part was placed in a wire basket; these baskets were of standard dimensions, 3 inches in diameter, 3 inches deep, mesh 3 mm., and contained about 1 pound of the prepared soil, which was well pressed into the bottom and sides of the baskets. The baskets containing the soil were then repeatedly dipped into a bath of melted paraffin-wax until a good coating was obtained. Six germinated kernels of wheat were planted in a row in the soil of each basket and a thin layer of clean white sand was placed on the top of the soil. The filled baskets were then weighed and placed in a greenhouse where favorable conditions for growth were maintained.

When the wheat plants had reached a height of about two inches enough distilled water was added to each basket to bring the weight up to the first weighing, and a paraffined paper disk was fitted about the stems of the plants and sealed to the sides of the basket by means of a small amount of melted paraffin-wax. By this device all escape of moisture from the soil was practically cut off except by way of transpiration through the plants. The baskets were again weighed, and thus the optimum weight was ascertained. The baskets were then returned to the greenhouses and maintained under favorable conditions for growth.

The amount of water transpired by the plants was ascertained by weighing each basket at intervals of three or four days.

After each weighing enough distilled water was added to bring the weight slightly above the optimum.

The experiment with sample (a) was carried on for fourteen days after the baskets were sealed. With the sample (j) the test was conducted for eighteen days. At the end of these periods the green plants were cut off close to the paper disks and weighed.

The following table gives a summary of the results of these tests.

SOIL SAMPLE (a)

Series Three Baskets Each	Fertilizing Constituents Added	Total Water Transpired. Grams.	Weight of Green Plants. Grams.
I.	Nitrogen and phosphorus	134.9	2.796
II.	Nitrogen and potassium	165.2	3.840
III.	Phosphorus and potassium	102.0	2.130
IV.	Nitrogen, phosphorus and potassium	129.6	3.083
V.	N, P, K and calcium	144.4	3.445
VI.	Calcium	102.3	1.850
VII.	Blank, nothing	112.3	1.880

In this table a comparison of series I. with IV. and of I. with II. indicates a lack of potassium in the soil. A comparison of II. with IV. and of II. with III. shows but little, if any, deficiency of phosphorus in the soil. A comparison of III. and IV. and of III. with II. clearly shows a deficiency of nitrogen in the soil. With regard to calcium in the form of lime a comparison of VI. and VII. indicates that lime alone is of little or no value. It is of interest to note here that the actual application of lime alone to this soil under field conditions did not give any increase of crop. But, as is well known, the application of lime alone will give poor results on land deficient in nitrogen and in mineral constituents, especially potassium compounds. A comparison of V. and IV. indicates that lime used in conjunction with mineral fertilizers may be of value on this soil. In this table, as well as in the following one, it is noteworthy that the amount of water transpired keeps pace with the weight of the green plants; that is, the larger the green weight of the plants the greater is the total transpiration.

SOIL SAMPLE (j)

Series Three Baskets Each	Fertilizing Constituents Added	Total Water Transpired. Grams.	Weight of Green Plants. Grams.
I.	Nitrogen and phosphorus	160.5	2.970
II.	Nitrogen and potassium	212.5	4.278
III.	Phosphorus and potassium	146.7	2.632
IV.	Nitrogen, phosphorus and potassium	203.2	3.841
V.	Blank, no fertilizer	196.8	3.295

In this table a comparison of series I. with IV. and of I. with II. shows a deficiency of the soil in potassium. A comparison of II. with IV. and of II. with III. does not indicate a lack of phosphorus; in fact, it raises the question as to whether or not the acid phosphate may have done actual harm in the case of III. With regard to nitrogen a comparison of III. with IV., with II. and with I in turn shows a deficiency of this element.

On the whole the results of tests with samples (j) agree with the results of those with sample (a). Though from these tests sample (j) would seem to be in a better chemical condition than sample (a), in that (j) responds less readily to treatment with fertilizers than does (a). Compare VII. of Table (a) with the other series of Table (a) and V. of Table (j) with the other series of Table (j). A bit of evidence bearing out this contention is to be found in the statement that soil (j) has actually yielded 40 bushels of corn per acre while soil (a) has given but 10 to 12 bushels of corn to the acre.

From all these tests it appears that the soil of the Boydton Institute is deficient mainly in nitrogen and potassium and in humus. As a result of these tests and in view of the difficulty of obtaining a sufficient supply of farmyard manure at Boydton, the writer has advised the use of green manuring, for this purpose turning under cow peas, or crimson clover, to be stimulated by the application of potassium, in the form of muriate of potash, and small dressings of available phosphates.

The president of the Boydton Institute, Mr. John R. Hague, at whose instigation these experiments were made, has agreed to conduct at Boydton field tests which shall be comparable to these wire-basket experiments. The main crops to be grown are corn and wheat.

Frank T. Dillingham
Bussey Institution,
Harvard University,
April, 1908

SUDAN III. DEPOSITED IN THE EGG AND TRANSMITTED TO THE CHICK

In repeating the experiments reported by Dr. Oscar Riddle[1] in Science, June 19, 1908, p. 945, for the purpose of demonstration before the third session of the Graduate School of Agriculture of the United States, held July 6–30, 1908, at Cornell University, the results obtained by Dr. Riddle were confirmed; *i. e.*, Sudan III. fed to hens during the laying period stained red the layers of yolk deposited during the feeding of the Sudan. The amount of the stain used was much greater (20 to 25 milligrams at a dose) than Dr. Riddle for his special purpose found desirable, hence the yolks were strikingly colored, and always in concentric layers. Even when all the food eaten by the hen during the entire twenty-four hours was mixed with Sudan, the layers of the yolk were marked.[2]

In order to carry the investigation a step farther and to answer the question whether this coloring matter could be carried over to the chick, some of the "red eggs" were incubated, with following results:

1. As the yolk softened during the processes of growth of the embryo the layered mass became homogeneous and of a uniform pink. This was marked from the third day onward. For the first ten days the transparent embryo showed no sign of the color.

2. As soon as the developing chick began to deposit fat, at the seventeenth day of incubation, a minute mass of fat lying in the loose connective tissue between the leg and the abdomen was found with the characteristic pink color which depositing fat takes in adults fed with this stain. At this time the egg mass is of a nearly uniform dark red and almost enclosed within the body.

3. At hatching and several days thereafter the pink fat increased in amount, extending along the side of the sternum, the neck and head and finally appearing on either side of the back in the pelvic region. At the same time the yolk was losing its red color.

4. It was hoped that the peculiar fat of nerve fibers might take up some of this stain in the period during which myelinization is rapidly proceeding; but the nerve tracts showed only their usual glistening white.

To briefly summarize:

1. The specific fat stain, Sudan III., colors the fat laid down in the living hen and in the fatty portions of the yolk while the feeding experiments are in progress, and thus serves to give exact data concerning the time and amount of deposit.

2. The eggs so colored hatch, and the chick utilizing the yolk as food, produces fat in its own body colored as in the adult, showing in the most striking manner the transmission of a specific and unusual or foreign substance

[1] Riddle's paper was presented at the zoological meetings during convocation week at Chicago, 1907–8. He kindly gave to the authors personally the technique necessary for obtaining the colored eggs.

[2] If any of the readers of Science desire to experiment with Sudan III. the following hints may be of service: Sudan III. may be purchased of any dealer in microscopic supplies, *e. g.*, the Bausch and Lomb Optical Company, Rochester, N. Y. It is practically tasteless and the dry powder may be mixed with the food or it may be dissolved in olive oil and that mixed with the food. The dose is small (for a hen, 3 to 25 milligrams). The larger doses give more brilliant coloration. Water, glycerin and formalin do not dissolve either fat or Sudan III., hence watery solutions of glycerin and formalin are good preservatives of tissues containing the stained fat. The most satisfactory preservative found both for the eggs and for the entire animals containing colored fat is 5 per cent. formaldehyde. (Strong formalin 10 parts, water 70 parts.) Eggs are best prepared by boiling 15 to 20 minutes, then the shell is removed from the large end and the white and yolk cut off in thin slices, holding the egg and knife under water. Sections through the germinal disk are the most instructive. For permanent support and preservation of the prepared eggs glycerin jelly has been found satisfactory.

from the mother to the egg, and from the egg to the offspring, and thereby marking the transmission of the actual substance of the egg, and indirectly of the mother, to the offspring.

3. The precision of the method and its striking results apparently open to biologists a field which has lain dormant since its discovery by Daddi[3] twelve years ago, *i. e.*, the possibility of following with great exactness at least one of the processes of nutrition.[4]

Simon H. Gage
Susanna Phelps Gage

GEOLOGY AT THE BRITISH ASSOCIATION

The seventy-eighth annual meeting of the British Association for the Advancement of Science was held at Dublin, September 2 to 9, largely in the buildings of Trinity College and the Royal University. The Lord Lieutenant of Ireland, the universities, and the city cooperated to extend to the visitors a true Irish hospitality. In addition to the presidential address by Dr. Francis Darwin, popular illustrated evening addresses were delivered by Professor Turner, of Oxford University, on "Halley's Comet," and by Professor Davis, of Harvard University, on "The Lessons of the Colorado Canyon."

The mornings only were devoted to the reading of papers, the afternoon hours being wholly taken up by excursions and by elaborate social functions. In the sectional meetings an innovation was introduced in a large bulletin board set up at the front of each room, on which appeared "Papers Now Being Read." Beneath this were placed large letters to designate the individual sections of the association, and under each was a peg on which was hung up the number of the paper which at the moment was being read. A boy in attendance almost noiselessly received the telephonic messages at one end of the presiding officer's desk and adjusted the numbers on the board after the manner in use at American football games. The method proved a success, and might well be adopted by the American Association. As some of the section rooms were rather widely separated, an inter-section service of automobiles running at ten-minute intervals was instituted, but of its success the writer is unable to speak.

The invitation of the city of Winnipeg for the association to hold its meetings of 1909 in that city was brought by Dr. Bryce, vice-president of the Royal Society of Canada, and was accepted. The meetings will be held at Winnipeg during the last week of August and will be followed by an excursion through the Canadian Rockies by special train to Vancouver, B. C., with stops at Banff, Glacier and other intermediate points. To members of the British and American Associations the trip will be made for one fare, or $50, and an excursion from Vancouver to Alaska and perhaps to still more distant points is under consideration. To members of the American Association attending the meetings the usual dues of a sovereign will be remitted, and it is hoped that the occasion will be notable by reason of the large number of British, Canadian and American scientists brought together. As was the case on the occasion of the South African meeting of the British Association, a considerable number of distinguished scientists will be made the special guests of the occasion.

Section C (Geology) was well attended by representative geologists of Great Britain, and the distant dependencies of the empire were represented by Hume, of Egypt; Hayden, of India; Maitland, of Western Australia; Hatch, of South Africa, and Grabham, of the Soudan.

The address before the section was delivered by Professor John Joly, F.R.S., of Trinity College, Dublin, the president of the section, on "Uranium and Geology." It was an able and scholarly address dealing with the recent developments in the study of radio-activity as a factor in geological dynamics, and ascribing to it large importance in the explanation of the earth's interior heat and of mountain growth. Professor Joly's own studies in connection with the great Alpine tunnels, where he found the least quantity of radium corresponded to the greatest depth below the surface, he explained by the radio-active nuclei originally distributed fortuitously through the earth's mass, heating and expanding beyond the capacity of the surrounding material, and in consequence rising to the surface. It would thus seem that it is not necessary to assume such large quantities of radium to be still contained in the core of the earth as are now to be found in its outer shell.

[3] Daddi, in 1896 (*Arch. Ital. de Biol.*, T. XXVI., 1896, p. 143), was the first to show that fat deposited in the living body is stained by Sudan III. when ingested with the food.

[4] The authors wish to express their thanks to the staff of the poultry department of the New York State College of Agriculture for the abundant facilities and assistance placed at their disposal.

Dr. Milne, the veteran earthquake specialist, read a paper on "The Duration and Direction of Large Earthquakes," in which he called attention to an apparent tendency of large earthquake waves to travel farther to the west than to the east, and to an apparent difficulty which they encounter in getting across the equator. Professor W. M. Davis discussed "Glacial Erosion in North Wales," laying stress especially upon the prevalent corrie, the broad valley, and the hanging side valley, as undeniable evidences of the important eroding power of glaciers.

Dr. Tempest Anderson made a report upon "Changes in Soufrière of St. Vincent" based upon a recent trip to the island and upon his earlier visit made just after the great eruption of 1902. Of special interest are the changes observed in the torrent of hot mud which had filled the Wallibu Valley to a height in places of more than a hundred feet. The greater part of this deposit has since been washed away, fragments remaining, however, in a terrace 60 to 80 feet high on the north side of the valley. In general it may be said that in place of each of the earlier valleys there are now found two parallel valleys developed on either side of the mud streams which have filled them. Each present valley thus has for one of its walls the original valley wall and for the other a cliff cut in the ash of 1902.

Professor Lapworth contributed a report upon important revelations made by excavation through critical sections in Shropshire and North Wales. A very interesting case of thrust and crush brecciation in the Magnesian Limestone of County Durham was presented by Dr. Woolacot.

The most interesting feature of the meeting to the geologists was a formal symposium on the subject of mountain building, to which Professor Joly, Sir Archibald Geikie, Professor Lapworth, Professor Sollas and Professor Cole contributed. Professor Joly in opening the discussion focused attention upon the Alpine type of mountain, and credited largely to Professor Lugeon the discovery of the great overturned folds and thrusts of the northern Alps. Radio-activity was brought into the problem so as to connect the areas of mountain elevation with areas of sedimentation. The immediate surface rocks were of such richness in radium as to preclude the idea that a similar richness would extend many miles inward. Now as the sediments grew in thickness this original layer was depressed deeper and deeper, yielding to the load until at length it was buried to the full depth of the overlying deposit. Here the law of increase of temperature with the square of the depth came in, and the effect of the accumulated sediment was thus a reduction in the thickness of that part of the upper crust capable of resisting a compressive stress. Along this elongated area of weakness the crust found relief and was flexed upwards.

In continuing the discussion Professors Geikie and Lapworth took the ground that the revelation of Alpine structure must be largely credited to earlier geologists, and especially to Heim and Bertrand, whose observations and conclusions had been elaborated and very ably presented by Professor Lugeon. By Professor Lapworth mountains were discussed especially in relation to the plan of the earth, the distribution of the great mountain arcs, and the relation of the elevation of shores to the depression of the neighboring sea-bottom, in connection with which treatment he paid a glowing tribute to Eduard Suess.

Professor Sollas described a recent excursion which he had made under the leadership of Professor Lugeon in examination of the great overthrusts exhibited about the lake of Lucerne. The frequent location of active volcanoes at the rear of growing mountain ranges—on the side from which the overthrust was exerted—was explained by the use of Willis's law of competency of structure. The elevation of a competent layer of rock relieved the pressure from underlying rock material, thus allowing it to fuse and shift laterally in the direction of the rear of the fold.

The numerous excursions of the geologists to points in the vicinity of Dublin were most instructive and offered greatest interest to students of structural geology. The excursion of Saturday to the Skerries under the leadership of Dr. Matthies afforded the opportunity of examining a section which revealed in great perfection all the common types of folds, including small recumbent folds and overthrusts. The relation of gashing and healing to the position of arches and limbs was strikingly brought out. Professor Cole and Mr. Seymour conducted another all-day excursion to the Devil's Glen and Glendalough through some of the most picturesque sections of County Wicklow. Here the contact zones of great batholiths of granite in surrounding shistose rocks were well displayed. Other interesting excursions were conducted by Professor Reynolds and Mr. Muff.

Wm. H. Hobbs

University of Michigan,
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DEMOCRACY AND SCHOLARSHIP

THE most noteworthy fact in nineteenth century history is the onward sweep of democracy. It has shown itself not only in the formal establishment of republican forms of government, but in the virtual establishment of the power of the people in countries where aristocratic and monarchic forms of government have been maintained. Broadly speaking, democracy has established itself in many directions, if not in the complete absorption of political power, in monarchic England and in imperial Germany, as truly as in the republican United States of America. It has made its way sometimes by violence, as in the revolutions which in the middle part of the last century agitated various countries of Europe; but, generally speaking, its greatest progress has been by agitation, education and constitutional methods. Nor is the movement stopped. It is rather going on with increased momentum. The world is destined to see more democracy among a larger number of people and over still wider areas and in more countries than is the case now. The masses are demanding a wider recognition, through a more extended suffrage, in Germany, in Portugal, in Austria-Hungary, in Russia, in Persia and in India. Indeed, they have already won it in Austria-Hungary, and it is unlikely that the worn-out machinery of the old Russian government can stand much longer in their way.

Democracy has not won its way, however, without arousing a good deal of criticism and many somewhat doleful prognostications of the evils that its success will surely bring in its train. There are prophets, not a few, crying in the wilderness of exploded political and social conditions that the success of democracy means the decay of refinement, the destruction of the higher ethical, intellectual and spiritual motives and ambitions; and the substitution of the gray gloom of mediocrity, in all departments of life, for the brilliant, if sometimes flaunting, diversity and exuberance of talent and activity that are fostered in the supposedly more genial atmosphere of an aristocracy. Nor are these critics of democracy so unimportant as to deserve scant attention. It is not necessary to go back to the great names of Aristotle and the many other critics, who, during the dark period of the suppression, or non-existence, of democracy found the richest and best of human existence in its absence. Within the limits of the nineteenth century we find many brilliant names in the list of those who deprecate the success of the democratic movement, and insist that the richest fruits of civilization can not be gathered in a democratic society.

It is doubtful whether we can find a more incisive presentation of the comparative merits and demerits of aristocracy and democracy in the literary pyrotechnics of Lecky, the crystal clear and cold presentation of Matthew Arnold, the dispassionate scientific exposition of Herbert Spencer, or the historical ponderosity of Sumner Maine, than is given in the simple but brilliant passage from De Tocqueville in which, while displaying an affectionate regard for democracy, he dwells with a lingering fondness on the advantages of aristocracy. He remarks:

If it be your intention to confer a certain elevation upon the human mind, and to teach it to regard the things of this world with generous feelings; to inspire men with the scorn of mere temporal advantages; to give birth to living convictions, and to keep alive the spirit of honorable devotedness; if you hold it to be a good thing to refine the habits, to embellish the manners and cultivate the arts of a nation, and to promote the love of poetry, of beauty and of renown—if you believe such to be the principal object of society, you must avoid the government of a democracy. But, if you hold it to be expedient to divert the moral and intellectual activity of man to the production of comfort, and to the acquirement of the necessaries of life; if a clear understanding be more profitable to men than genius; if your object be not to stimulate the fruits of heroism but to create habits of peace; if you had rather behold vices than crimes and are content to meet with fewer noble deeds, provided offences be diminished in the same proportion; if, instead of living in the midst of a brilliant state of society, you are contented to have prosperity around you—if such be your desires, you can have no surer means of satisfying them than by equalizing the conditions of men and establishing democratic institutions.

Of all the theoretical criticisms that have been directed, or are now directed, against democracy, we are concerned for our present purpose only with that which alleges the hostility of democracy to scholarship and its manifestations in culture, literature, art, poetry and philosophy—the intellectual and spiritual essence of civilization. We turn, therefore, to inquire a little more closely into this so-called incompatibility.

It is asserted with much show of logic and much parade of evidence that democracy and scholarship are irreconcilable. The brilliant critic of democracy in America in its early days has remarked that high scholarship can not flourish in a democracy, since the desire of democracy is to utilize knowledge and not to discover it. He asserts that the pure passion for knowledge "can not come into being and into growth as easily in a democratic as in an aristocratic society, for the reason that men's minds are in a constant state of agitation in a democracy, that prolonged meditation is impossible, and that men are more intent on knowing what will be of material benefit then on discovering truth from the love of it." One defendant of democracy, overwhelmed with the sense of its failure in this respect, tells us that "aristocracy distributes political power and rewards in favor of intelligence and at the expense of justice; democracy distributes them at the expense of intelligence, while trying, perhaps unsuccessfully, to satisfy the claims of justice."

It is hardly worth while to spend time criticizing the somewhat preposterous statement that aristocracy favors culture more than democracy. For, in the first place, aristocracy as a form of government and of society has had a far longer lease of life in the world's history than has democracy, so that a fair comparison can not be made. Moreover, we certainly can not say that the members of any aristocracy have been the developers of culture, or its exponents. It is probably true that more of them have been devoted to the racing track than to poetry and art, and to the exploitation of the rest of society by war and government than to the promotion of their interests by letters and the arts. The long list of names great in science, art, poetry, literature and philosophy is composed largely if not mainly of those of poor men of the middle or lower class. The only sense in which it can be claimed that an aristocracy is favorable to culture is that its members act as patrons of culture and have aided its devotees. But the claim is too great, if it is meant to be exclusive. The heroes and martyrs of civilization have as often gnawed crusts and fed on crumbs as they have sat at the banquet table of aristocracy as equals. What aristocrat paid for the Acropolis? Was it the classes or the masses that inspired Watt, Fulton, Shakespere, Milton, Kant, Voltaire?

When one sits in that little room in Dresden and feels stirring within himself the spiritual ideals of a hundred generations of his race, is he to feel grateful to any aristocracy or to any aristocrat for the immortal work of Raphael? Is it not rather true that that great work is the expression of the spiritual ideals and life of the common people and that it was made possible by the beneficence of that great democratic institution, the Roman Catholic Church? The possession of wealth, whether in railroad bonds or broad acres, does not prepossess its owner in favor of culture. That is a matter of the spirit. If the spirit is present the leisure that wealth gives aids, to be sure, but it never can create, culture.

Later prophets warn us that democratic materialism, commercialism and the demand for the practical are killing pure science and throttling literature. But yesterday a Cassandra voice in our midst announced that there is no scholarship in this democratic country of ours, and a representative of a people, many of whom like to claim that there is no scholarship but among themselves, proposes to promote it here by killing off two thirds of the professors in our university. When these critics are told to look about them and see what this democratic people of ours is doing to promote higher education and to stimulate scholarship and research by their great public school system and their state universities, unable to deny the facts, they take refuge in a subterfuge. They tell us, as an eastern university president did, not long since, that while it is true that many of the states are promoting higher education, it is a kind of higher education which is not consonant with, but antagonistic to, culture. We are told that the state universities may develop practical education, that from them we may look for great results in engineering and in agriculture, and in all those matters which are sometimes criticized as "bread and butter" studies; but for things of the spirit, for the cultivation of intellectual independence, for the pursuit of knowledge which seems to have no direct utilitarian application, we must look to those institutions which depend for their existence on private beneficence; that only here, free from the agitation and the tyranny of a democratic majority, can we hope that the pure light of learning will be kept burning. This line of criticism involves two assumptions, the mere statement of either one of which makes the whole position ridiculous. If the criticism be true, then it must be that the choice spirits are to be found at endowed universities only, that by some irresistible attraction they find their way to those institutions of learning to the loss of those which are supported by public money; or else it must be that the people, the democratic majority, refuse to have culture in their state institutions, an assumption which by no means is justified by historical facts or *a priori* theory.

In spite of all these criticisms, however, democracy is reaching out and taking possession of the field of higher education. "Those who believe that the practical instincts of men, as witnessed in a long stretch of history and over a broad area of political existence, do not easily go wholly wrong; and that in the case of a conflict of practical life with theoretical criticism the latter is most apt to be at fault, will be likely to demand a revision of theory" (Dewey). In view of this fact, I venture to put forward and to defend the thesis, not only that democracy is not incompatible with high scholarship in any line, but that, on the contrary, the cultivation of scholarship by democracy is necessary to its stability, progress and perpetuation. I assert that, using scholarship in a broad sense, the permanent interests of developed democracy demand that the pursuit of knowledge shall be made in its own interest, by its own servants, supported by itself, to the end that knowledge shall not be made to subserve the purposes of a class, but become the general property of the community for the promotion of its material, intellectual and spiritual well-being.

There is truth in the charge that scholarship has not developed in the United States, which may be regarded as a representative modern democracy. It is true that we are suffering now-a-days from an excess of materialism, from the arrogant assertions of positivistic science over imagination and spirituality; from the subjugation of idealism to realism, and from the too great importance attached to mere material prosperity. But it is not alone the greatest democracy of the world that is thus suffering, although perhaps it suffers more than others. The condition exists throughout the civilized world, and we hear protests against materialism from the apostles of the ideal in every country, whether monarchic, imperial or democratic. It is a passing phase of civilization. Civilization does not move forward equally in all directions at the same time. It develops first on this line, then in that direction, and later on still another plane. The great geographical and industrial discoveries of the past century have put emphasis upon material growth for the present, and the light of things spiritual seems low by contrast. But that light has not gone out. Mankind has seen similar conditions before, and now, as hitherto, they are but temporary.

For, in the first place, in the United States particularly, men have been obliged by the conditions attached to life in a new country to devote themselves to the pursuit of economic success. A nation, like an individual, can do only one great thing at a time. Our work during the first century of our existence was that of the conquest of a continent. In the second place, democracy has not until lately joined itself with the educated classes for the promotion of scholarship, because it has distrusted scholars and scholarship for the reason that in the past they have been the allies of aristocracy. They have, in large measure, walked hand in hand with the oppressors of the people. The educated classes have chosen to identify themselves with the propertied classes rather than with the propertyless classes.

The truth is that most of the criticisms of democracy are founded on a misconception of its character and of its mode of declaring its will. Certainly, its most recent critics, like Mr. Lecky, Mr. Maine and Mr. Mallock, have confounded democracy with universal suffrage, which is a condition of democracy, but is not all of democracy; and then have misinterpreted the nature and effect of universal suffrage. "One of the great divisions of politics in our day," says Mr. Lecky, "is coming to be whether, as the last resort, the world should be governed by its ignorance or by its intelligence. According to the one party the preponderating power should be with education and property. According to the other the ultimate source of power, the supreme right of appeal and of control, belongs legitimately to the majority of the nation told by the head—or, in other words, to the poorest, the most ignorant, the most incapable, who are necessarily the most numerous." I deny that either experience or theory drives us to any such conclusion. I assert that universal suffrage does not make necessary the predominance of ignorance, nor democracy insistence upon intellectual equality. As Professor Giddings has truly put it: "It is not true that control by the ignorant implies the rule of ignorance." The expression of the will of a democratic people is the expression of a consensus of opinion. It is not simply the sum, or the difference between two sums, of single individual opinions each formed without reference to any other. The vote of a democratic people reflects a consensus of opinion and judgment originated and molded by their leaders. Hence, even if we should grant that democracy means the decision of matters by the mass of ignorant voters, it does not follow that their decision would be an ignorant decision.

Democracy may be either a form of government, or a form of the state, or a form of society. As a form of government it places direct control of all government matters in the hands of the whole body of voters, and no such government exists on a large scale. As a form of the state, democracy acts through representatives and its government is republican, like our own. As a form of society, democracy lodges ultimate power in all matters of societary character and interest in the hands of the whole body of the people. There is no need of a discussion of these differences here. For our present purpose we are concerned with democracy as a form of society and as a form of the state.

Democracy implies equality, but not necessarily equality of condition or status in all directions. It implies equality of civil and political rights. It may claim a closer approximation than we now have to social and economic equality. But it is not true, even in the United States, as De Tocqueville thought, that "the theory of equality is in fact applied to the intellect of man."

The observations of De Tocqueville were made at a time when democracy in this country was socially and economically homogeneous. At that time the economic condition of one citizen was approximately the same as that of another, and equality assumed the aspect of identity or sameness of condition in all respects. In a highly developed or heterogeneous society, like our present, however, conditions are different. Here we find classes performing different services to the community and securing unequal rewards in proportion to the importance of their class functions. It is essential for the preservation of democracy, that under such conditions equality of opportunity to pass from one class to another shall remain absolutely open to all individuals. Great inequalities of material wealth are not incompatible with democratic government, or democratic society, but the pursuit of wealth as the principal object of the members of that society and its adoption as the criterion of personal success and worth, are a danger to democracy. It is necessary, therefore, to have tests of success and ideals of life, in addition to those of a mere economic character. Hence, we must have a variety of social classes in different important pursuits, success in each of which is as well thought of by the people and is as well rewarded by public applause as success in any other, and the opportunity to pursue any one of which is equally open to all. It is true, therefore, that in a democracy there is room for a class of scholars as well as for a class of carpenters. But it is not enough for my purpose to say that there is *a place* for scholarship in the democratic scheme. We must show the need for it and show that scholarship will supply the need.

Intellectual and spiritual inequality are established by nature, and no form of society can do away with them. Now the preservation of opportunity to secure equality of status in intellectual and spiritual matters, depends on the existence of an accessible class whose service is the promotion of scholarship and research and who are devoted to the service of the public. For, in the first place, the existence of this scholarly class and the promotion of scholarship will open up ever new lines of industrial opportunity and will therefore tend to prevent the permanent lodging of the power of wealth in any one group, since the poor man of to-day may be the rich man of to-morrow.

In the second place, and of far more importance, the promotion of scholarship and the existence of a scholarly class will furnish the true leaders of democracy. For the destiny of democracy will be determined, in the last analysis, by the character of the influential few who mold public opinion. The people demand and follow leaders. No race and no class can make progress without them. The opportunity for the talented to become leaders should be furnished, therefore, by a democratic society. The scholar is and should be the pioneer of such a society to discover new lands for democracy to possess; its frontiersman, to push forward the boundaries of its life, to enlarge the possibilities of its prosperity and happiness, to leaven its mass and create the conditions of a changing type of democratic citizenship. The pioneer discoveries of the scholar become in time the substance of the education and life of the democratic masses. As the problems of democracy become more numerous and complex the need for such leadership is more keenly felt. In its absence, caused in part by misunderstanding and distrust of those who are devoted to higher education, the people have turned to that curious and contemptible product called the "boss." But the boss can not always retain his leadership. He will retreat before the advance of intelligence. What is necessary is a proof that the scholar is a more honest and competent guide than the boss, and signs are not wanting that the public is learning to have more confidence in him. In short, if a democracy is to be stable, progressive and permanent, it must itself provide educational facilities which will maintain and improve its material prosperity; educational facilities which will train men to uphold its political, ethical and intellectual ideals and to improve upon them by pushing forward the boundaries of knowledge by the discovery of new truth. It must train for its own leaders all who are capable of serving as such in any line of human activity or thought. This necessity involves the frank recognition of the fact that the doctrine of equality, which underlies democracy, can not be applied in the same sense in all directions. It means equality of status in civil and political matters, but not equality in economic condition, and, still less, in intellectual matters. Democracy will find its safety and growth only in a frank acceptance of the intellectual inequality of men, the selection of the superior as its leaders, and the provision of men and means to train these leaders as experts in its service in every line of its wants, including those whose special interest shall be the development and preservation of the intellectual and moral ideals and standards of the democracy. Unless it does this it will become the prey of the demagogue and of corrupt wealth.

But what kind of scholarship should a democracy support and in what ways can scholarship be shown to meet those needs of progress and leadership which I claim are necessary to the stability and permanence of a democratic society? By scholarship in this connection I mean not only the wide and deep knowledge of a particular subject, but the power to add new truth to the world's stock of knowledge which commonly goes under the name of research.

There is an idea not infrequently expressed that a publicly supported system of education, whether grade schools or universities, ought to be more concerned with those studies which are likely to contribute immediately or directly to earning a living than with those which have no immediate or direct connection with the acquisition of the material good things of life. I have already adverted to this thought, and I shall try in a moment to show that it is entirely without foundation, and that the continued success of a democracy not only permits but requires devotion to the pursuit of the most abstract sciences and the loftiest flights of imagination as well as to those more concrete subjects whose advance ministers to the immediate prosperity of an individual, a class or a community.

In considering this subject De Tocqueville roughly grouped all subjects of scientific pursuit into those which are theoretical, with no known application, those which are theoretical but whose study is carried on because the immediate application of the theory is obvious, and finally, the applied or so-called practical studies.

Of the three divisions into which we may group the lines of scholarly research the utility to democracy of what may be called practical scholarship and research is so obvious that we need not discuss it at length. This division of our subject comprises research in all those practical subjects which minister directly to the economic wants of the people. It comprises the whole group of applied sciences, including those engineering and agricultural subjects which have taken so prominent a place in our recent educational development. It is commendable and necessary to study how to make two blades of grass grow where one grew before, how to improve our soil so that the product of the acre shall continue to feed the growing multitude of the city and at the same time increase the profit of the farmer; how to harness the forces of nature to complicated machinery so that sufficient food and clothing shall be put within the reach of all. These things, I say, are desirable and necessary, and it is natural that a new community with unaccumulated wealth should for a time devote all its energies to their accomplishment and promote the studies which accelerate them. No defense, therefore, is needed for the promotion of applied science at the public expense in a democratic community.

What shall we say, however, to justify the expenditure of public money to support people and supply means for inquiry into the abstract subjects of philosophy, mathematics, literature, history, psychology and similar studies, which, in the opinion of the masses and of most of the classes, are of "no use" and no direct utility to them? In the first place, we may say that there is no necessary conflict between such branches of study and the other group which we have just discussed. If there were, who would undertake to say which is the more important—subjects which promote the material welfare of the people or those which create and uplift their spiritual and intellectual ideals? There are times in the life of the nation when a Tyrtæus is needed as a leader more than a Cæsar. There are times when the enthusiasm for righteousness, the passion for truth, ebbs so low in the lives of individuals and nations that their welfare and progress, even in an economic sense, can be best promoted by arousing them to new enthusiasm and stirring them to new ideals. A democracy, therefore, is not compelled to choose between this kind of research and the other, as if it could not do both; as if, forsooth, it were compelled to choose which god it would serve. In the long run, applied science, theoretical science, and the abstract studies of a more speculative character must stand or fall together in the life of the people.

For, in the first place, as I have remarked, these lines of scholarship run into each other. "All experience proves that the spiritual is the first cause of the practical." In the eloquent words of Walter Bagehot, the "rise of physical science, the first great body of practical truth provable to all men, exemplifies this in the plainest way. If it had not been for quiet people who sat still and studied the sections of the cone, if other quiet people had not sat still and studied the theory of infinitesimals, or other quiet people had not sat still and worked out the doctrine of chances, the most dreamy moonshine as the purely practical mind would consider, of all human pursuits; if idle star gazers had not watched long and carefully the motions of the heavenly bodies, our modern astronomy would have been impossible, and without our astronomy our ships, our colonies, our seamen, all which makes modern life modern life, could not have existed. . . . It is the product of men whom their contemporaries thought dreamers, who . . . walked into a well from looking at the stars—who were believed to be useless to the world; who, to the practical mind, were mere theorizers, but without whose theories, of the study of which we sometimes grow so impatient, the practical results which we desire could not be reached."

Who could have foreseen that Franklin's experiment with the kite, with numberless other experiments that to the practical mind of the time seemed mere boy's play, would result in the vast modern practical development of electricity?

There are not many men in the ordinary walks of life who have ever heard the name of Willard Gibbs. Yet there is no name entitled to a more honorable place in the world of learning in the long list of those connected with Yale University since its foundation. He devoted his life to the study of an abstruse subject called vector analysis. In his application of this method of mathematical investigation to the study of the relations between heat and the energy of chemical combination he contributed, in the words of Professor Ostwald, "untouched treasures in the greatest abundance, and of the greatest importance for the theoretical and experimental investigator, and revolutionized in some of its branches the theories of chemical science."

Last fall one of the professors of this university by chance read in French a folk lore story which, after some research, he found was common to the Scandinavian, the German, the Hebrew, and probably other, peoples. As a result of his investigation he read an important paper last December at the meeting of the Modern Language Association in Columbus, Ohio, trying to show that this story and the spiritual or ethical precepts underlying it were the common property of many nations. Was his time wasted? Can such an inquiry be of any use to the people of a democracy? I answer yes. It is of use for its own sake, because it reaches down and stirs again into activity the elemental feelings common to all nations, and leads them to think of the unity of the race and the oneness, if I may say so, of its basic, moral and intellectual ideas. It is defensible, too, on a lower, or utilitarian, ground. I can conceive of the use of the facts brought out by this investigation as a help in promoting the assimilation of the foreign elements of our population. One fact concerning our immigration, which more than any other stands in the way of rapid assimilation, is the feeling of separateness or alienation among thousands of the foreigners who are now coming to our shores. The Slav, the Magyar, the Italian, the Russian, the Jew, feels that there is nothing common to him and this new American life into the midst of whose hurly-burly he is thrust. The telling of a story which is the common property of many races, to a group of such foreigners, gives them a certain community of feeling and interest, helps to break down their feeling of separateness, and shows them that the distance between the emotional and intellectual nature of themselves and the native American is after all not so great. This is one of the keys to success in some social-settlement work.

The other day we laid at rest, with such poor honors as we could show, one of the gentlest spirits and most enthusiastic scholars of our group. Gustav Karsten had a passion for research in his chosen field. Although from my conversations with him I judge that he had no thought that his work was capable of any possible practical application, yet who shall say that in time to come his study of philology and his researches into the elements common to many languages and his study of phonetics, may not aid in producing a language that shall be the common property of the commercial world and promote that very practical life from which his subject of study was so far removed? It is not a new thing in experience for philological and historical research to produce political and practical, as well as scientific and literary, results.

But the study of abstract subjects has another defense than is found in the fact that they may unexpectedly contribute to the practical. Even a democracy has classes with spiritual and intellectual aspirations, and such studies tend to produce results that satisfy the desires and better the lives of some classes, at any rate, in the community. Now a democracy may not insist that public money spent on education shall be restricted to the kind of education that will benefit one class only. Every class in the community has a right to ask that its interests, the subjects to which its heart and mind turn, shall receive their due attention. To justify the promotion of scholarly study in cultural subjects, it is enough, therefore, to show that in a democracy there is a class whose happiness is promoted by such studies.

But we may place our argument on yet higher ground. The defense of the maintenance of scholarship in abstract and purely theoretical subjects rests not merely on the possibility that they will help us to more or better economic opportunities, or that they will satisfy the cultural demands of a class. Their strongest defense lies in the fact that a democracy needs to develop scholarship pure and simple, in the abstract—philology, art, philosophy, history, literature—in order to subserve wants that can not be satisfied by any other kind of knowledge. The satisfaction of the higher wants of a democratic people is necessary to prevent the decay of democracy. If any evidence of this were needed we see it all about us as a result of the too exclusive attention that we have thus far given to merely economic or material development. The present evils of our body social and politic are largely due to our over-emphasis of wealth, and the undue honor we have attached to the class that has supplied our economic wants.

Carlyle expressed a great truth when he said that the people would have leaders. Democracy needs ideals and leaders to sustain itself. Few people do their own thinking. Most inherit or borrow their beliefs. In the past the masses have taken their ideals and leaders from the class whose interests were not at one with their own or not primarily devoted to them. Democracy must train its own leaders, set up its own standards, establish its own ideals. The true life of a people is intellectual and spiritual. Material prosperity is a means, not an end. No democracy can endure which rests content with material prosperity. It must have as its ideals, intelligence, honesty, honor, service, all that makes character for an individual; liberty, fraternity and equality of opportunity, for public life. It can get and keep these ideals only if it provides means to men to gather for it the world's knowledge, to add to this knowledge, to set standards of public opinion and to stir the moral and spiritual nature of the people. We should have less occasion to-day for the denunciation of iniquitous wealth and we should see less of the betrayal of honor and trust in high places, if we had laid more emphasis in the last generation upon the necessity of knowledge in leaders of our people. We should have a better political and social policy if we had trusted more in the leadership of men who know the race life, its changing ideals, its history, its experiences, and its impulses. In the absence of such leaders the people, in their desire to be led, have turned, as they always will do, to the nearest demagogue who professes to be appointed to "prepare the way of the Lord."

What means now are appropriate for training such leaders and for setting up such standards of democratic life? I answer research, scholarship, in history, literature, philosophy and art—the records of human experience, the interpretation of human life, the analysis of human motives—to supply inspiration and formulate ideals that may be woven into the life of the people and become the intellectual and spiritual inheritance of the nation; to frame and furnish the ideas and impulses that shall be the substance of the common consciousness and find expression as the consensus of public opinion through political action in the formulation of law, creed and the general social order.

The nineteenth century was one of great material development whose activity has hardly yet slackened. If democracy is to endure, or is not to sink into a materialism like communism, the twentieth century must develop our legal, political, social and ethical ideals and institutions to a corresponding degree. In the absence of such development the only alternatives are the worship of materialism leading to the communistic or socialistic order, or the destruction of democracy by the propertied classes, who will not permit communism. For the prevention of either disaster the promotion of scholarship in every subject of study will help.

If any evidence were needed that democracy requires ideals and scholarly leaders we shall find it in the evils that we are suffering from in our present conditions. We are concerned with the necessity of solving certain great problems. The problem of poverty which is ever with us is crying constantly for a scientific and ethical solution. The problem of city government is one the treatment of which has made our democratic people the laughing stock of the world and has done more to discredit democracy and raise doubts about its future success and permanence than almost any other of its failures. The great problem of immigration with its necessity of assimilation of our foreign population and the consequent problems of the modification of our forms of government to adapt them to the spirit and race conditions of a new people, is looming large in the immediate future. The adjustment of class relations, our relations to the people across the sea whom we have recently tied to ourselves, the negro problem, the currency problem, the problem of taxation, whose present condition in almost every state in the union is a disgrace to the intelligence of the people—all of these are pressing on us for solution, and upon our success in solving them will depend the continuance of our republican institutions. To whom shall the people look for guidance? To the ward heeler and the boss? To the man in the street, as we have been doing, who wins a following by his glib eloquence? Or shall we turn to the men who have studied deeply into the history and the experience of other peoples in the lines in which these problems run? It is to the philosopher, the student of literature, the student of the social sciences, aye, to the poet and the artist as well as to the man with a sense of practical administration, to whom we must turn for proper ideals and correct principles, on which to solve these problems and handle these difficulties.

There are, indeed, some signs of a change from our practise of following ignorant bosses. We have put our federal bureau of corporations, our census bureau, many of the divisions of our department of agriculture and some other branches of our government service directly in charge of those who are scholars in their respective fields. One of the most prominent, if not the principal figure, of the American delegation at the recent Peace Conference was one of our group, known and honored for his scholarship in the subject of international law. It has been said recently that "no governor of a commonwealth can permanently command public confidence except he add to political shrewdness the gift of political idealism." And there is other evidence that "our country still aspires to be led by men who shall prove their claim for leadership not by concrete material achievements, but by their character and their ideals."

Thus, then, is the future progress and welfare and permanence of democracy bound up with its promotion of scholarship and research; the promotion of technical research for its material welfare; the promotion of research in the theoretical and abstract sciences and in the humanities, to furnish ideals and leaders, to satisfy its intellectual and spiritual needs. Democracy, if it thus supplies its own need for leadership, will not die. The equalization of power is destined to spread further than it has, in industry and government—in every direction. It will be better balanced because it will depend more on natural and trained leadership. In the past the masses have depended for leaders on the capable few whose interests were aristocratic, because they had no other choice; and the present distrust of scholarship is simply, in part at least, a revulsion from this coercion. They will depend again on a chosen scholarly few, and because they choose to do so they will provide for and command and control their services in the interests of all. They will create a scholarly class devoted to the service of the people, supported by the people, and entrance to which is free to all who have natural talent and the capacity. The masses will recognize more and more that while seeking greater equality in civil and political rights, in legal status, in industrial opportunity and condition, the natural inequality based on differences of capacity, ability and talent can never be eradicated; that, therefore, they must be utilized in the service of the people. That to be devoted to the service of the people they must be supported by the people and must be looked to as the source of supply of the ideals and the leadership needed to keep active the intellectual and spiritual life necessary to the permanence of democratic institutions.

We must not shut our eyes to the fact that scholarship supported by a democracy is subjected to some peculiar dangers. In the first place, the scholar can not command results, and there is danger that the impatience of the public for results will imperil the prolonged support necessary for the quiet meditation without which scholarship can not flourish at all. This danger can be met only by educating the public, and there are signs that the educative process has begun.

In the second place, scholarship supported by democracy is subjected to danger to liberty of thought and opinion—a danger to which the minority is always exposed from the tyranny of the majority. There is danger always that unpopular truth will be rejected and its advocates persecuted. True, there are some who believe that that danger is passing away. I do not share their belief. I see no signs that the tyranny of popular opinion is any less to-day than it ever was, or that there is likely to be greater liberty of opinion in the future than in the past. It is true, still, as it always has been, of all those who are in advance of their times and who hold the lamp of spiritual and intellectual truth aloft for the guidance of the people that

> The age in which they live
> Will not forgive
> The splendour of the everlasting light
> That makes their foreheads bright,
> Nor the sublime forerunning of their time.

There is no means of removing this danger, although, fortunately, "in the development of the policy of the great labor organizations, there are signs that the wage earners are learning the truth that liberty is the mother of progress." It is questionable, however, whether it is a more serious danger than befalls a scholarship supported by an aristocracy. There is as much danger that in the latter case truth will be colored to meet the ideas of the supporters of the scholars and their work, as that in the latter case it will be colored to curry popular favor. The duty of the scholar is plain—he must be the servant, not the slave, of democracy. He must have the courage of the seeker after truth. He must be ready, if necessary, to be a martyr to public opinion for the sake of the truth he finds. The scholar must see to it, too, that he does not yield to popular clamor and emasculate education by popularizing learning. He must ever "insist that studies which can never by any possibility be popular, or appeal even to any large number of students, but which have demonstrated their power to enlighten and to ennoble those who pursue them, shall not be given up in obedience to popular clamor, merely to make way for other things that seem to be of more immediate utility." Consequently, we must put in the curriculum of our graduate schools those subjects whose study best disciplines the mind and character, makes strong men, establishes high ideals; subjects the most abstract and far removed from the material needs of mankind, even though popular clamor in its mistaken zeal is against them.

The state of Illinois has taken a noteworthy step in the history of democratic government in appropriating money specifically for the support of a graduate school of the arts and sciences. It is evidence that the democratic people of Illinois believe that scholarship is necessary to progress, prosperity and the continuance of democratic ideals. Their act is evidence of the existence of at least a subconscious belief that only thus can the democratic institutions that have become endeared to us be made permanent. The public of this state has learned more rapidly, and in a way that the people of scarcely any other state has learned, the value of research in the arts and sciences, from the splendid success and service of applied science, particularly in agriculture and engineering. They are carrying the lesson over and showing that they believe that the satisfaction of the intellectual and moral needs of the masses is as important a matter for public support as their material prosperity, or economic progress. It is therefore a high trust that is committed to us. We are called on here to lay plans which will bear fruit in the enrichment of the spiritual and intellectual nature and life of the people of our state and country. We are called on to add to the sum of the world's knowledge in the name of and through the support of a democratic people, to the end that the world shall be a better world, that democracy in particular shall be able to follow truer ideals and reach a higher life than it can without such scholarship. We are called on to make the State University the center of knowledge and information for all matters relating to public life and private welfare, in the interest of the citizens, and to furnish them the means for their intellectual, ethical and spiritual growth.

David Kinley

University of Illinois

PROFESSOR WHITMAN AND THE MARINE BIOLOGICAL LABORATORY

Professor Whitman's services to biology as director of the Marine Biological Laboratory have been so notable and his retirement from that post is a matter of so much general interest that consent has been obtained to publish the following abstract from the minutes of the trustees of the laboratory:

University of Chicago

August 8, 1908.

To the Trustees of the Marine Biological Laboratory, Woods Holl, Mass.

Gentlemen: This year has brought the twenty-first birthday of the Marine Biological Laboratory. For these many years you have continued to honor me with the directorship of the laboratory. In late years I have so far drifted out of office and out of use that a formal resignation at this time can be scarcely more than an announcement of the fact accomplished. The time has arrived, however, when a reorganization seems to be imperatively demanded, and as a prelude thereto, I must ask you to accept this note as a somewhat belated announcement of my resignation of the office of director.

Let me take this opportunity to thank you one and all very heartily for the cordial support you have extended to me.

Respectfully,

C. O. Whitman

Marine Biological Laboratory
Woods Holl, Mass.,
August 13, 1908.

The corporation and trustees of the Marine Biological Laboratory, in accepting the resignation of the director, Professor C. O. Whitman, have ordered to be put upon their records and to be forwarded to Dr. Whitman the following minute:

The corporation and trustees desire to express to the retiring director their regret that he finds it necessary to withdraw from the active directorship of the laboratory and their appreciation of the inestimable value of his services. Since the establishment of the laboratory at Woods Hole, twenty-one years ago, he has been continuously its director and he has to a very large extent guided its growth and development. He has stood for the principles of cooperation and independence which have made the laboratory unique in its character and truly national in its influence. His high ideals and his generous appreciation of the work of others have been an inspiration to the many biologists who, during these years, have attended the laboratory. These ideals are the most valuable possession of the laboratory.

The corporation and trustees desire that the retiring director may continue to serve the laboratory as honorary director and trustee and that in the future as in the past his presence at the laboratory may continue to be an inspiration.

University of Chicago
August 17, 1908.

To the Corporation and Trustees of the Marine Biological Laboratory, Woods Holl, Mass.

Ladies and Gentlemen: Your action of August 13, in which you express a desire to have me serve the laboratory as "honorary director and trustee" is, in itself alone, an all-sufficient reward for whatever service I have rendered as director. Your *good will* is the all-important recompense, and no title that you could confer could add to the weight of your approbation. In fact, titles belittle the spirit. Let me have the latter without the former—without title or office of any kind. Please respect this wish and believe me, as ever, a sincere and devoted friend of the laboratory.

Respectfully and cordially,
C. O. Whitman

SCIENTIFIC NOTES AND NEWS

It is announced that the Berlin Academy of Sciences has received a legacy of 30,000,000 Marks (about $7,500,000), being the entire fortune of a millionaire named Samson, a Berlin banker, who recently died childless at Brussels.

The National Academy of Sciences will hold its autumn meeting in the physical laboratory of the Johns Hopkins University, Baltimore, beginning on the morning of Tuesday, November 17.

The navy department has received a letter from Commander Peary, dated from the *Roosevelt* on August 17, announcing his safe arrival at Etah, North Greenland. The trip so far had been satisfactory, and he expected to proceed north on that night.

Dr. Albrecht Penck, professor of geography at Berlin, arrived in New York on Saturday, and has this week begun his duties as Kaiser Wilhelm professor at Columbia University and Silliman lecturer at Yale University.

Professor Russell H. Chittenden, director of the Sheffield Scientific School of Yale University, has been appointed the university's representative at the Darwin celebration to be held at the University of Cambridge next June.

Dr. S. H. Babcock, of the University of Wisconsin, has been presented with a silver medal by the European DeLaval Separator Corporation of Stockholm, Sweden, in recognition of the distinguished service which he has rendered to the advancement of dairying. The medal, which was issued on the occasion of the twenty-fifth anniversary of the corporation, bears on one side the busts of Dr. Gustaf DeLaval, the inventor of the separator, and Sir John Bernstrom, originator of important improvements, and, on the reverse, figures of the genius of invention handing the separator to Mercury, the god of commerce, to be carried around the world.

Dr. A. Tingle, B.Sc. (London and Aberdeen), Ph.D. (Pennsylvania), has been appointed scientific adviser to the viceroy of the Province of Chili, China. Dr. Tingle's address is care of No. 5 Post Office, Ho Pei, Tientsin City, China.

The district foresters who will be in charge of the six field districts of the Forest Service, beginning on January 1, 1909, have been selected by United States Forester Gifford Pinchot. They are as follows: District 1, W. B. Greeley, Missoula, Montana; District 2, Smith Riley, Denver, Colorado; District 3, A. C. Ringland, Albuquerque, New Mexico; District 4, Clyde Leavitt, Ogden, Utah; District 5, F. E. Olmsted, San Francisco, California; District 6, E. T. Allen, Portland, Oregon.

Professor Harry Gideon Wells, dean of the Medical Department of the University of Chicago, will spend the fall in some special study and investigation at the Sheffield Physiological Laboratory, Yale University.

F. W. Foxworthy, who is connected with government scientific work in the Philippine Islands, has during the past summer been engaged in the study of the trees in Sarawak and the Federated Malay States. He intends to return for a visit to the United States in the near future.

Dr. E. R. Downing, of the Northern State Normal School, who has been studying the past year in the biological laboratories of Europe, has returned and may be addressed again at Marquette, Michigan.

R. B. Grieg, lecturer on agriculture at Marischal College, Aberdeen, and R. P. Wright, principal of the West of Scotland Agricultural College, at Glasgow, have been visiting the leading American agricultural colleges, with view to securing information to be used in improving agricultural education in Scotland.

The College of Arts and Sciences of the University of Maine announces for the fall semester a series of lectures on the history of science. Dean Hart will lecture on the history of mathematics, Dean Stevens on the history of physics, Professor Aubert on the history of chemistry, Professor Merrill on the history of biological chemistry, Professor Drew on the history of zoology, and Professor Chrysler on the history of botany.

Dr. Daniel Coit Gilman, professor of geography at Yale University from 1863 to 1872, president of the University of California from 1872 to 1875, first president of the Johns Hopkins University from 1875 to 1901, first president of the Carnegie Institution from 1902 to 1904, eminent for his services to higher education, died suddenly on October 14, at Norwich, Conn., where he was born on July 6, 1831.

The deaths are announced of Dr. Alexander Korkin, professor of mathematics at St. Petersburg, at the age of seventy-one years; of Dr. Alexis Hansky, associate astronomer in the Pulkowa Observatory, at the age of thirty-eight years, and of M. D. Clos, director of the Botanical Garden at Toulouse.

United States civil service examinations are announced as follows: On November 5, for biological chemist in the Bureau of Chemistry in the Department of Agriculture, at a salary of $1,200; on November 9, for chief of the cattle and grain investigation laboratory in the same bureau at a salary of $2,500, and for assistant in agricultural education in the Office of Experiment Stations, at a salary of from $1,400 to $1,800.

In the belief that our knowledge of comets may be considerably enlarged through a proper use of the opportunities presented by the approaching return of Halley's comet and the systematic observation of such other cometary phenomena as may be presented during the next few years, the Astronomical and Astrophysical Society of America has appointed a committee upon comets, consisting of Professors George C. Comstock, chairman, Edward E. Barnard, Charles D. Perrine and Edward C. Pickering. It is the purpose of this committee to canvass the whole field of cometary research, inquiring what parts of that field will best repay systematic cultivation at the present time and securing, so far as possible, cooperation in such research.

At the Johns Hopkins University two acres of ground at the new site have been devoted to a botanical garden. On this plot a greenhouse, 80 feet long, and a laboratory for plant physiology have been erected. An acre and a quarter of land has been laid out in four formal squares bounded by hemlock hedges. Within these squares are beds and pools which have been planted with some three hundred types illustrating the adaptation of vegetative organs of plants, the structure and cross-pollination of flowers and the dispersal of fruits and seeds. Next season other squares will be planted with a collection of economic plants. The greenhouse and laboratory are completed and will be occupied during the year by students doing research or laboratory work in plant physiology.

It is stated in *Nature* that to mark the completion of the fiftieth year of the existence of the Geologists' Association, it is proposed to issue a volume dealing with the geology of the districts of England and Wales visited by the association since its foundation. The work, which will be edited by Messrs. H. W. Monckton and R. S. Herries, will be illustrated by maps and sections, and be ready for publication, it is hoped, before the end of the present year. Orders for copies should be sent to the secretary of the association.

The annual meeting of the New England Geological Excursion will be on Long Island on October 24 to study the terminal moraine and other glacial and geological features. The party will start from New Haven, where arrangements for the transportation of the party will be made by the Yale geological faculty. Details concerning the itinerary, expenses, leaders, etc., will be sent to members of the organization in a few days. Geologists, not members, are invited and may obtain information by writing to the secretary, Professor H. F. Cleland, Williams College, Williamstown, Mass.

We learn from the *British Medical Journal* that Sir David Bruce, who was director of the Royal Society's commission in 1903, has left England on his second visit to Uganda, where he will continue his investigation as to the pathology of sleeping sickness. The expedition has been organized at the request of the Colonial Office, and the treasury is finding the necessary funds. Sir David Bruce will be accompanied by two other officers of the Royal Army Medical Corps, Captain H. R. Bateman and Captain A. E. Hamerton. Lady Bruce, who has accompanied her husband on similar missions in Uganda, Zululand and Malta, is a member of the new commission, and will take an active part in the investigations. The headquarters of the work will be selected two miles from the lake shore in a wild and depopulated region in the province of Chagwe. There the Uganda government has been preparing a laboratory and station for the purposes of the mission. It is expected that the work of the commission will occupy about nine months.

The twenty-ninth free lecture course of the Field Museum of Natural History will be given on Saturday afternoons at three o'clock, as follows:

October 3—"Through the Cataracts of the Nile," by Professor James H. Breasted, the University of Chicago.

October 10—"A Naturalist in Venezuela," by Dr. N. Dearborn, assistant curator of ornithology, Field Museum of Natural History.

October 17—"The Great American Deserts as seen in New Mexico and Sonora," by Professor Thomas H. Macbride, the State University of Iowa.

October 24—"The Geology and Scenery of the Pipestone Region," by Professor Samuel Calvin, the State University of Iowa.

October 31—"Among the Birds in Costa Rica and Panama," by Mr. J. F. Perry, assistant, division of ornithology, Field Museum of Natural History.

November 7—"Life of a Lake in Summer," by Dr. Edward A. Birge, University of Wisconsin.

November 14—"The Heraldry of the Indians," by Mr. James Mooney, United States Bureau of Ethnology.

November 21—"The Glaciers of the St. Elias Region, Alaska," by Professor R. S. Tarr, Cornell University.

November 28—"Holland," by Professor James Howard Gore, the George Washington University.

We learn from *Nature* that an International Rubber Exhibition was opened in London on September 14. The exhibits consisted wholly of objects of interest to members of the rubber and allied trades, and comprised illustrations of the growth of the commodity and examples of the machinery employed in its manipulation. Rubber trees in all stages of their growth were shown, together with the raw material obtained from them, and the varied forms into which it is manufactured. Demonstrations were given in a laboratory, and growers, manufacturers and others had an opportunity of discussing questions relating to the industry at an international congress, to which delegates were sent by many continental countries. Borneo, Mexico and other rubber-producing countries took part in the enterprise.

The National Conservation Commission has caused the first comprehensive attempt at a census of the standing timber in the United States ever undertaken. The Forest Service has for several years been eager to take such a census, and the Bureau of the Census has expressed its willingness to cooperate, but funds have never been available. The conservation commission, however, needs the information to help complete its inventory of the country's natural resources, which it will include in its report to the president, and since that report is to be submitted on the first of next year, it needs the information at once. Large portions of the forests of the country, including practically all the national forests, have been estimated at various times, but these figures have never been brought together and no organized effort has ever been made to gather them into one total, nor to supply the deficiencies where hitherto no estimates have been made. As a result, the guesses as to the amount of standing timber in the United States, range from 822,682 million to 2,000 billion board feet. In the opinion of the Forest Service, the most carefully prepared estimates yet made are those by Henry Gannett, published by the Twelfth Census in 1900. These placed the total stumpage at 1,390 billion board feet. Mr. Gannett has been chosen by the president to compile the information gathered for the commission, and with his previous acquaintance with the subject of forestry, he is at work now enlarging the knowledge of forest areas at present available. The importance of this census lies largely in the fact that it will give an accurate basis for computing how long our timber supplies will last. Through the cooperation of the Forest Service and the Census Bureau the country's annual consumption of wood is known with tolerable accuracy, although even here there are some discrepancies, because a large amount of wood is used for posts, fuel and domestic purposes, for which no satisfactory data have yet been collected. But the consensus of opinion is that the present annual consumption is about 100 billion board feet, or something more than that. One leading authority has placed it as high as 150 billion board feet. Assuming a stumpage of 1,400 billion feet, an annual use of 100 billion feet, and neglecting growth in the calculation, the exhaustion of our timber supply is indicated in fourteen years. Assuming the same use and stand, with an annual growth of 40 billion feet, we have a supply for twenty-three years. Assuming an annual use of 150 billion feet, the first supposition becomes nine years, and the second thirteen years. Assuming a stand of 2,000 billion feet, a use of 100 billion feet, and neglecting growth, we have twenty years' supply. Assuming the same conditions, with an annual growth of 40 billion feet, we have thirty-three years' supply. With an annual use of 150 billion feet, these estimates become, respectively, thirteen and eighteen years.

Accidents in the coal mines of the United States in 1907 resulted in death to 3,125 men and injury to 5,316 more—an increase of 1,033 in the number of deaths and 516 in the number of injuries over the record for 1906. This record marks the year, in all other respects the most prosperous, as one of the worst in the history of the coal-mining industry of the country. Even the above figures, however, fail to represent the full extent of the disasters, for any statistical statement that attempts to cover coal-mining accidents for the entire United States is necessarily somewhat incomplete. The U. S. Geological Survey, by which the figures for the country are published, does not collect the information directly, but obtains it through the courtesy of state or territory mine inspectors or other officials who compile data concerning accidents and their causes and effects. A number of the coal-producing states have no officials charged with these duties, and one or two of the state officials failed to reply to the inquiries sent out by the survey. In 1906 returns were received from 21 states and territories; in 1907 only 18 reported. The reports received indicate a death rate per thousand employees of 3.31 in 1906 and 4.86 in 1907, and the number of tons mined for each life lost decreased from 194,950 to 145,471. The state which had the lowest death rate per thousand (0.95) in 1907 was Missouri, where 499,742 tons of coal were mined for each life lost. Michigan was second on the roll of honor as far as death rate per thousand employees was concerned, and Kentucky was second in the number of tons mined for each life lost. The death rate in Michigan was 1.76 per thousand; in Kentucky it was 1.89. Kentucky mined 336,035 tons of coal for each life lost; Michigan mined 290,837 tons. Arkansas reported a death rate of 1.97 in 1907, with 133,522 tons mined for each life lost, and Utah, with a death rate of 2.72, mined 324,601 tons for each life lost. West Virginia reported the largest death rate in 1907—12.35 per thousand—and the lowest production for each life lost—65,969 tons. New Mexico stood next to West Virginia, with a death rate of 11.45 and a production of 77,322 tons for each life lost, and Alabama was next, with a death rate of 7.2 per thousand and a production of 92,535 tons for each life lost.

Nature states that silver medals are this year offered by the Industrial Society of Mulhouse for the synthesis of a gum possessing the properties of Senegal gum, and for a handbook treating of the drugs used in the dyeing and printing industries; a medal of honor is offered for an economical substitute for dried egg-albumen, or for a decolorized blood-albumen for the same purpose. Other awards will be given for papers on the coloring matter or on the carmine in cochineal; the theory and manufacture of alizarin reds; the composition of aniline black; the transformation of cotton into oxycellulose; the composition of coloring matter and synthesis of a natural color, various mordants, bleaching processes and colors, etc. Papers, etc., must reach the Président de la Société Industrielle de Mulhouse, Alsace-Lorraine, before February 15, 1909.

The smelter production of copper in the United States in 1907, according to L. C. Graton, of the United States Geological Survey, was 868,996,491 pounds. From the record figures of 1906 this is a decrease of 48,809,191 pounds, or 5.6 per cent., the largest actual decrease ever recorded and the largest relative decrease since the American copper industry became important. This is the first time since 1901 that the annual production has been smaller than that of the preceding year, and the first time since 1872 that it has been smaller than that of the second year preceding. The total given above is made up of the fine copper content of blister produced and of the smelter output of ingot and anode copper from Michigan. Of this quantity, approximately 10,075,048 pounds in blister were produced in foreign smelters from domestic materials exported. In addition to the domestic materials handled, smelters in this country turned out as blister 64,145,648 pounds from foreign ore, concentrates, and matte. Domestic blister containing 42,350,963 pounds was exported unrefined, while blister from foreign sources containing approximately 183,530,132 pounds fine copper was imported for refining in this country. The greatest decreases in smelter output are shown by the returns from the three states that rank highest. Montana's production, which was 294,701,252 pounds in 1906, was but 224,263,789 pounds in 1907, and the state yielded first place to its rival, Arizona, whose production, however, showed a decrease of nearly 6,000,000 pounds, from 262,566,103 pounds in 1906 to 256,778,437 pounds in 1907. Michigan still holds third place, with its production decreased from 229,695,730 pounds in 1906 to 219,131,503 pounds in 1907. Decreased production is also shown by the returns from Alaska, Oregon, Washington and North Carolina. Many of the other copper-producing states showed substantial gains. The output of Utah, the fourth state in point of production, was nearly 16,000,000 pounds in excess of that of 1906—66,418,370 pounds in 1907 as against 50,329,119 pounds in the preceding year. The production of California increased from 28,153,202 pounds in 1906 to 33,696,602 pounds in 1907; that of Colorado from 7,427,253 pounds in 1906 to 13,998,496 pounds in 1907; that of New Mexico from 7,099,842 pounds in 1906 to 10,140,140 pounds in 1907, and that of Idaho from 8,578,046 pounds in 1906 to 9,707,299 pounds in 1907. Nevada and Vermont also showed productive gains.

A NOTE in the London *Times* says that the fine herd of Indian cattle presented to the London Zoological Society by the president, the Duke of Bedford, has been a considerable attraction, and now that two of the cows—of the Mysore and Hissar breeds—have produced calves, the interest of visitors in these animals has increased. In the same house is a black calf of the Chartley × Vaynol blood, two abnormally colored calves having been thrown in succession by the same cow. A serow born in the garden proved to be an example of the Sumatran species (*Capricornis sumatrensis*), but, unfortunately, it lived only a few days in the menagerie. The other, which has been in the collection for more than two years, is in excellent condition; so far as can be ascertained, it is the first to reach England. For some little time the waders' aviary has been under repair; the birds have been removed to the covered-in paddocks in front of the anthropoid house, but will probably be brought back in the course of a few days. The curassow chicks hatched out in the northern pheasantry are doing very well, and now mount up on the high perches. The practise of feeding the young was continued by the mother for more than a fortnight. In the aviaries in the new bird house is the finest collection of birds of paradise ever brought together. The last importation was effected by the society in conjunction with Sir William Ingram, by whom Mr. Horsbrugh was sent out to New Guinea. News has been received that the collector now working there for Sir William Ingram has obtained a great prize—a fine male of Prince Rudolph's bird of paradise (*Paradisornis rudolphi*), first obtained by Hunstein and described by Finsch and Meyer in 1885. In this species the side-plumes, of which there are two on each side, are blue, which is the dominant note of the plumage. The type-specimen is in the Dresden Museum, and when Dr. Bowdler Sharpe wrote his monograph on the birds of paradise there was no skin of a male in the national collection in Cromwell-road.

UNIVERSITY AND EDUCATIONAL NEWS

THE annual report of the treasurer of Yale University for the fiscal year ending June 30, 1908, shows additions to the funds during the year of $1,263,444. The principal items are $63,149 from the Yale Alumni fund; from the Archibald Henry Blount bequest, $337,291; from the Lura Currier bequest, $100,000; by bequest of D. Willis James, $95,250; from contributions to the university endowment and extension fund, $335,665; and from balance of the Ross library fund, $112,220. From the Blount bequest $242,903 has been used to repay advances made by alumni to secure the Hillhouse property. Gifts to income amounted to $76,494, of which $30,000 came from the Alumni Fund Association. The following table is given showing the cost and receipts per student in the different departments:

Department	Students in Attendance	Average Cost per Student	Average Receipts per Student	Percentage of Receipts to Expenses
Graduate	357	$159.45	$ 40.17	25.2
Academical	1,315	339.56	152.27	44.8
Sheffield Scientific	948	279.66	160.25	57.3
Theological	80	641.03	.....	...
Law	339	177.14	122.86	69.3
Medical	137	396.90	130.22	32.9
Art	39	315.02	69.25	21.9
Music	83	268.99	140.12	52.1
Forestry	61	469.39	119.17	25.3
All departments	3,359	$296.85	$133.25	44.9

GOVERNOR G. W. DONOGHY, of Arkansas, President John Tillman, of the State University, and George B. Cook, state superintendent of education, have been visiting representative institutions of higher education in the middle west to gather information with a view to recommending an appropriation of $500,000 for the extension and improvement of the State University of Arkansas.

THE zoology department of the University of Kansas has received a large consignment of marine biological specimens collected during the summer on the gulf coast in Texas under direction of Professor C. E. McClung. This material will be used in the biological classes of the university and will also be furnished at cost to zoology classes in the accredited high schools of the state.

The registration at the close of the first week at the University of Wisconsin shows an increase of 331 students over the number enrolled at the same time last year. This gain indicates that the total number of students at the university this year will be over 4,500.

The new building of the engineering laboratory of the Heriot-Watt College, Edinburgh, was opened by the Earl of Rosebery on September 16.

The Russian minister of public instruction has forbidden women to attend university lectures in the future, but permits those to complete their studies at universities who have already received permission, and whose transfer to higher educational institutions for women is impossible.

At Wesleyan University (not Northwestern University, as previously stated) David R. Whitney, of Columbia University, has been appointed instructor in biology, and J. W. Turrentine, M.Sc. (North Carolina), Ph.D. (Cornell), instructor in physical chemistry.

Dr. Harry T. Marshall has returned from Manila and has assumed charge of the work in pathology and bacteriology at the University of Virginia. He is assisted by Dr. Carl Meloy, who returns to the university this year as adjunct professor of pathology.

The following appointments have been announced in the Sheffield Scientific School of Yale University: Arthur Lyman Dean, Ph.D., to be instructor in industrial chemistry; J. F. McClelland, M.E., to be lecturer on mining engineering, and William Harry Kirkham to be instructor in biology. In the Medical School Dr. Marvin Scarborough, M.A., has been appointed instructor in pharmacology.

At the College of the City of New York the following have been promoted from the grade of tutor to that of instructor: In chemistry, Robert W. Curtis, Ph.D. (Yale); William L. Prager, Ph.D. (Clark); Reston Stevenson, Ph.D. (Columbia); in descriptive geometry and drawing, William Chadwick and Frederick W. Hutchison; in education, Samuel B. Heckman, Ph.D. (Pennsylvania); in philosophy, Howard D. Marsh, Ph.D. (Columbia); in physics, David H. Ray, Sc.D. (New York University). Dr. W. L. Estabrooke has been appointed a tutor in the department of chemistry.

At George Washington University Mr. Sidney I. Kornhauser has been appointed instructor in biology and Dr. Irving K. Phelps, instructor in physiology.

Mr. James P. Barrett has resigned an assistantship in botany at Illinois Agricultural Station to accept a fellowship in botany at Cornell University.

The board of governors of the University of Toronto in July last established, at the urgent request of Professor A. B. Macallum, the head of the department of physiology and physiological chemistry, a second professorship in the department and on September 24 the board appointed Professor T. G. Brodie, M.D., F.R.S., of the Royal Veterinary College, London, to the position as titular professor of physiology. Professor Brodie has accepted the appointment and will assume his duties at Toronto in November.

DISCUSSION AND CORRESPONDENCE

AN UNUSUAL METEORIC FALL

To the Editor of Science: There was an unusual and somewhat remarkable fall of meteoric masses in this vicinity on the evening of Thursday, September 17, some of the facts concerning which may be worthy of record in Science. I was an eye-witness of some of the phenomena, as will appear. The general account is gleaned from the newspapers of the following day. On the date mentioned, at about quarter past seven o'clock in the evening, a large and brilliant meteor passed over the whole state of Massachusetts from west to east. According to reports, a large fragment of it dropped into Boston harbor between Apple Island (a small island) and the shore of the town of Winthrop, which is a few miles north of Boston. This same meteor was seen to pass over the city of Springfield, about ninety miles west of Boston, and according to newspaper reports "its glare lit up the earth as bright as day," "the hissing of the fiery mass could be plainly heard in some sections," it had "a white head and a reddish tail of burning gases." The Springfield accounts state that a few seconds after its passage over that city it seemed to explode into particles which were burned or vaporized before falling to the earth. The Boston account indicated that it parted high up in the air, one piece dropping in a southwesterly direction. The piece that fell into the harbor is described as seeming to be of the size of the full moon. "Several small boats," so one account states, "were observed in the vicinity when one piece dropped into the water near Winthrop." It is unfortunate that if this was the case, the exact spot of the fall was not noted, as the water there is probably not more than a few feet deep, and the fragment, heated (as such bodies are) only externally in their flight, might be found almost intact in spite of its impact with the water. Moreover, it is probable that its velocity was well spent and that the water resistance would so far reduce the speed that it would not even bury itself in the earth below.

My personal observations in regard to this meteor are as follows: While journeying eastwardly from the direction of Pittsfield to Springfield with a party in an automobile we followed the road which runs approximately parallel to the Boston and Albany Railroad tracks east of the town of Huntington. At a point about a mile southeast of that town and about eighteen miles west of Springfield, with a clear sky but somewhat smoky air, we were startled by a very bright illumination of the landscape, like that given by an intense flash of lightning though much more prolonged. On looking upward at once for the cause, our attention was at once fixed upon a brilliant body descending rapidly and almost vertically, and apparently nearly overhead. It appeared to fall into the woods on a hill to the left of us. The light was remarkable as being of a pure and intense greenish blue, which continued at full intensity until the mass was lost to sight in the woods. This fragment of the larger mass which itself continued on east, appeared to me to owe its luminosity to an actual combustion in our air, as its velocity of fall was apparently much too low for it to have been maintained at a high temperature by air resistance. In fact our first impression was that it was falling almost directly upon us or might strike nearby; an impression confirmed by the appearance that although we were moving at moderate speed along a straight part of the road our horizontal direction of view was changing quite rapidly with respect to its line of descent. I am convinced that this was no illusion. The vivid green blue color of the light rendered the effect very beautiful.

It seems to indicate an unusual chemical composition, something which readily burned in the air and which at the same time gave a pure light, spectrum lines in the green and blue, or green-blue only.

Elihu Thomson

Swampscott, Mass.,
September 24, 1908

DR. W. J. HOLLAND ON THE SKULL OF DIPLODOCUS

In the second volume of the *Memoirs of the Carnegie Museum,* Pittsburg, page 225, Dr. W. J. Holland has written at considerable length on the skeleton of *Diplodocus.* Most of his original matter is based on the well-preserved hinder part of a skull that was found in Wyoming. On request Dr. Holland kindly sent me this skull for examination, and I have carefully compared it with the skulls of various reptiles, living and extinct. I regret that I find myself at variance with Dr. Holland as regards many of his determinations of bones and foramina in this skull; but it is essential that errors in such important matters be corrected as early as possible.

First of all it may be said that most of the sutures between the bones are far less distinct than they are represented in Dr. Holland's figures, and some of them do not appear to be where they are drawn.

Three pairs of bones forming the side walls of the brain-case have been identified by Dr. Holland as the exoccipitals, the alisphenoids and the orbitosphenoids. As to the exoccipitals, he is right. Nothing whatever is said by him about the prootics, although they are among the most important and constant bones of the reptilian skull. The fact is, however, that the bones regarded by our author as the alisphenoids are in reality the prootics, while his orbitosphenoids are the alisphenoids. The orbitosphenoids are only slightly developed and are thoroughly consolidated with the alisphenoids. That the bones called by Dr. Holland the orbitosphenoids are in fact the alisphenoids is shown by the presence of the optic foramina in front of them.

Dr. Holland has represented the supraoccipital bone as occupying a small lozenge-shaped area on the upper surface of the skull and narrowing to a point right and left. Now, in all reptiles this bone, by virtue of its epiotic element, takes an essential part in the formation of the internal ear, containing, as it does, the posterior semicircular canal. It must, therefore, come into contact with the exoccipital and the prootic not far above the fenestra ovalis. The three bones concerned are, in the Pittsburg specimen and all others known, thoroughly coossified and the sutures are nearly effaced. However, the writer believes that the suture between the supraoccipital and the exoccipital starts about 25 mm. above the fenestra ovalis and runs outward and backward to a notch in the hinder border of the posttemporal fossa. In Dr. Holland's figure 5 this suture would start from the suture ascending at the left of the letters *ex.o*, at the upper border of the postfrontal bone and run backward just below these letters, and end under the bone *sq*. The suture between the prootic (Dr. H.'s alisphenoid) and the parietal falls so low that it would properly be hidden behind the postfrontal. The line representing the hinder border of the parietal in the supratemporal fossa is, in that figure, directed too far to the rear as it descends. The letters *ex.o* lie on the supraoccipital. On the upper surface of the skull, the suture between the supraoccipital and the exoccipital probably starts on the midline, as represented by Dr. Holland's figure 4, and runs outward to the notch already mentioned and seen near the letters *AS*. The supraoccipital is thus given the importance that it has in the reptilian skull.

Dr. Holland has correctly identified the olfactory, the optic and the hypoglossal foramina, likewise that giving entrance to the internal carotid artery; as to the others, I believe that he is in error. The foramen assigned by him to the oculomotor nerve is situated between the alisphenoid and the prootic, which is just the place for the trigeminal nerve. Just below this there is, in the Pittsburg specimen, a group of three small foramina which are supposed by Dr. Holland to have given entrance to the anterior branch of the internal carotid. These foramina are below the floor of the brain-case and almost certainly opened into the pituitary fossa; and probably they afforded exit to the ophthalmic artery.

As already indicated, that foramen which Dr. Holland has identified as that for the trigeminal nerve is regarded by myself as the fenestra ovalis. It lies on the boundary between the prootic and the exoccipital, where the fenestra ovalis is to be sought. It is a trilobate opening, but in a specimen in the U. S. National Museum the anterior lobe is cut off by a bridge of bone. Here probably escaped the facial nerve. The base of the stapes was no doubt placed in the remainder of the opening.

The foramen for the internal carotid artery lies in the exoccipital near its anterior border. Just behind this comes the foramen called by Dr. Holland the fenestra ovalis. While not believing it to be this fenestra I can not, in the present condition of the skull, say with certainty what was its function. It seems probable that here, as in some other reptiles, the ninth nerve passed out through this foramen separately from the tenth nerve. The latter certainly escaped through the foramen marked by Dr. Holland with the Roman numeral IX. in his figures.

In speaking of his supposed fenestra ovalis

Dr. Holland says that he knows of no other opening through which the auditory nerve could escape from the brain cavity; but unfortunately he did not think it necessary to indicate the distribution of this nerve.

The writer knows of no fossil skull that is better fitted for section than the one described by Director Holland. Had it been divided along the median plane and had the matrix then been removed, much valuable information would have been secured. Probably some sutures that do not show on the rough outer surface would reveal traces of themselves on the inner surface; and important suggestions regarding some of the foramina would offer themselves. Especially, it would then be possible to obtain a complete cast of the brain-cavity of this interesting dinosaur.

Two long splints of bone which extend from the premaxillæ to the front of the external nares, joining along the midline, were supposed by Marsh to be processes of the premaxillæ. Dr. Holland regards them as distinct bones and suggests that they are the lateral ethmoids. It would be interesting to learn how the lateral ethmoids could migrate from the prefrontal region and come to lie on the midline in front of the nostrils. It is very doubtful whether the splints are distinct from the premaxillæ.

The bone called the presphenoid by Dr. Holland is the parasphenoid.

As is well known, the nostrils of *Diplodocus* lie far toward the rear of the skull, between the orbits. On each side of the face, far in front of the orbits, there is found a fontanel in each maxillary bone. This opens into the cavity above the pterygoid bones. Dr. Holland suggests that these openings were probably a pair of supplementary nostrils. From what we know about the development of the rectum it is imaginable that a nasal passage might divide into two passages, and that one of these might remain in its place while the other, with its external opening, might migrate to where we find it in *Diplodocus*. But had this happened in *Diplodocus* the nostril that retained its primitive position would be represented by one of the two clefts found near the midline at the front of the long premaxillary splints already mentioned, which clefts, as Dr. Holland says, opened into the nasal passages. If then the maxillary fontanels were also supplementary nostrils, we should have an animal with three pairs of nostrils. As to those in the maxillæ, it would, I think, be difficult to explain their morphogeny. We must certainly look on the proposition as a fanciful one. I see no reason to doubt that the fontanels in the maxillæ were in life filled with connective tissue and covered over by the skin.

In a foot-note Dr. Holland informs us that certain groups of reptiles have no external ears and that *Diplodocus* probably lacked these organs; but we should like to know what reptiles do have external ears.

In nearly all of Dr. Holland's references to the two skulls of *Diplodocus* in the U. S. National Museum he gets the numbers 2672 and 2673 exchanged. Apparently only the reference on page 239 is correct. On page 235 he credits to the U. S. National Museum two specimens that are in the American Museum of Natural History, New York, Nos. 545 and 969.

Oliver P. Hay

THE SPREADING OF MENDELIAN CHARACTERS

The point made by Mr. Hardy in his note on "Mendelian Proportions in a Mixed Population" in Science of July 10, 1908, is a very important one, though it is open to a dangerous misunderstanding. What Mr. Hardy gives us is a mathematical proof that *under the assumptions of Mendelian inheritance* a dominant character does not tend to spread or a recessive character to die out. A *strictly Mendelian* character would not tend either to increase or diminish its representation in a species, unless favored or opposed by selection. This is a mathematical confirmation of the biological evidence that Mendelism has no relation to evolution.

Nevertheless, the proviso of strict Mendelian inheritance robs the demonstration of a truly biological significance and forbids us to rely on it as a protection against the spread of brachydactyly or other abnormal characters in man himself or in our domesticated plants and animals. In other places I have attempted to show the need of definite recognition of the fact that the transmission of characters is quite distinct from expression.[1]

The spread of a character through a group by transmission does not appear to have any relation to the frequency with which the character comes into visible expression. In their ability to spread through species recessive characters have a distinct advantage over dominant characters. In the presence of an adverse selection a recessive or latent character could continue to spread, even in spite of the elimination of all the individuals in which the character came into expression, whereas a dominant character would be destroyed as soon as its representatives were exterminated.

It is also known that the potency, or power of a character to come into expression, is subject to pronounced changes, even among different individuals of the same stock. Thus one of Professor Davenport's tailless fowls produced only tailed chicks, though the Mendelian reckoning called for large percentages of tailless birds. And yet the tailless character reappeared in Mendelian proportions in the progeny of a son of the same bird.[2]

Thus the biological probabilities regarding brachydactyly are altogether different from the mathematical calculations based on the Mendelian assumption that parental characters are *transmitted* by only half of the germ-cells. The biological indication is that brachydactyly is *transmitted to all the descendants* of a brachydactylous ancestor, and is likely to regain expression, or even to become prepotent, in any generation, near or remote.

O. F. Cook

Washington,
July 16, 1908

[1] "Transmission Inheritance distinct from Expression Inheritance," Science, N. S., XXV., 911. "Mendelism and Other Methods of Descent," *Proc. Wash. Academy of Sciences*, IX., 189. "Heredity Related to Memory and Instinct," *Monist*, XVIII., 263.

[2] "Altogether, out of 200 offspring of this tailless cock, where I expected 90 per cent. tailless birds, I got not one. On the other hand, using some of the same hens with another cock (the son of No. 117), from 50 offspring, where I expected 25 tailless, I got 24 tailless. In No. 117, although tailless, the tailed tendency strongly dominates over taillessness, so that not in the first nor in the second hybrid generation does taillessness appear, and of the Mendelian segregation in the second hybrid generation there is no trace! On the other hand, another cock reveals typical Mendelian phenomena." See Davenport, C. B., 1907. "Heredity and Mendel's Law," *Proc. Washington Academy of Sciences*, IX., 184.

SCIENTIFIC BOOKS

A Text-Book of the Principles of Animal Histology. By Ulric Dahlgren, Assistant Professor of Biology in Princeton University, and William A. Kepner, Adjunct Professor of Biology in the University of Virginia. Pp. xiii + 515. Price, $3.75. New York, Macmillan Company. 1908.

This book is so unlike the usual text-books of human and mammalian histology that it will seem like an entirely new subject to most readers. It comes as a welcome relief from the multitude of text-books which differ from one another only in the order and arrangement of the subjects treated. For many years the comparative method has been recognized as the "saving salt," as Michael Foster expressed it, of anatomy and embryology, but strange to say, few works have attempted to deal with histology from the comparative point of view, and this subject has been adequately treated only in the case of man and of a few mammals. If we except the early pioneer work of Leydig and the incompleted work of Fol, the only works which deal specifically and adequately with the subject of comparative histology are the large manual of Camillo Schneider and this volume by Dahlgren and Kepner, and the present work is, I believe, the first attempt which has been made in English to put histology upon a comparative basis.

The purpose of the authors is clearly stated in the preface to be

To produce a work that covers the general field of histology, and is not restricted in the main to human and mammalian forms. It is intended to be a work that teaches general principles and teaches histology as a pure science and for its own sake. It is believed that it will serve as a broad foundation for future studies of morphology and embryology as well as for the medical studies.

The book admirably fulfills the purpose thus outlined. The field which it covers is greater than that of any other existing work on this subject; every phylum in the animal kingdom is drawn upon for illustrative material and in a few cases plant cells and tissues are also considered. A glance at the 470 excellent figures, most of them original, which illustrate the book shows from what a wide field the material has been drawn and how extensive the researches have been upon which this work is based.

Such wealth of illustrative material would inevitably lead to confusion were it not for the fact that general principles rather than specific structures are everywhere kept in the foreground. These principles are in the main the general physiological properties common to all organisms. The authors have shown that even histology may be best treated from the standpoint of the living, functioning organism. After seven introductory chapters dealing with protoplasm, the cell, multicellular organization viewed from the phylogenetic and from the ontogenetic standpoints, mitosis and amitosis, epithelium and glands, connecting, supporting and filling tissues, there are taken up in order, tissues for the production of motion, electricity, light and heat; tissues connected with circulation, sensation, pigmentation, alimentation, ductless glands, tissues concerned with respiration, gas secretion, excretion, protection, reproduction, accessory reproductive tissues and tissues for the nourishment of the young. This summarizes briefly and in a very general way the purpose, method and extent of the work and it must be apparent at once that within the proper limits of such a review as this it is impossible to deal critically with each of these sections of the book. Comment must be limited to the general features of the work rather than to specific details.

One of the fundamental ideas which are set forth in the first chapter and which runs through the whole book is that the cell can produce only substances and that dynamic products, such as heat, light, electricity and motion are the results of the chemical activities of the substances which the protoplasm has formed by its own "vital" activity. The substances thus formed usually appear as granules and are known respectively as "thermochondria," "photochondria," "electrochondria" and "myochondria." Even in the case of other forms of energy which can not be certainly referred to any of the four types named, the authors are apparently inclined to follow this same idea, and accordingly the granules of the nerve cells are called "neurochondria." The treatment accorded these types of energy and their production by animal tissues is particularly striking and valuable. Other histologies deal with the tissues concerned with the production of motion, but no other text-book deals so fully and satisfactorily with the production by animals of heat, light and electricity. In the treatment of practically every topic touched upon in the book the broadening influence of the comparative method is shown, and most of the illustrative material figured and described is new. Indeed, the work as a whole is much more than a text-book, for it contains a large amount of original observation here published for the first time. This applies to every chapter, but particularly to those which deal with the production of light and electricity, and with the sense organs. However, owing to the fact that investigators' names are rarely mentioned it is difficult for one not thoroughly acquainted with the subject to distinguish between the author's researches and those of others.

In the opinion of the writer the most serious criticism of the work for use as a textbook is that it "falls between two stools"; it can be used advantageously only by advanced students who have had a pretty thorough training in zoology, while much of the material described is quite inaccessible to average classes. This makes the book valuable as a reference work and for use with advanced students, but for this purpose it should be more detailed in character and should include a more extensive bibliography with references to the principal literature. No general bibliography is given, on the ground that it would necessarily discourage rather than stimulate the student, but the writer has found in reading the book that a larger number of references to special papers and to general works would have been helpful and desirable. The references given are not always definite nor exact.

Now and again throughout the book a kind of teleology appears, which in the present state of biological science it is best to avoid, although it is often difficult to do so; *e. g.*, on page 102, it is said that "muscle must be developed wherever needed," again, on page 142, "heat production is stimulated by its need," etc.

The terms employed are sometimes open to criticism; thus on page 174 "perception" is given as a function of the nerve cell where only irritability or sensitivity is meant; sometimes the style and grammar used are not above suspicion, and in places the malevolence of the printer's "devil" is manifest, as on page 233, where a discovery of the brothers Sarasin is attributed to the Saracens.

However, in view of the many excellences of the work it seems almost ungenerous to call attention to these minor defects; they are slips which we may expect to see corrected in future editions of the book.

When one considers the narrow, technical training which students in histology usually receive, whether they be medical students or not, one can not but wish that a course similar to that outlined in this book might be given in every college and university.

E. G. Conklin

ANTHROPOLOGICAL PUBLICATIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY FOR 1907–1908

The anthropological publications of the American Museum of Natural History, during 1907 and 1908, comprise Volume I., and Part I. of Volume II., beginning a new series entitled *Anthropological Papers of the American Museum of Natural History;* the closing sections of Volumes XV., XVIII. and XVIII. of the Museum *Bulletin;* and the last part of Volume III. of the Museum *Memoirs:* eleven papers with an aggregate of 1,099 pages, 82 plates and 373 text figures. Formerly minor anthropological papers were published in the annual Bulletin, primarily designed for biological publications. By the segregation of these papers and their issue under a distinct title the Museum has made a change for the better.

Volume I. of the Anthropological Papers opens with Mr. Charles W. Mead's "Technique of some South American Featherwork" (pp. 1–18, pls. I.–IV., 14 figs.). In two distinct sections, the author describes the feather-technique of the ancient Peruvians and of the modern natives of South America. The most striking difference between the two is found in the mode of attaching feathers: the Peruvians employing knots while the modern Indians substitute a loop or simple turn about the shaft.

In Part II. (pp. 19–54, pls. V.–VII., 26 figs.) Dr. Clark Wissler discusses, "Some Protective Designs of the Dakota." The shields or shield-covers of the Dakota were formerly painted with designs, derived from supernatural experiences which imparted to them supernatural efficacy. On modern shields, the thunder, lightning and spider symbols play an important part; but there is evidence for the greater prominence in the old days of simple circular designs representing the heavenly bodies. The designs on supposedly bullet-proof shirts, worn in the ghost-dance, are characterized by a tendency to represent animals, such as turtles, believed to be proof against missiles. While the use of these garments is modern, the author insists on the aboriginal character of protective designs, long antedating, as they do, the outbreak of 1890. In his conclusion the author explains the animistic basis on which interpretations of designs rest, notes the psychologically interesting predominance of animal motives, and mentions the coalescence of apparently incongruous power-symbols as representations of the same natural forces.

Parts III. (pp. 55–139) and IV. (pp. 141–282, pls. VIII.–XIII., 44 figs.) embody Dr. A. L. Kroeber's fairly representative collection of "Gros Ventre Myths and Tales," and his "Ethnology of the Gros Ventre." In the latter paper the author gives an historical account of the tribe, followed by brief notes on the material culture and an extended treatment of decorative art and ceremonial life. While their ceremonial organization is in many respects similar to that of the Arapaho, the Gros Ventre seem to be unique among Plains tribes in having the same ceremony performed by *several* distinct companies of men of approximately the same age, each of these societies bearing a nickname independent of the character of its dance. Perhaps the chief interest of the paper centers in its comparative analysis of the decorative styles of Northern Plains tribes. In their embroidery designs, the Blackfoot prove to be the most clearly differentiated tribe—distinct alike from the Sioux-Assiniboine and the Arapaho-Ute-Shoshone groups; while neither Gros Ventre nor Cheyenne seem to have developed an individual style. In parfleche painting, the author distinguishes three types of decoration, basing his classification on the relative prevalence of square and triangular units. The employment of coordinate square and triangular elements is noted as a diagnostic peculiarity of Shoshone parfleches, the subordination of triangular to square forms occurs rarely, though, in all these tribes, while in all but the Shoshone an exclusively triangular style predominates.

"The Hard Palate in Normal and Feeble-Minded Individuals" (Part V., pp. 283–350, pls. XIV.–XXII., 8 figs.) sums up the results of a comparative anthropometric study by Drs. Walter Channing and Clark Wissler, based on large series of casts of the palates of mentally normal and abnormal individuals. The most important result is that the general type of palate, as determined by average measurements, is the same for feeble-minded and normal individuals; while the palates of feeble-minded individuals are somewhat more variable. The significance of this difference is, however, negatived by absence of clear differences in the correlation of dimensions for the two groups.

Volume I. closes with Mr. M. R. Harrington's "Iroquois Silverwork" (pp. 351–370, pls. XXIII.–XXIX., 2 figs.). Silver ornaments of Iroquois make date back as far as the end of the seventeenth century, apparently superseding those of copper and brass. The author describes silver ornaments still found, silversmith's tools, and the process of manufacturing several classes of objects. While admitting European influence, he is disposed to regard many of the ornamental patterns as of native origin.

Volume II. opens with Dr. Clark Wissler and Mr. D. C. Duvall's "Mythology of the Blackfoot Indians" (pp. 1–162). The tales are grouped under five headings: tales of the Old Man; star myths; ritualistic origins; cultural and other origins; and miscellaneous tales. In his introduction, the senior author shows by comparison with Central Algonkin mythology that, irrespective of the present conception of Old Man as a trickster pure and simple, the cycle probably represents the basic beliefs of the Blackfoot. The ritualistic myths exhibit a somewhat puzzling variability as compared with the rigid inflexibility of the correlated ceremonial practises. While in a majority of these stories the relation of myth and ritual is fundamental, there are others in which the origin of a ceremony is only episodically interwoven with the body of the tale. Dr. Wissler notes that, in the latter case, the plot is, as a rule, common to several other Plains tribes; while ritualistic tales proper are almost all confined to the Blackfoot. The primarily ritualistic myths are apparently older; and it seems as though in accordance with a wide-spread psychological tendency, rituals of relatively recent introduction from without had become secondarily associated with tales, usually also of foreign origin, which thus came ostensibly to account for the origin of the ceremonies. From a comparative point of view, the author calls attention to special points of contact with the western Cree and the Crow, as well as to the occurrence of significant resemblances to tales of the Arapaho and Gros Ventre.

During the year 1907 the final papers in three volumes of the *Bulletin* and one volume of the *Memoirs* were issued. Professor Franz

Boas's "The Eskimo of Baffin Land and Hudson Bay" is concluded in Part II. (pp. 371–570, pls. V.–X., figs. 173–269) of Volume XV. of the *Bulletin*. Material gathered by a number of independent observers is shown to yield corroborative evidence for the author's previously expressed conviction that Eskimo culture from Alaska to Greenland formed originally a firm unit; and that differentiations are due to local causes, such as the influence of the coast and Yukon River Indians on the Alaskan Eskimo.

Part V. (pp. 381–498, pls. LIX.–LXXII., figs. 68–118) of Volume XVII. of the *Bulletin* consists of Dr. Roland B. Dixon's monograph, "The Shasta," closely patterned in general mode of treatment on his description of the Northern Maidu. The Shasta are found to share part of their material culture with the tribes of northwestern California, but are fundamentally distinct in religious and social life. A relatively close connection with Oregonian culture is hypothetically advanced.

In Part IV. (pp. 279–454, pls. LVII.–LXXXVIII., figs. 103–180) of Volume XVII. of the *Bulletin* Dr. Kroeber discusses the religious life of the Arapaho. The sun-dance of the northern Arapaho of Wyoming is compared and found essentially identical with that of their southern congeners in Oklahoma, and there is a brief account of old tribal customs. This is followed by a detailed treatment of modern ceremonial objects with descriptions of the crow-dance and the peyote cult, which have superseded the ancient ceremonial organization. After discussing number and color symbolism, the author concludes with a sketch of individual relationship to the supernatural.

Part IV. (pp. 327–401, pls. XXIV.–XXVII., figs. 536–592) Volume III. of the *Memoirs* contains two papers—Lieutenant George T. Emmons's "The Chilkat Blanket" and Professor Franz Boas's "Notes on the Blanket Designs." Emmons describes in detail the process of weaving the ceremonial robe, once characteristic of all the North Pacific coast tribes, but now confined to the Chilkat, a branch of the Tlingit. Boas describes the disposition of design units in the Chilkat blanket, showing that the ornamentation is not influenced by the technique of weaving, but is bodily derived from the decorative surfaces of painted pattern-boards.

Robert H. Lowie

BOTANICAL NOTES

PAPERS ON ARCHEGONIATES

Professor Doctor D. H. Campbell describes in a recent number of *Torreya* some of his experiences in collecting liverworts in Java, "perhaps the most interesting region in the world for the botanical student." On account of the heavy rainfall, and the great range in elevation, from sea-level to an altitude of more than ten thousand feet, the flora is very rich in species as well as individuals. "It is said that there are over fifteen hundred species of trees in the island" which botanists will remember is about double the number we have in North America. In this region Dr. Campbell found the greatest abundance of liverworts, some of remarkable interest.

The same author's paper, "Studies on the Ophioglossaceae" in the *Annales du Jardin Botanique de Buitenzorg* (Vol. VI.) adds materially to our knowledge of the round of life of these low ferns. The prothallia of the two species studied (*Ophioglossum molluscanum* and *O. pendulum*) are "subterranean and normally destitute of chlorophyll." That of the first species is short-lived, while in the second it is "apparently capable of unlimited reproduction by means of detached buds." As to relationship the author says "the nearest affinity of *Ophioglossum* is probably with the *Marattiaceae*, but it is probable that there is also a remote affinity with the *Equisetineae*."

In a later paper on "The Prothallium of *Kaulfussia* and *Gleichenia*, in the same journal (Vol. VIII.), Dr. Campbell describes and figures the prothallium, antheridium, archegonium and embryo of *Kaulfussia aesculifolia* a somewhat rare fern of the *Marattiaceae* found in the Indo-Malayan region. The prothallium is fleshy and more than one cell in thickness except at the extreme margin, and looks much like the gametophyte of *Anthoceros*. In the second part of his paper he shows that the prothallium of *Gleichenia* is more or less lobed, and has a massive midrib. The antheridia usually develop first "but continue to form after the archegonia are mature."

In a still later paper, "Symbiosis in Fern Prothallia" (*American Naturalist*, March, 1908), the same author discusses the significance of the presence in many gametophytes of archegoniates of fungal endophytes. He finds that "an endophytic fungus is normally present in the green prothallia of several *Marattiaceae*, *Osmundaceae* and *Gleicheniaceae*."

MISCELLANEOUS BOTANICAL PAPERS

The successive numbers of the *Fern Bulletin* show that it is another of the botanical journals that from small and humble beginnings has grown to be one of the periodicals that every botanist must have. The editor has certainly succeeded in making it a readable and helpful journal for all who are interested in ferns. It will be especially helpful to every young botanist.

With the September number, the journal long known as *Forestry and Irrigation* changes its name to *Conservation*. Under the old title many of its articles were of much interest to all botanists excepting perhaps some of the narrower specialists, and the editorial indications are that under its new title this botanical interest will be measurably increased. The ecologist will find much of his kind of botany in it now.

Somewhat allied to the foregoing is Mr. Brown's "Arboriculture," in which the editor gives his ideas about trees and tree-growing in simple, non-technical language, helped out by excellent reproductions of illustrative photographs. The writer of these notes classes this among his valued botanical periodicals.

A new journal, *Southern Woodlands*, published by the Georgia Forest Association, has confessedly a narrower field than the two journals just mentioned. However, in the August number R. M. Harper's article on "Some Neglected Aspects of the Campaign against Swamps" will be read by botanists with pleasure, since it calls attention to the fact that the drainage of swamps is by no means always to be commended; to which every botanist will say "amen."

In line with Mr. Harper's paper is one by Professor Herbert Osborn, entitled "Needed: A System of Aquatic Farming," in the *Popular Science Monthly* for July, suggesting a possible increased usefulness of swamps as swamps, by proper treatment without draining them.

That there is no danger of an immediate exhaustion of problems in the field botany of the higher plants in the vicinity of New York City, is well set forth in a paper on the subject in the July number of *Torreya*. It is worth careful reading by all field botanists.

Incidentally the same author suggests an interesting line of work in his paper on "Some Native Weeds and their Probable Origin" in a recent number of the *Torrey Bulletin*.

Professor Headden, chemist of the Colorado Experiment Station, in Bulletin 131 concludes that the continued use of arsenical sprays is the cause of the "black heart" and certain forms of "root rot" of fruit trees.

RECENT PAPERS ON FUNGI

Professor Atkinson, in a paper on "The Identity of *Polyporus 'applanatus'* of Europe and North America" in *Annales Mycologici*, shows that the *Boletus applanatus* of Persoon (1799) was antedated by *Boletus lipsiensis* of Batsch (1786). Other specific names, as *megaloma* (Lev. 1846), and *leucophaeus* (Mont. 1856), are shown to be synonyms. Finally he shows that Karsen's genus *Ganoderma* probably should include this very common large bracket fungus, so that its name should be *Ganoderma lipsiensis* (Batsch) Atkinson.

Doctor Clinton's Report of the Station Botanist of the Connecticut Experiment Station for the year 1907 contains notes on fungous diseases for the year, a paper on the root-rot of tobacco, and a longer one on certain heteroecious rusts. The report is excellently illustrated.

Several important papers on fungi appear in the Twenty-first Annual Report of the Nebraska Experiment Station, viz., "Some Tomato Fruit-rots during 1907," by Miss V. W. Pool, with ten plates; "A New Form of Sphaeropsis on Apples," by Miss L. B. Walker, with ten text illustrations; "Seed Treatment for the Smuts of Winter Barley," by Dr. F. D. Heald, with four text illustrations; "The Mold of Maple Syrup," by Dr. F. D. Heald and Miss V. W. Pool, with seven text illustrations; "A Rot of Grapes due to *Pestalozzia uvicola*," by F. A. Wolf, with one plate.

An excellent popular description of the "Smuts of Sorghum" by Dr. E. M. Freeman and H. J. C. Umberger is published by the United States Department of Agriculture as Circular No. 8, of the Bureau of Plant Industry.

Charles E. Bessey
The University of Nebraska

GEOLOGY AND RADIOACTIVE SUBSTANCES

A paper of uncommon interest, particularly to geology and geophysics, has just appeared as a *Bulletin of the Geological Society of America* (vol. 19, pp. 113–146). The author, Dr. George F. Becker, of the U. S. Geological Survey, has brought together the physical data upon radioactive substances, reviewed them carefully for the information of any to whom they are not familiar, and then discussed their bearing on the solution of some of the great questions of terrestrial and cosmogonic history.

Assuming that the relation now established between helium, radium and uranium points to the common origin of the chemical elements, Dr. Becker calls attention to the fact that only helium, hydrogen and nebulium have been identified in the nebulæ, and that an orderly progression can be noticed in the atomic weight of the identifiable elements found in the stars. "Helium stars pass by the finest gradations into hydrogen stars of the Sirian type and these again into Solar stars" which contain elements of atomic weight as high as barium (137.4). The spectroscope has never indicated the presence of uranium in any celestial body, in the sun, or in meteoric matter, although helium is widely distributed. Furthermore, the uranium and thorium minerals on the earth are confined to the pegmatitic facies of the granites and syenites. There is, therefore, abundant incentive for a comprehensive investigation of a direct evolution of the elements from lowest to highest atomic weight, and the progress of this evolution will bear the closest relation to the evolution of our present earth.

Dr. Becker does not believe that inferences as to the age of the earth are competently drawn from the ratio of uranium to helium or to lead in particular minerals (Rutherford, Boltwood). Neither does the assembled physical evidence indicate that the high temperature of the interior of the earth is due in any considerable part to radioactivity (Dutton), though perhaps one tenth of the surface temperature gradient may be of such origin. This would accord with the determinations of the earth's age—not far from sixty million years—made by methods independent of the surface temperature-gradient, including his own discussion of a cooling globe printed in Science last February. There are definite limits of depth below which radioactive matter can not be expected and there is a conspicuous absence of uniformity in its distribution, the concentration in the ocean beds being particularly important.

Dr. Becker closes with a new and ingenious theory of the formation of granite which undertakes to account for the enormous energy content of the radioactive group of minerals. Supposing the earth to have sometime presented a surface of rhyolitic or trachytic magma, it may be supposed to have solidified under stable conditions at about 1,300°, surrounded by its atmosphere of water vapor far above the critical temperature of water. It is now assumed that granite must have formed by the surface action of water vapor (aqueo-igneous fusion) upon the rhyolitic or trachytic mass and that the temperature must have fallen below 800° for the stable formation of quartz. In the interval there must have been opportunity for a tremendous potentialization of energy near the surface. What offers a better repository for this than the formation of elements of high atomic weight which would then constitute with the granite a surface layer of limited thickness or a radioactive shell, as Dr. Becker terms it?

The whole paper is of extraordinarily suggestive character, not only in the direction of pure speculation, where but scanty data can ever be gathered, but in offering several points of contact with direct laboratory measurement.

Arthur L. Day

SPECIAL ARTICLES

PREGLACIAL DRAINAGE IN CENTRAL-WESTERN NEW YORK[1]

The present drainage in central-western New York is to the north. The principal river is the Genesee, which traverses the entire state from the Pennsylvania line, beyond which it rises, to Lake Ontario. Its principal tributary is the Canaseraga, which joins it below Mount Morris.

Throughout Allegany County, the Genesee flows in a comparatively broad and open valley with sloping drift-covered sides, and with more or less drift-filling in its bottom. In a few places the bed rock shows in the river bed, indicating that the drift-filling in the bottom of the valley is not deep. The middle portion of the river lies in a series of gorges, with a total length of about 20 miles. The first of these gorges begins opposite Portageville, and in it occurs the upper Portage falls, about 70 feet high. Beyond this the river passes across an ancient drift-filled valley, the rock floor of which lies nearly at the level of the present river below the upper falls. A partial reexcavation of this valley has produced Glen Iris. Having crossed the ancient valley on its rock bottom, the river drops a further 100 feet, cutting a gorge into the northeastern rock wall of the ancient valley to a depth of 365 feet. A mile and a quarter beyond this, the river again emerges into an ancient drift-encumbered valley, into the rock floor of which it has incised a narrow canyon. Just before this ancient valley is reached, the river makes a final drop of nearly a hundred feet, in the lower falls. The Genesee is thus incised at the lower falls about 250 feet below the rock bottom of the ancient valley which it crosses at Glen Iris. The distance between the two points is a mile and a half. The bottom of the gorge below the lower falls is likewise nearly 200 feet below the rock bottom of the ancient valley at that point. The two ancient valleys thus crossed by the modern stream have accordant bottoms. They are, however, two distinct valleys which join opposite Portageville, where the system of gorges begins. We will speak of these ancient valleys as the Glen Iris Valley, and as the Lower Falls Valley, respectively. The name Upper Genesee Valley is given to the open valley in which that river flows from its source to Portageville. The Glen Iris Valley and the Lower Falls Valley unite southward, and from Portageville south are continued as a single valley in the Upper Genesee Valley. A third narrower drift-filled valley joins the Upper Genesee Valley at this point, its mouth being at the head of the first of the postglacial gorges. Thus three ancient valleys, now drift filled, unite at Portageville, one from the north (Lower Falls Valley) a second from the northwest (Glen Iris Valley) and a third from the west. These valleys are con-

[1] Abstract of a paper presented before the New York Academy of Sciences, Section of Geology and Mineralogy, December 2, 1907. Read by title, Albuquerque meeting of the Geological Society of America, December 31, 1907. Only the main points are here discussed; the complete paper, which will appear shortly, will contain a detailed discussion of the critical points of the region. Since the manuscript of this paper was submitted (January, 1908) Fairchild's discussion of the drainage of this region (Bull. N. Y. State Mus. 118, January, 1908) and Spencer's "Evolution of the Falls of Niagara" (Can. Geol. Survey) have been received. In both the northward drainage systems are defended. Fairchild treats all the valleys as obsequent streams tributary to a westward flowing Ontario River, while Spencer reasserts the existence of his Laurentian River. These papers will be fully considered in the more extended discussion of this subject now in preparation.

tinued southward in a single valley about a mile wide (Upper Genesee Valley), which is only slightly clogged by drift.

Beyond the Lower Falls, the ancient valley is obscured by drift, yet not to the extent of becoming untraceable. The modern river makes a detour through the High Banks gorge, the walls of which are over 500 feet high. At St. Helena, four miles to the north of Portageville, the modern river again enters the old valley and continues in it for about 10 miles, flowing northeasterly. This St. Helena valley is clearly the northward continuation of the Lower Falls Valley, the old connection being drift filled. This course of the ancient valley (now partly reoccupied by the Genesee), from St. Helena to the Lower Falls, and thence in a direct line to Portageville, was outlined by Hall in 1842. Several miles above Mount Morris the modern river leaves this ancient St. Helena Valley, and has cut a fourth short gorge. At Mount Morris the modern river enters at right angles, from the west, a broad open valley nearly three miles in width and with a rock bottom 190 feet below the river level, and therefore more than 600 feet below the rock bottom of the ancient valleys first described, and more than 650 feet below the rock bottom (as tested by borings) of the Upper Genesee Valley at Portageville less than twenty miles away. In this broad and deep ancient valley, to which the present author fifteen years ago applied the name Preglacial Canaseraga Valley, the Genesee continues for thirty-five miles to Rochester, where it enters the Rochester gorge with its three falls. The preglacial Canaseraga Valley, which contains the Genesee flats north of Mount Morris, is continued southward as an open valley for fifteen miles to Dansville, beyond which it is choked by drift. The modern Canaseraga follows this valley to its junction with the Genesee at Mount Morris. This valley is clearly an independent valley, parallel to the Upper Genesee Valley, and cut by an independent stream as suggested by the author in 1894. There is practical unanimity of opinion on this point. The question at issue is: was this a northward or a southward flowing stream? It is generally held that this was a northward flowing stream, and that the Genesee, also a northward-flowing stream in preglacial times, joined the stream of this valley south of Mount Morris, by way of the broad Nunda Valley. The present Nunda River enters the Canaseraga Valley through a rock gorge. A careful examination of the banks of the Canaseraga Valley from Mount Morris southward, shows rock exposures everywhere, the lowest of which are more than 200 feet above the present bottom of the Canaseraga Valley. *The Genesee could not enter this valley except by a narrow gorge.* Moreover, unless it is assumed that the Canaseraga Valley was deepened by glacial erosion to the extent of 600 feet below its original depth, the Genesee could not be its tributary, since the old rock floor of the Genesee Valley is more than 600 feet above that of the Canaseraga Valley, the distance between the two being not much over fifteen miles along the supposed ancient course.

Attention is now invited to the Glen Iris Valley. This is half a mile or more in width, and 250 feet deep. Evidently such a valley could only have been cut by a stream of some length. If the Genesee flowed northward by way of the Nunda or some other channel, this valley must have been that of a tributary stream, unless it marks the path of the northward-flowing Genesee itself, as formerly suggested by the author. In any case this valley must have been continued far beyond Glen Iris. It is filled by local drift. For ten miles northwest from Glen Iris the country is flat and deeply drift-covered. Then we come to the Warsaw Valley, an ancient valley extending northwestward, and later bending to the north. At the bend north of Warsaw, another ancient valley, the Dale Valley joins it from the northwest. The junction is somewhat obscured by drift, but can be traced. The Dale Valley at its junction with the Warsaw Valley is as broad and deep as anywhere along its course. It is evidently a tributary valley. If the Warsaw Valley was cut by a northward-flowing stream, two streams, one from the southeast, and the other from the northwest came together at Warsaw in exactly opposite directions, and continued northward. The Dale would thus turn an angle of over 135 degrees, coming from the northwest, and turning north. Truly a remarkable course for a well-adjusted stream, though not an impossible one. On the hypothesis of a southward drainage, the Dale from the northwest and the Oatka from the north, united opposite Warsaw, and continued southeastward after the approved manner of normal streams. On this hypothesis we must look for a southeastward continuation of the Warsaw River formed by the junction of the Dale and Oatka. For ten miles the country is drift-covered, then we come to the Glen Iris Valley, which is exactly in line with the course of the Warsaw, and which, as we have seen, requires a northwestward continuation. This then is furnished after an interval by the Warsaw Valley, while conversely the Warsaw Valley finds its southeastward continuation in the Glen Iris Valley. Each finds its complement in the other, the requirements of each are fulfilled by the other. The only unknown quantity is the drift-filled interval between Glen Iris and Warsaw. Thus a southward drainage for the Preglacial Warsaw and its two tributaries, the Dale and the Oatka, and their junction with the Genesee at Portageville, explains all the known phenomena, and there are none known which oppose such an explanation. On the hypothesis of a northward flow of the Warsaw, many known facts are unexplained, many are opposed to it, and the drainage takes on a most complicated manner, instead of the simple direct course of a southward-draining system.

One of the chief objections to the hypothesis of southward drainage of the Warsaw and its tributaries is the greater depth of the Warsaw over the Glen Iris Valley. This difference finds a very simple explanation in the hypothesis of glacial deepening of the Warsaw Valley. Is there any evidence of such deepening? There is the most direct evidence. The sides of the Warsaw Valley are much steeper than those of ancient valleys not deepened. At the aforementioned bend of the valley opposite Warsaw, the west or concave bank is almost precipitous. It is here that a valley glacier would produce the greatest erosion. The drift in the southern part of the valley and between it and Glen Iris, is local, composed of the material gouged out of the valley. But the most conclusive evidence of glacial deepening of the Warsaw Valley is the junction of the Dale Valley. This, as has been said, is as broad and deep at its junction with the Warsaw Valley, as anywhere above. But its rock bottom is nearly 200 feet above the rock bottom of the Warsaw Valley. It is thus clearly a hanging valley, and the only explanation of this relation would seem to be glacial deepening of the Warsaw valley by ice. This removes the only known objection to the southward drainage of the Warsaw system.

Considering the southward drainage of the Warsaw system into the Genesee at Portageville as proved, we must next note that the stream which formerly occupied the St. Helena-Lower Falls valley, and into the floor of which the modern Genesee has incised its bed, was also a southward-flowing stream. This is generally accepted, and was, I believe, first pointed out by Fairchild. It could indeed be interpreted in no other way, since it was very evidently not the path of the ancient Genesee. As has been shown, a third ancient valley of smaller size joined the Genesee from the west. Thus three southward and eastward flowing streams united at Portageville. If the Genesee was a northward-flowing stream, and the combined system flowed out to the Canaseraga Valley by way of the Nunda Valley, a complicated system existed, with the streams turning back in direction upon themselves. Moreover, in that case the Canaseraga Valley was deepened by ice to the extent of 650 feet. That it was glacially deepened to some extent will be shown later to be the case, but the evidence is clear that such deepening was not more than half the amount required by the hypothesis of northward drainage, and probably much less.

On the hypothesis of southward drainage of the Genesee, the Nunda Valley must be regarded as that of a southwestward-flowing tributary of the Genesee. Its junction with the Genesee was about five miles south of Portageville, where now an immense drift barrier exists. The great apparent width of the Nunda Valley, much wider than the Genesee Valley, which has led almost all observers to accept it as the preglacial continuation of the Genesee, following Hall, is readily understood, when it is seen that the valley is worn out on the strike of the strata, and is therefore of the subsequent or inner lowland type. It lies at the junction of the soft Portage shales and the overlying hard Chemung sandstones. The latter form a cuesta inface, which rises several hundred feet above the top of the northern boundary of this broad and rather indefinite valley.

Coming farther south, we find an ancient valley joining the Upper Genesee Valley from the northwest, at Caneadea, where the present river makes a sharp bend. Still farther south, near Angelica, the ancient Black Creek joined the Genesee in a broad valley from the northeast. That the drainage, if southward, continued in the Genesee Valley to Wellsville, and beyond across the Pennsylvania line, and perhaps to the Susquehanna, seems to be indicated by the broad character of the Genesee Valley to within a short distance of the state line. The country beyond this point is deeply drift-covered, for we are near the terminal moraine. That this direction was not the one permanently followed by a southward-flowing stream is indicated by the much broader and more open valley which branches off from the Genesee Valley near Belfast, and which is followed by the Pennsylvania railroad to Cuba and Olean. This valley is as broad, open and deep as is the Genesee Valley. It is a very ancient valley cut into the hard Chemung rocks, and maintains its integrity all the way to the Alleghany at Olean. It is true that south of Cuba the valley is narrower, but this corresponds exactly to the nature of the rock. Near Cuba comes in the heavy Cuba conglomerate lentil, and a little south of Cuba this forms the bottom of the bank on either side. It is here that the narrowest part of the valley begins, perhaps half a mile to three quarters of a mile at the bottom, though over a mile at the top. This continues until the dip carries the conglomerate below the valley bottom, when the valley widens out again. This Cuba outlet forms an excellent one for a southward-flowing Genesee, to the Alleghany and thence to the Ohio, and the Mississippi. On the hypothesis of a northward-flowing stream, a divide must have existed somewhere in this Cuba Valley, unless the Alleghany and perhaps the Ohio also flowed north through the Genesee Valley. Then we are confronted with the remarkable fact that the valley at the divide is as deep and almost as wide and fully as well defined as at any other part. Regarded as the pathway of a southward-flowing tributary of the Alleghany, which, gnawing headward, finally tapped the Genesee at Belfast and diverted it into the Alleghany, all its characteristics are readily explained, and it becomes a part of a normal southward drainage system, of which all the features are normal and perfectly comprehensible. All that is required is a moderate tilting of the land as a whole, an elevation on the north, and a depression towards the south. That there is abundant independent evidence of such tilting is well known, and will be considered again. It will be shown farther on that the relation of these valleys to Lake Ontario is such that only a southward drainage can explain it.

Turning now to the Canasaraga Valley and its tributaries, we find that it constitutes an independent system, which in preglacial time had no connection with the Genesee. The valley south of Mount Morris, at which point the modern Genesee enters it, is as broad and open as above, in some places even broader, though its sides are steeper owing partly to the harder strata in which they are cut. The preglacial Canaseraga, then, which cut the southern part of the valley, was also fully competent to cut the northern part, without the aid of the Genesee River. As at present constituted the Canaseraga Valley is more than twice as wide as the Upper Genesee Valley, and its rock bottom is more than 600 feet below that of the Genesee. Evidently this was the master stream of the region, whether northward or southward flowing. From Mount Morris to Dansville the direction of the valley is southeastward, and half way between these two points, it receives a tributary valley from the north, this valley in its upper part being occupied by Conesus Lake. The junction of this valley with the Canaseraga Valley is more or less obscured by drift, but can be readily traced. The former stream of this valley evidently discharged southward into the Canaseraga, and if the course of that stream was northward, we have here a swinging of the waters of the preglacial Conesus through an angle of 135 degrees or more. Since the present northern end of Conesus Lake is only five miles in a direct line from the Canaseraga Valley at the village of Avon, a point twenty miles north of, and therefore, on the supposition of northward drainage, down stream of, the point where the ancient Conesus joined the Canaseraga, it is difficult to understand why a branch of the main stream from Avon did not capture and reverse the drainage, especially since the modern drainage is along that line, and the rocks there are softer than farther south. On the other hand, the hypothesis of a southward drainage, in preglacial times, of the Canaseraga and its tributaries meets with no such difficulties, and the form of the system is a perfectly normal one.

South of Dansville the Canaseraga Valley is filled with drift, the top of which has a nearly constant level between 1,300 and 1,400 feet above sea-level. Since the elevation of the valley bottom at Dansville is 700 feet, the depth of the drift is between 500 and 600 feet. This is mostly local, and its characteristics indicate that a glacier occupied the valley to Dansville, and the discharge from it built up the drift deposits in the valley to the south. This valley, the southward continuation of the valley at Dansville, is fully as broad and ancient as the valley at Dansville. Without change in character, this valley continues south past Burns and Hornell and so along the present Canisteo Valley to the Susquehanna. Any one who has traveled through this region on the Erie railroad, must have noted the well-developed and continuous character of these valleys. If there ever was a divide here between a northward- and a southward-flowing stream, as contended by the advocates of a former northward drainage, this divide was in a valley as broad, as deep and as open as any portion of the valleys of these two streams for fifty miles to the north and to the south of this divide. Of course one might account for the character of these valleys, by assuming that the entire drainage system of the Susquehanna, including that stream as well, discharged northward into the Ontario Valley, but I doubt if any of the advocates of northward drainage would go to such an extreme. The non-existence of divides in these valleys, such as should be expected in a normal drainage system, even though it were developed on an ancient peneplain surface, as we have good evidence to believe was the case with the drainage system under discussion, this absence of divides is in itself almost sufficient to condemn the hypothesis of northward drainage.

South of Dansville, where the ancient valley changes from a southeasterly direction to one a little west of south, the Wayland Valley, of similar width and ancient character, comes in from the east. Five miles east of the junction the Wayland Valley receives the Springwater Valley as a tributary valley from the north, opposite the village of Wayland. Seven miles north of Wayland, this ancient Springwater Valley forks, the two prongs being occupied by Hemlock and Canadice lakes, respectively. Here we have another drainage system, of the southward-draining type, which joins the Canaseraga near Dansville. Such a southward uniting of all the valleys is wholly inexplicable on the hypothesis of northward drainage during its development. The Wayland Valley continues eastward to North Cohocton, without change of character, and with an average width of about a mile. Here it receives another ancient tributary from the northeast. This also forks, and in the western branch lies Canandaigua Lake. The valley of Honeoye Lake comes in here from the north as another ancient tributary valley. The points of junction of these valleys near Naples are obscured by heavy drift deposits, but they are not difficult to trace. They are well shown by the outcrops of the strata delineated on the geological map of the

Naples quadrangle issued by the state survey. Here we have another series of southward-uniting valleys, easily understood as tributary, with other similar series, through the Wayland Valley, to a southward-flowing Canaseraga, but difficult to understand if not inexplicable on the hypothesis of preglacial northward drainage.

If this system drained southward, and there seems to be no escape from such a conclusion, it appears that the Honeoye and Canandaigua system originally drained south by way of the Cohocton to the Chemung and the Susquehanna, but was diverted by capture to the Canaseraga-Canisteo drainage system. Or it is possible that the Canandaigua-Honeoye system originally was tributary to the Canaseraga, and that the Cohocton cut off these more eastern branches from that drainage system, conducting them by a shorter route to the Chemung than is traversed by the more western tributary of the same stream. If that was the case, the capture by the Cohocton was accomplished in comparatively late preglacial time, since the Cohocton Valley is still narrow, though deep. We do not know enough of the elevations of the rock bottoms of these ancient valleys to decide which is the more likely.

On the hypothesis of northward drainage, we are again confronted by the anomalous character of the valleys at the point where a divide should have existed. Dryer has pointed out that the broad, open character of the east and west Wayland Valley is incomprehensible on the hypothesis of northward drainage, such a valley being entirely out of place at the divide of two normal river systems which flow in opposite directions. On the hypothesis of southward drainage this valley is easily understood.

It should be noted in this connection that the rock bottom of the Wayland Valley, so far as it is known from outcrops in the beds of streams south of Dansville, is above that of the Canaseraga Valley, the difference being perhaps 200 feet. Since the valley at Dansville is a thousand feet deep, not counting any drift-filling in the bottom of this valley, this difference is of no great significance, so far as the importance of the valleys is concerned. It indicates a deepening of the Canaseraga Valley by ice. This is further suggested by the steepness of some parts of the banks of the valley at Dansville, and the local character of the drift which partly fills the southward continuation of the Canaseraga Valley.

A glance at the geological and topographical maps of the regions around the other Finger lakes shows that they too have the southward drainage expression. Keuka Lake has two southward-uniting branches, the united valleys becoming tributary to the Cohocton. Seneca and Cayuga Lakes are continued southward in more or less open valleys to the Chemung and Susquehanna. That these and many of the other valleys were more or less deepened and widened by ice erosion is, I believe, pretty generally held in spite of objections raised against this idea. The evidence seems to be overwhelmingly in favor of this explanation of their characteristics.

Let us now consider the evidence which Lake Ontario has to offer in this connection. Opposite the mouth of the modern Genesee, the lake is 576 feet deep. Eighteen miles further east it is 738 feet deep. The surface of the lake is 247 feet above mean sea level. The fall of the Genesee from Mount Morris to Avon is ten feet in a distance of fifteen miles in a straight line but twice that distance by the river. This gives on the average a fall of a third of a foot per mile. The rock-bottom at Mount Morris is 191 feet below the river level; at Cuylerville, four miles to the north, it is 184 feet below that level. At Piffard, four miles farther north, it is 158 feet below the same level. This gives a *rise of the rock floor northward,* of about six feet for the first four miles and of twenty-six feet for the next four miles. The record at Piffard is probably not of the greatest depth, yet the northward rise of the rock floor of this valley seems to be undoubted. Taking the smaller figure, a rise northward of 1½ feet per mile, the rock bottom of this ancient valley at Lake Ontario, forty miles north of Mount Morris, would be 196 feet above the *level* of Lake Ontario, or 772 feet above its floor (934 feet above its deepest part). This is truly an astonishing relation for a tributary of a river occupying the Ontario Valley. The differences in elevation between the rock bottom of the Canaseraga Valley (modern Genesee Valley) at Mount Morris, forty miles south of Lake Ontario, and the surface of Lake Ontario, is 136 feet; the rock bottom at Mount Morris is 712 feet above the valley bottom of Lake Ontario opposite the mouth of the modern Genesee, and 874 feet above the deepest part of Lake Ontario, seventy miles away. We have seen evidence that the valley at Mount Morris was deepened by ice to the extent of at least 200 feet. This would make a difference of over a thousand feet between the valley bottom at Mount Morris and the bed of Lake Ontario. The advocates of northward drainage will find it difficult to make the preglacial Genesee descend this interval in the space of seventy miles. Nor can they appeal to constant deepening of the valley northward, which would enable us to regard the difference as due to tilting; for we have seen that, instead of declining, the valley bottom rises northward, until on the smallest recorded rise it reaches very nearly the general level of the country about Rochester.

It is thus very evident that the valley of Lake Ontario has been deepened far below that of the Genesee and Canaseraga Valleys. (The rock floor of the Genesee Valley at Portageville, which on the hypothesis of southward drainage is regarded as independent of the Canaseraga Valley, is 1,500 feet above the deepest part of Lake Ontario, the distance between the two points being about ninety miles.) What has produced this excessive deepening? Those who know the region will not consider differential warping as a factor: the dip of the strata scarcely varies over this region. Ice erosion of the Ontario Valley can not be appealed to, since the course of the valley is nearly at right angles to the movement of the ice. (The question of ice erosion of the Ontario Valley has been fully discussed by Gilbert, and more recently by Grabau in the Bulletin on Niagara Falls. Both authors agree that the evidence does not favor the ice erosion theory.) Other explanations, such as deepening by the solution of the limestones are not favored by the facts. The only satisfactory explanation seems to be that Lake Ontario Valley was deepened by normal river erosion. If that is the case, and the preglacial streams of western New York flowed northward, and were tributary to the Ontario River, their valleys should have been deepened in conformity. That they were not so deepened is a powerful argument against the northward flow of these streams.

On the hypothesis of southward drainage first advocated by the present writer, in 1901 (Bull. 45 N. Y. State Museum), and subsequently in this journal, the ancient valleys of central and western New York must be regarded as formed by streams arising in the Canadian region, and flowing across New York. They were gathered in by either the Susquehanna or the Alleghany. This drainage developed upon an old peneplain which beveled the strata, as shown by abundant evidence (this is discussed quite fully by Grabau in Bulletin 92, New York State Museum). The development of this drainage system took place in Tertiary time, when the land in the north stood high, and the Mississippi embayment and the Atlantic coast south of New York were depressed. The evidence for this is well known. The main stream of the region was the Dundas, flowing out through the Dundas Valley at the west end of Lake Ontario. This stream was of the consequent type, and one of its subsequents carved out the broad Ontario Valley as an inner lowland on the soft Siluric and Ordovicic strata. This subsequent stream gradually beheaded the streams flowing across New York, capturing their headwaters, and carrying the drainage to the Mississippi embayment. Such a stream would soon deepen its valley on the soft Medina rocks, and thus the great subsequent deepening of Lake Ontario would be accounted for. This deepening, then, occurred after the valleys of New York were cut, these valleys remaining behind with beheaded southward-flowing streams which were incapable of deepening or widening their valleys any further. Meanwhile short northward-flowing or obsequent streams came into existence along the southern border of the deepening Ontario Valley. This southern border, partly shown in the Niagara escarpment, must be regarded as the inface of a revived cuesta, of which the Ontario Valley is the inner lowland. Examples of obsequent streams flowing down the inface of the cuesta, and cutting backward from it, are found in the old Saint David's gorge, which had cut back as far as the present Whirlpool; in Irondequoit Bay, often regarded as the former path of the Genesee, but clearly deepened beyond any depth reached by the Genesee or Canaseraga; and probably Sodus Bay. Eastward the Ontario Valley becomes narrower though the flooded portion is wide. The Ontario River headed eastward, probably passing through Oneida Lake from Little Falls, where the divide between the eastward-flowing Mohawk and the westward-flowing Ontario River was situated. At the Thousand Islands occurred another divide, between the northeastward-flowing preglacial St. Lawrence and a southwestward-flowing tributary of the Ontario River. Spencer's Laurentian River, which carried the drainage of all the Great Lake valleys (except Superior) out across the Thousand Island divide, never existed. There is no good evidence for, and abundant evidence against, its existence.

To sum up: The evidence seems to be all in favor of southward drainage in Tertiary time of the streams which cut the Finger Lakes and the other parallel valleys of New York. Many of these were subsequently deepened by ice erosion. Part of this drainage went out by the Susquehanna to the Atlantic, and that of the more western valleys probably to the Ohio and Mississippi embayment. The drainage of the valleys of the Great Lakes also went out in that direction, and the system developed as a normal sequential drainage system on a peneplain surface of nearly horizontal strata. Capture of the headwaters of the New York streams left their beheaded portions in the old valleys which they had not the power to further deepen or widen. The Ontario Valley, however, was deepened without reference to the Finger Lake Valleys. All this occurred while the land in the north stood higher than now, and the Mississippi embayment and the Atlantic coast south of New York, lower, as shown by marine sediments of Tertiary age.

A. W. Grabau

Columbia University,
December, 1907

NOTES ON A SMALL COLLECTION OF SHELLS FROM TEXAS

During part of the month of August, 1906, Mr. A. B. Wolcott, a Chicago entomologist, collected extensively about the region of Brownsville and Corpus Christi, Texas, and incidentally secured an interesting collection of land and fresh-water mollusks. Mr. Wolcott found the river very high and hence was able to do nothing in the way of collecting the Unionidæ. A few fresh-water shells were secured from the river drift. The land mollusks were notably abundant, particularly the Polygyras and the Bulimulæ, as were also the Helicinas and the Euglandinas. No novelties were obtained, but the material seems to be of enough interest to be placed on record. The collection has been presented by Mr. Wolcott to the Chicago Academy of Sciences.

In working up this list constant reference has been made to the excellent paper by Pilsbry and Ferriss, on the "Mollusca of the Southwestern States," II., published in 1906 in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, page 134.

HELICINIDÆ

Helicina orbiculata tropica "Jan" Pfr.

Corpus Christi; tropical forests, Esperanza ranch, Brownsville, on shrubbery; river drift, Brownsville; on beach, Port Isabel.

In a lot of 25 specimens, 5 are partly red and blue and the balance are blue. A common species in this locality.

HELICIDÆ

Praticolella griseola (Pfr.).

Chaparral near Brownsville; old Fort Brown and in river drift, Brownsville; Port Isabel, on beach.

The specimens collected show a wide range of variation in the number and position of the bands. Specimens from Brownsville are strongly banded, the lower band being very wide or split up into from two to six bands. In one specimen there are two wide, dark, brownish-black bands; in the rest of the specimens the bands are light brown in color.

Praticolella berlandieriana (Moricand).

Sinton, under railroad tie; river drift in Brownsville; Corpus Christi.

Several of the specimens are unicolored and translucent. Apparently a rare species in this locality.

Polygyra texasiana (Moricand).

River drift, Brownsville; under mesquite in house-yard, Brownsville; on beach, Port Isabel; Corpus Christi.

The specimens of *texasiana* collected by Mr. Wolcott show a large amount of variation both in size (7.50 to 13.50 millimeters in diameter) and in the height of the spire, the latter varying from flat to strongly elevated. Several specimens have the aperture modified, a characteristic due to immaturity or disease. Three specimens are without a parietal tooth and one specimen has a single very small parietal tooth and two small tubercles in place of the peristome teeth. The sculpture of the lot of eighty specimens is interesting. Forty-six are typical *texasiana*, 22 are transition forms between this and the next variety and 11 are typical *hyperolia*.

Polygyra texasiana hyperolia Pilsbry.

River drift, Brownsville.

Apparently not common.

BULIMULIDÆ

Bulimulus dealbatus liquabilis Reeve.

Corpus Christi.

Two specimens apparently referable to this race of *dealbatus* were found in a lot of *B. alternatus mariæ*. They are rather corpulent, unicolored and resemble fig. 7, pl. 6, of Pilsbry and Ferriss's paper.[1]

Bulimulus alternatus mariæ Albers.

Sinton, on mesquite; Point Isabel, on beach; Brownsville; Corpus Christi.

The Brownsville specimens show a wide range of variation in color. Eleven are pure white, 29 have the upper whorls streaked, 19 are irregularly striped all over and 2 are plain chocolate colored. Two specimens with streaked spires have a well-developed columellar tooth and several specimens show a thickening in this region. Of the Corpus Christi specimens six have a columellar tooth while seven are without it or have only slight indications of it.

OLEOCINIDÆ

Euglandina singleyana (W. G. Binney).

Tropical forests, La Esperanza Ranch, Brownsville.

Apparently a common species. The two dozen specimens secured show little or no variation.

PUPILLIDÆ

Pupoides marginatus (Say).

Old Fort Brown, Brownsville.

Typical, but apparently not common.

Bifidaria pellucida hordeacella Pilsbry.

Old Fort Brown, Brownsville.

Very common, associated with the two following species.

Bifidaria procera (Gould).

Old Fort Brown, Brownsville. This is the most common pupa in the Brownsville region. It varies somewhat in corpulency.

Bifidaria contracta Say.

Old Fort Brown, Brownsville. Not particularly abundant.

ZONITIDÆ

It is singular that Mr. Wolcott secured no representatives of this family, as the various species are common throughout Texas.

SUCCINEIDÆ

Succinea luteola Gould.

On mesquite near Brownsville. Very common and typical. Specimens of all sizes were obtained, varying from the young, about 2 millimeters long, to old specimens 16 millimeters in length.

PLANORBIDÆ

Planorbis glabratus Say.

River drift, Brownsville. Several specimens, the majority of which are half-grown, seem referable to this species, which would seem to be distinct from *trivolvis*, the whorls being narrower and the shell generally more polished.

Planorbis cultratus Orbigny.

A single specimen of this acutely keeled *Planorbis* was found in river drift at Brownsville. It measures 3 millimeters in diameter.

Planorbis liebmanni Dkr.

River drift, Brownsville.

Segmentina obstructa (Morel).

In river drift, Brownsville. Numerous and apparently typical.

Frank Collins Baker

[1] *Proc. Phil. Acad.*, 1906, p. 134.

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The fifteenth summer meeting of the society was convened at the University of Illinois on Thursday and Friday, September 10–11, 1908. The scientific program occupied a morning and an afternoon session on each day. On Thursday evening a social gathering and dinner at the University Club contributed much to the pleasure of the occasion.

The first session was opened with an address of welcome by Professor E. J. Townsend on behalf of the University of Illinois. In the absence of the president of the society, Professor H. S. White, the chair was occupied by Vice-president Professor G. A. Miller, relieved by Professors E. B. Van Vleck and Ziwet. At the close of the meeting resolutions were adopted expressing the society's appreciation of the generous hospitality of the University of Illinois and its officers.

The total attendance at the various sessions was over fifty, including thirty-eight members of the society. Among the visitors present was Professor Max Abraham, of the University of Göttingen. At the meeting of the council the following persons were elected to membership in the society: Dr. G. G. Chambers, University of Pennsylvania; Dr. G. M. Conwell, Yale University; Mr. F. F. Decker, California Polytechnic School; Professor A. E. Haynes, University of Minnesota; Mr. P. H. Linehan, College of the City of New York; Mr. H. F. MacNeish, University High School, Chicago; Mr. Lewis Omer, High School, Oak Park, Ill.; Professor J. C. Stone, State Normal College, Ypsilanti, Mich. Six applications for membership in the society were received. The total membership is now 598.

The following papers were read at this meeting:

Eduard Study: "Zur Differentialgeometrie der analytischen Curven."

L. E. Dickson: "On definite forms in a finite field."

G. A. Miller: "Answer to a question raised by Cayley as regards a property of abstract groups."

Arnold Dresden: "The second derivatives of the extremal integral."

O. E. Glenn: "On the decomposition of forms into quadratic factors."

Louis Ingold: "On the Kowalewski integral."

L. D. Ames: "A method for the approximate solution of n equations in n unknowns."

Oskar Bolza: "Heinrich Maschke: his life and work."

G. A. Bliss and Max Mason: "Fields of extremals in space."

J. B. Shaw: "Qualitative algebra."

Virgil Snyder: "Construction of plane curves of given order and genus having distinct double points."

Arthur Ranum: "The division of riemannian space into congruent parts."

Arthur Ranum: "Parallelopipeds in lobachevskian geometry."

F. L. Griffin: "Families of central orbits related to circular trajectories."

F. R. Sharpe: "The identical relations of the strain and stress components of an elastic solid."

Virgil Snyder: "Surfaces derived from the cubic variety having nine double points in four dimensional space."

L. E. Dickson: "On Fermat's last theorem."

L. E. Dickson: "Rational reduction of two quadratic forms" (preliminary communication).

W. R. Longley: "Note on implicit functions."

E. B. Wilson: "Note on statistical mechanics."

E. J. Wilczynski: "A projective generalization of Meusnier's theorem."

E. R. Hedrick: "On the convergence of the jacobian."

Edward Kasner: "Conformality in connection with functions of two complex variables."

G. A. Miller: "Groups with regard to modular systems."

J. W. Young: "Two-dimensional chains and the classification of complex collineations in a plane (second paper)."

J. H. Maclagan-Wedderburn: "On the direct product in the theory of finite groups."

W. B. Fite: "The class of a group all of whose operations except identity are of order three."

C. N. Moore: "The summability of the developments in Bessel functions, with applications."

E. J. Townsend: "Interchange of order of differentiation."

H. B. Newson: "On characteristic equations."

L. W. Dowling: "The arrangements of the real branches of a plane sextic curve."

C. N. Haskins: "On the second law of the mean."

L. I. Hewes: "Necessary and sufficient conditions that an ordinary differential equation of the first order and nth degree shall admit a continuous conformal group."

The next meeting of the society falls on Saturday, October 31. The San Francisco section held its fourteenth regular meeting at the University of California on September 26. The southwestern section will meet in the Thanksgiving holidays.

F. N. Cole,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 23, 1908

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 FUNCTION OF THE ENGINEER IN THE CONSERVATION OF THE NATURAL RESOURCES OF THE COUNTRY

THE prosperity of a country depends primarily upon its natural resources. The raw material which the farmer and the manufacturer use and the products of which furnish business for the merchant, come from or depend upon timber, fuel, minerals, soil, water. These are the natural resources of any country, and as they exist in large or small quantities, as they are easy of access, as their quality is good or bad, must depend the agricultural and industrial prosperity and success of the nation. Some countries have large supplies of one or more of these natural products and a few are blessed with them all. This country is especially fortunate in that it originally had within its bounds not only all of these natural resources, but large quantities of each of them, and that they were rich in quality and easy of access. When the country was first settled by Europeans, the new inhabitants gave little thought to the question of natural resources except in so far as these directly concerned their daily life. They established themselves where the soil was rich because they wished to pursue agriculture as a vocation, but they made no study of soils further than this. Forests were regarded as an encumbrance to be cleared away as soon as possible, for they interfered with agriculture, which was the chief business, and they were the lurking places of wild beasts and wilder men. They were useful only for the purpose of furnishing lumber and fuel. A very small amount of forest on each farm was sufficient for these purposes and so the settler did not hesitate to cut down as much as he possibly could. The other natural resources he knew little or nothing about. It was many years before coal came into use, and then only in those sections where it could be dug from the ground near at hand. Precious metals were unknown. The little iron that was used was brought from abroad. The waterways were used wherever possible and in many sections of the country they were the only avenues of travel and the supply of water was sufficient for the purpose of navigation. Under conditions such as these it was only natural for the inhabitants to suppose that the resources of the country were inexhaustible. They had all they could use and more, and if they had thought of the question of exhaustion, it would have seemed to them that all they had to do was to move to another section, north, south or west, and start over again. While they depended for their livelihood upon one of the natural resources, the soil, they were practically independent of most of the others. And hence they regarded them as of little moment. As the country developed and civilization increased their dependence upon the natural resources increased also, but at first in a scarcely perceptible way. This dependence has grown up to the present time, but it is still difficult to make people see the force of this dependence. Most of the products which come from the natural resources of the country are used at a great distance from the raw material, and hence it is difficult for people to realize the connection between the two and their dependence upon the latter. The natural resources have been so freely drawn upon and often so ruthlessly used that already along some lines they are beginning to disappear to an alarming degree. Investigation has shown that they are in great danger of exhaustion. This is a grave state of affairs and proper steps should be taken so far as possible to prevent it by preserving the natural resources that remain and by carefully and judiciously using them in the future. Unless we can prevent the absolute destruction of the natural resources the ruin of the nation is assured. We should aim to transmit to the generations which are to follow us a country which is better than the one we received from our ancestors and not one which is being rapidly depleted and impoverished. That this can be done has been shown by the work of scientific men during the past few years. Of course some of the natural resources can not be replaced, but their rapid depletion can be stopped and they can be preserved for our use for many centuries. The soil should never be allowed to grow poor. It should grow richer as it is cultivated longer. The forests can be retained through planting at the same time that timber is being cut for use. Fuel and iron can not be replaced, but they can be carefully and economically used. The use of water, either for navigation or power, does not destroy the water and hence does not endanger the waterways system.

With the growth of civilization the wants of men multiply and hence greater demands are made upon nature, for the supply with which these wants are satisfied must come primarily from nature. This will cause a greater drain in the future than in the past. The use of the natural resources has made us a great nation, and if we are to maintain our position among other nations we must be able to use these natural resources in the future, and even to draw upon them to a greater degree. This makes it absolutely essential that the wasteful methods now in use should cease and that a careful and systematic study of the use of the materials we now have be intelligently made. Our land is nearly all taken up. There is remaining in the possession of the government a comparatively small amount excepting that which is useless for cultivation. Nearly all the forests have disappeared; in some sections entirely so, and very little effort has been made to replace them. Our coal and iron are rapidly disappearing and will in time entirely disappear. Our waterways are injured and many of them are entirely useless for navigation or for power. The question of the conservation of our natural resources is then a serious one and deserves careful and mature deliberation. Even with the natural resources not in danger of exhaustion it would seem wise to use them to the best advantages.

On May 13, 14 and 15 there was held at the White House in Washington a conference on the conservation of the natural resources of the country. This conference gathered at the invitation of the President of the United States and was composed of the governors of the states with three delegates from each state appointed by the governor; of the members of the cabinet, the judges of the supreme court, some of the members of congress, and representatives from all the great engineering societies. As president of this society I received an invitation and attended the conference. This meeting was one of the most notable ever held in the country. The President of the United States opened each session and presided at the first and last. At the opening session he delivered a strong address upon the question of conservation which is one that has received his earnest attention for many years. The governors of forty-four states were present. Many members of the cabinet, of the supreme court and of both houses of congress accepted the invitation and attended one or more of the sessions.

Addresses were made upon the subjects of forestry, fuel, mineral products, soil wastage, irrigation and the waterways. Papers were read by Mr. Andrew Carnegie and Mr. James J. Hill, who have taken a great interest in the questions under consideration. Many of the governors and quite a number of the other delegates took part in the discussion. Every one present seemed to be impressed with the importance of the gathering. To many of the governors and their associates the subject seemed to be entirely new. It had never been directly presented to them and they had not, of course, understood its importance, but there was not a dissenting voice as to the necessity of conserving our natural resources and making them serve the nation as long as possible. A number of the governors stated that upon their return home they would immediately appoint forestry and other commissions which would study these questions within the borders of their states, and that when these commissions made their reports they would do all in their power to carry out the recommendations.

The representatives of the scientific societies probably appreciated the condition of affairs and the momentous possibilities of the questions discussed better than any one else with, perhaps, the exception of the president. Some of them read papers and a number took part in the discussions. At the close of the session a statement of the present condition of affairs and a recommendation as to the proper steps to be taken to conserve the natural resources of the country were adopted as the sense of the convention.

The engineer adapts the forces of nature to the use of men and this adaptation should be done both economically and efficiently. It is not enough to show that a certain force can be made to work when a machine transforms raw into finished product. The work must be done efficiently—

that is to say, the greatest amount of good must come from a given expenditure of energy. This makes the machine efficient and shows that it is doing all that it is possible for it to do, and when this is the case it is generally considered that the engineer has successfully performed his duty. If it is a question of using the force or material in some other way, through some other kind of machine; then the engineer may also be concerned and it may be necessary for him to change his methods of work to conform to a new demand—that is, of economy. In some cases the application of the force or the use of material is not economical, for reasons which are beyond the power of the engineer to control, for they may be economic in their character. In the future, waste of raw material should be abhorrent to the engineer and his aim should be to conserve the materials which nature has provided for his use. The agriculturist and the forester, as well as the engineer, are concerned in the conservation of the natural resources, but in a broad sense all may be considered as belonging to the same class. They all develop the natural resources of the country and prepare them for the use of men. I shall speak of these resources separately and try to show in what way the engineer, the forester and the agriculturist may work for their conservation.

FORESTS

I have already stated that in the early days of our history it was the one aim of the settler to destroy the forests because they were in his way. He was an agriculturist and needed to have his land cleared of trees and other obstructions in order that he might harvest the greatest crop. As the country grew the demand for lumber increased and then it became necessary to save the trees in the forest and turn them into lumber, but the supply still seemed inexhaustible and only the finest and best of the trees were used. The destructive use of the forests thus begun has continued ever since, though perhaps not in so great a degree. It takes from thirty to seventy-five years to grow a tree, but the lumbermen only cut those which have grown the straightest and cleanest and only use the best parts of the tree that is cut. The branches and the upper part of the tree are left to decay in the forest. They are not only wasted, but they are scattered over the ground in such a way as to prevent future growth, for the soil is covered with a mat of material through which it is hard for any living thing to penetrate. It is necessary to burn this over in order that a new growth may rapidly start. But the burning over of the forest effectually kills the young trees which were growing among the old ones and thus entails a further loss upon the forest and its owner.

The demand for lumber has increased enormously during the past few years. In 1880 the consumption per capita in the United States was 360 feet, while in 1906 it was 440 feet. The total amount of lumber cut in 1906 was over 40,000,000,000 feet, and this yearly amount will largely increase in the future, both through the increase in population and through the increase per capita, unless some steps are taken to prevent it. No accurate census of the amount of timber in the country has been made, but it is estimated that we have now of standing timber about fourteen hundred billion feet. We are using forty billion feet per year. Upon this basis the present lumber supply will last thirty-five years, but this does not take account of the increase in the amount used per year nor does it take into account the amount of timber which will grow during the next thirty-five years. If nothing is done to increase our forest area we may suppose that these two will balance each other, although it is probable that the lumber cut will increase faster than the growth. But even the more conservative calculation shows that our forests can not last more than thirty-five years on the present basis of cutting. Long before that time the cost of lumber will largely increase and at the end of that period there will be no timber fit to cut. When we consider the extent to which wood is used at the present time, how much it means to all men, this is a most serious question.

The government has tried to check this depletion of our forests by establishing forest reserves in different parts of the country. It is estimated that at present there are in forests about seven hundred million acres, of which twenty per cent. are in national and state hands. This does not mean that all of this land is fully covered with forests, for large sections of it may be totally barren, but surrounded by forests in such a way that it is necessary to call the whole forest land, until a very accurate survey has been made. The National Bureau of Forestry of the United States Department of Agriculture and a number of state departments of forestry have done a great deal towards arousing public interest in the subject and establishing scientific methods of cultivation. Many of the state universities have established departments of forestry which are training foresters to take charge of the development of the forest interests of state and nation.

It is evident that in the future lumber must be considered as a crop to be planted and tended and harvested with the same care that other crops receive. It differs from them only in the methods of cultivation and the length of time necessary for its development. Under this scientific treatment trees will be planted on waste areas or other sections where ordinary crops are not profitable; they will be thinned out until only those which are likely to attain a mature growth are left, and they will be guarded against the destructive effect of forest fires. When a certain proportion of the crop is ready for harvesting the lumbermen will go in, cut the proper trees, carry away or burn the tops and branches, and then the forester will plant new trees in place of those felled. In a few years another crop will be ready and the same treatment will be repeated. The older forests will be treated in a similar way except that the first stage of planting will not be necessary. In this way the forests will yield a regular crop of lumber once in so often. Under this treatment the forests become profitable to a very much greater degree than under the old method of cutting off all trees large enough for lumber at one time and practically destroying all the young growth.

In some European countries where this method of forestry is in use the entire public expenses of many townships are met by the sale of timber from the public forest lands. Our government reserves now yield but a very small income, but in time, as they are brought under the proper cultivation, they will yield large results. As soon as forest planting is taken up on a large scale by national and state governments and by individuals, the lumber question of the future will be settled. This process, however, is a slow one and we must expect that before that time comes the present forest reserves will be largely exhausted. The danger, however, has been seen and the necessary methods for its correction have been developed. This has been the work of the scientific forester, but the labor can only be done by those agencies which can supply the necessary funds.

The engineer is greatly interested in this question because he needs timber for many of his operations. He also has a hand in the conservation of our forest areas because of the use which he makes of steel and concrete in structural work. The amount of cement manufactured and used in the United States has increased each year until now it has reached vast proportions. Its use will be greatly increased in the future, especially in structural work, as we learn more and more about the strength of concrete reinforced with steel. The United States government, engineering concerns and technical colleges are making an extensive study of this great engineering question and the results of their researches are put into practise as soon as they are published. Every engineer believes that the opportunity for this kind of investigation is very great and that it should be encouraged by both national and state governments.

FUEL

Manufacturing industries depend upon fuel, and cheap fuel is a vital element of our supremacy in the world's markets. The amount used at the present time in the United States is very large. In 1906 the coal mined amounted to four hundred million tons of a value of five hundred and ten million dollars. The petroleum was valued at ninety million dollars; natural gas at fifty million dollars; coke at one hundred and ten million dollars and artificial gas at thirty million dollars. The total value of all fuels, including by-products, was almost one billion dollars.

Coal is found in almost every section of the United States, twenty-nine out of forty-six states having coal beds. Natural gas and petroleum are also found in many of the states. No matter how large the supply of these fuels may originally have been, a yearly drain, such as just mentioned, will inevitably in a few years sadly deplete it, and the amount used is increasing every year and at a very rapid rate. But this is not all; the figures just given are those for the fuel taken from the ground and used, but the amount wasted doubles or trebles this total. Although this latter has not been put to any use, it has been destroyed so far as its future usefulness is concerned.

Natural gas is one of the most perfect fuels in existence. It is found under such pressure that it can be carried long distances and delivered in the factory ready for use. The turning of a cock regulates the supply and there is no dirt or loss. Many wells which yield small amounts are allowed to waste their supply in the air and it has frequently happened that the product of large wells is more or less wasted because proper piping is not at hand or proper precautions have not been taken. In many oil wells there is more or less gas and little if any effort is made to secure this supply. One geologist estimates that at least a billion cubic feet of gas per day are allowed to go to waste in the United States. Only one state, Indiana, has passed stringent laws against this waste. This state found that her supply of natural gas was rapidly being exhausted and that factories formerly dependent upon it were obliged to change to some other form of fuel. After a large part of the supply had been exhausted, laws were passed forbidding operators to open gas or oil wells until precautions had been taken to save all the gas.

The waste in coal mines is very great. Nearly every coal vein has streaks of sulphurous or bony coal mixed with the first-class material. This contains a large amount of carbon, but is not as valuable as some parts of the seam; it is, therefore, left in piles inside the mine or dumped upon the culm bank on the outside. The amount of this low-grade coal varies from ten to fifty per cent. in every mine, and under the present system of mining and of coal using this is an absolute loss. As the roofs of coal mines will not support themselves and as timber is expensive it is the custom to leave great pillars of coal in the mine as supports. As a rule, these pillars are not taken out and so become absolute waste. In most coal mines there are several layers of the coal separated by shale formation. Some of these are narrow and can not be mined to advantage; others are so broken up and dislocated by the mining of adjacent seams that it is impossible to take them out. All of these causes and perhaps some others make up a loss of from forty to seventy per cent. of the coal in the average coal mine of the country. As we obtain only thirty to sixty per cent. of the coal, it is evident that we are exhausting our coal fields twice as fast as the actual amount of fuel used would indicate.

This immense drain upon the coal supply must very soon have an effect. It has been estimated that our anthracite coal can not last more than seventy-five years. The bituminous coal will last much longer, but it will become exhausted in those places where it is now used to the greatest extent. The most important coal vein in the United States is in the Pittsburg belt and is being more rapidly mined than any other. Each acre of land has supplied about eight thousand tons of coal, and at this rate the state geologist of West Virginia estimates that at the beginning of the next century there will be no coal within one hundred miles of Pittsburg. No one can fail to perceive that this will be a terrible blow to the manufacturing industries of that great industrial center. In many sections of the country where neither anthracite nor bituminous coal is found large deposits of lignite exist. This lignite can be used for heating purposes in houses, but is worthless for manufacturing purposes because the amount of ash is so great that it will not produce steam. In sections of country where this is the only fuel supply it is necessary to bring coal from long distances, which makes it very expensive and puts a great tax upon manufacturing industries.

Our coal measures cover such an extensive area and the supply has seemed so great that the conservation of our fuels has received very little attention until within the past few years. In 1903 the Technologic Branch of the United States Geological Survey was established in St. Louis in connection with the exposition, and since then a very extensive study of the fuel supplies of the country has been carried on. Dr. Holmes, the director of this branch; Professor Lord, of the Ohio State University, in charge of the chemical work; Professor Breckenridge, of the University of Illinois, in charge of the boiler tests, and Professor Fernald, of Case School of Applied Science, in charge of the gas producer and gas engine tests; are all members of this society. The results obtained by these men, all of them engineers, have been of an astonishing character. It has been found that the fine coal, the refuse of mines and breakers, hitherto regarded as of little value and sold at an extremely low price, can be made into briquettes at a comparatively low cost and it is then as valuable as the finest coal that can be obtained. It has also been found that many non-coking coals can, by proper methods, be coked as readily as the best coking coals of Pennsylvania. These two results alone are worth many times as much as this bureau has cost the government, for certain manufacturing industries must have coke for fuel and in some sections it has been necessary to bring the coke from long distances because no coking coal was at hand, although large supplies of other coal were easily obtainable.

But perhaps the most wonderful results from these experiments have come through the investigations in regard to the use of coal in the gas producer and the gas engine. With the old processes we do not obtain on the average more than five per cent. of the heat value of our coals. The steam engine utilizes from four to ten per cent., but the gas producer and the gas engine utilize from eleven to eighteen per cent. Coal converted into gas produces, then, two and one half times as much power as when burned under a boiler. The best Pocahontas coal under a boiler was found to produce .28 H. P. per pound of coal per hour, while with a gas producer the same amount of coal produced .96 H. P., or 3.34 times as much as when used in the ordinary way. A lignite which would produce only .01 H. P. per pound of coal per hour when used under a boiler produced .35 H. P. when used in a gas producer. A still more interesting fact is that the best Pocahontas coal used under a boiler produced .28 H. P. per pound per hour while a lignite in a producer gave .30 H. P. Thus, lignite turned into gas gave more power than the best coal when used under a boiler. These results indicate that there is fuel in all parts of the United States which can be used to produce power through the gas producer and gas engine, so that the amount of valuable fuel for power purposes has been increased many fold by the work of the Technologic Branch.

It is true that these results, while they show a great improvement over ordinary methods, look small compared to what should theoretically be obtained. Even the gas engine under the most favorable conditions does not utilize over eighteen per cent. of the heat value of the coal. There is still a great opportunity for the scientific man and the engineer to devise methods by which a larger per cent. of the energy of our fuels can be utilized. And the engineer has an important work to do in connection with the results already obtained. The gas engine has been in use in Europe for a number of years and is now being introduced into this country. There are some installations where the horse power runs into thousands, but these are isolated and are principally in connection with steel plants. The average manufacturer hesitates to install a gas engine because he fears that he can not depend upon it every day as he can upon the steam engine and because he knows that it can not be operated by the same engineer who can operate his steam plant. The steam engine is so simple and has been in use so long that it is very easy to make repairs upon it and it does not take very long comparatively to train a man to use it. The gas engine is more complicated, is not as well understood and at present there are very few men who are experienced in its use. The greater initial cost of the gas plant, the cost of operating and the feeling which the manufacturer has that it is unreliable will retard its use, but if our mechanical engineers, and especially if our engineering colleges, will make the thorough study of this question which it deserves, there is no doubt that within a few years the gas engine will practically supplant the steam engine. The manufacturer wants power and he wants it as cheaply as it can possibly be obtained. If a new form of prime mover will develop two and one half times as much power as the old without too much initial cost or expense of maintenance, the manufacturer will rapidly install the new form. I believe our engineering colleges should install gas plants and make a thorough and systematic study of their use from day to day. In this way their faults can be remedied and through published reports the manufacturer can be made to feel that they are reliable. At the same time it will be of immense benefit to the students in the mechanical engineering departments to have a thorough training in the principles and the use of this new form of engine.

IRON AND STEEL

This is an iron age. A nation's industrial progress is determined by the amount of iron ore it uses. Gold, silver, tin, lead and many other metals, while useful, could be dispensed with, but iron and copper are indispensable at this stage of the world's progress, and of these two iron is by far the more necessary and the more useful. In 1907 fifty-three million tons of iron ore were mined and up to this time seven hundred and fifty million tons had been mined in this country. The total amount of iron ore available in the United States is about as follows: In Lake Superior, one billion five hundred million tons; southern district, two billion five hundred million tons; other parts of the United States, five billion tons; or a total of about ten billion tons. The highest grade is found in the Lake Superior district and hence this ore is in the greatest demand. In 1907 forty-four million tons were mined in this region, and with the present increase in consumption the supply will be completely exhausted by 1940 unless new deposits are discovered. Up to the present time one thirteenth of the original supply of iron ore in the United States has been used. At the present rate of exhaustion the total amount in the whole country will be used up before the end of the present century. This includes, however, only that supply which is of a high enough grade to be worked at the present time. After that it will be necessary to use lower grades of ore or we must do what so many European countries do—import from other places. This, of course, would be a great blow to our material prosperity. We have held our position in the industrial markets for iron and steel products on account of the abundance of our iron and coal and the consequent cheap price of both. When it becomes necessary to import either coal or iron, the cost of manufacture will largely increase, and unless conditions are different from those at present, we shall no longer be an exporting nation. It will be necessary for the engineer to use all of his ingenuity and skill to avert the commercial and industrial disaster which will inevitably come when the supply of iron ore is exhausted. This may be done, perhaps, by new methods which will make it possible to use a lower grade of ore and yet obtain the manufactured product at the same price as at present. New alloys of iron will undoubtedly be discovered by the engineer which will make it possible to obtain the present strength for machines and structures with the use of less material, thus decreasing the amount of ore used. As concrete reinforced by steel takes the place of steel structures, a still greater saving in iron will be the result. This is inevitably coming, for the progress in this direction during the past few years has been astonishing. The engineer is deeply concerned with methods of transportation and by substituting water transportation for rail transportation the saving in steel is very great, for the same load can be carried by the former with one third the steel in the original plant that is necessary when loads are carried by rail.

RECLAMATION OF LAND

The problem of maintaining the fertility of the soil and of enriching the worn-out farming lands of the country is one which belongs to the scientific agriculturist and not to the engineer, but there is one question connected with the agricultural interests of the country with which the engineer is vitally concerned—that is the reclamation of the arid and swampy regions. When the population of a country is sparse people seek the richest farming lands. They use the most exhaustive and least scientific methods of agriculture and the soil is soon depleted, but they are indifferent to this because there are large areas not in use and they can move from the worn-out farm to a new section. But as population increases the richest lands are rapidly absorbed, those of second and third grade must then be used and in the end all the fertile soil of the country is under cultivation. After this, if population is to grow, more scientific methods of agriculture must be adopted or the hitherto useless land must be converted into fertile areas. The useless land consists of mountainous, desert and swampy regions. As a rule, the mountainous districts are not available for agriculture, though they may be for forestry. The desert land can in many cases be reclaimed by irrigation and the swampy land may often be reclaimed by drainage. Both of these processes, irrigation and drainage, are essentially within the province of the engineer and it is due to his efforts that so much fertile soil has been added to our national domain. Eight million acres have already been irrigated and in the next twenty-five years it is estimated that twelve million acres more may be reclaimed. We have in the United States eighty million acres of swampy land, of which twelve million have already been drained and twenty million more may be drained in the future. This will enable us to raise a food supply for many millions of people and hence population can grow to this extent. But the problem of reclamation is only a part of the greater problem of the food supply of the nation and this does not belong to the engineer.

INLAND WATERWAYS

The forests, water power, irrigation and inland navigation are more or less connected. The cutting away of the forests has been the cause of severe floods during certain sections of the year and very low water in the streams during the rest of the year. This has been detrimental to navigation and to the successful use of water power. Some streams are available, both for irrigation and water power and it is a question which of these is of the greatest value. If the water in a stream is used for irrigation it can not be used for water power and hence only one of these methods of utilization is available. Some streams can be used for power and also for navigation. The water which is used for power is not destroyed, but is turned back into the stream after its energy of motion or position has been used. The dams and other works necessary for the utilization of power form an impediment to navigation, but can be overcome by canals. Thus it seems that the question of the use of water must be studied from several standpoints and the final solution of the problem will depend upon a number of different facts.

The United States possesses an unrivaled natural system of waterways. Professor Johnson says that at present we have 25,000 miles of navigable streams and there is as much more that can be made navigable. There are 1,410 miles of navigable waters in the Great Lakes and we have 2,120 miles of canals. There are 2,500 miles of waterways in sounds, bays and bayous on the Atlantic and Gulf coasts. These can all be made into a splendid inland system by the construction of a comparatively few miles of canals. On account of the absence of these canals only a very small part of this natural water route is at present utilized. In view of the importance of our waterways very little has so far been done. We have wasted our natural routes of travel by the destruction of forests, by allowing our streams to fill up with sand, and by our neglect to use those which are still available. It is much cheaper to transport heavy material by water than by rail and the great advantage which comes from the proper use of waterways is shown wherever the government has given the necessary aid. The most striking evidence of the value of work properly directed is seen in the Great Lakes, where a hundred million dollars has been spent. The water in the lakes is deep enough for the largest vessels, but the rivers and straits connecting them naturally had only from eight to twelve feet of water. This has been increased through government appropriations to twenty-one feet, and now this body of Great Lakes forms one of the grandest pieces of navigable water known in the world. In 1889 twenty-five million tons passed through this system and in 1906 this had increased to seventy-six million tons. In 1907 it was eighty-three million tons and the increase will undoubtedly go on. In the Mississippi Valley two hundred and eight million dollars has been spent, but very little of it has gone for navigation. The larger part has been spent in jetties and dikes and so forth, necessary to prevent the loss of property and of life. So little has been done in the greater part of the Mississippi Valley that the tonnage has decreased during the past twenty years. The Inland Waterways Commission has done a most valuable work in showing the possibilities of our navigable streams, lakes and bays. It is to be hoped that congress will make the appropriations necessary to make this body permanent and that its recommendations will receive favorable consideration. In England, France and Germany the waterways have received far greater attention than here. Although these countries are much smaller than the United States a very much larger proportion of the total tonnage passes through the rivers and canals. We should take a lesson from these nations and learn to give this subject the proper amount of attention. The larger use of our waterways will not decrease the amount of railway traffic. The railways now have more than they can do and they have found great difficulty in raising money sufficient to increase their trackage and their transportation facilities.

Railroad transportation can only take place over a pathway which has been especially prepared and which has been laid with steel rails. Water transportation does not need this. A natural pathway is ready and it is only necessary to provide the vessels to carry the traffic. This makes the cost of transportation by water very much less than that by land. The initial cost is less and the cost of maintenance is less. Navigation has decreased during the past few years in many sections because the streams are shallow and the loads carried have been very small. As the railroads have reached into the districts formerly served by boats, the rapidity of transportation and the possibility of carrying large loads have decreased the cost below that of water service. If these streams, however, can be given the proper depth so that larger vessels can be used and greater loads carried, the transportation by water will be resumed. The whole question of water transportation belongs to the engineer. Whatever has been done in the past has been planned and carried out by him and all improvements in the future must be his work.

CONCLUSIONS

I have presented in a very imperfect way the present state of our natural resources and have suggested some of the steps which should be taken to conserve them. There is nothing original in this. The facts have been gathered from government reports and papers written by experts in each of the several divisions of this question. The point which I had in mind during the preparation of the paper and to which I wish to give especial emphasis is that this work of conservation is the work of the engineer. I am inclined to think that in some cases the statements in regard to the destruction of our natural resources have been overdrawn and that they will not be totally exhausted in as short a period as some seem to believe, but there is no doubt that the question is a grave one and that it should be faced before it is too late. We should try to avoid waste and unnecessary destruction and we should also try to make the best possible use of all of our resources. It will be the work of the engineer to accomplish both of these objects, and it will also be his province to determine new ways of accomplishing results now so wastefully performed. In the past the engineer has been concerned in getting results. If the results were obtained, the waste and destruction of the natural product have scarcely been considered, but in the future, economy of the natural product as well as economy in the final result must receive careful attention. I believe the engineers of the country are capable of solving these problems, and that if they are given the necessary governmental and private aid that the problem of the conservation of our natural resources will be solved.

The engineering colleges of the country will also have a share in this work. They are training the engineers of the future and from now on they must train them with this problem in view. They must not only give them the principles of engineering practise, but they must show them how the work of the engineer can be carried out with a view of transmitting to our posterity the natural resources in, so far as possible, an unimpaired condition. As has been pointed out in this paper, the conservation of some of our natural resources must be accomplished through new inventions. This means that the engineer of the future must be able to do more than the simple engineering work which comes to him from day to day. He must be so thoroughly trained in the principles of science and applied mechanics that he will be able to discover new processes and accomplish old results in new and more economical ways. He must be taught more thoroughly than ever before how to unite theoretical and practical knowledge. In short, he must be able to think along scientific and engineering lines. This is the most difficult thing which the engineering college has to teach. There are so many subjects in the curriculum, so much that is necessary for the engineer to learn, that he has not had the proper time to digest this mass of material. I feel convinced that this problem of teaching the student to think, of giving him the power to solve things for himself, has for many years received the earnest attention of the members of this society, but in view of the problem which I am discussing to-day, I wish to urge upon all who teach in our colleges the importance of giving it still more attention. Engineering science is progressive, the subjects taught in our engineering schools are alive and not dead. We shall grow, not only in knowledge, but in methods, and we shall accomplish the results we ought to accomplish and solve the problems presented to us.

Charles S. Howe
Case School of Applied Science,
Cleveland, Ohio

THE INCREASING IMPORTANCE OF THE RARER ELEMENTS[1]

In many of our courses in inorganic chemistry we have placed in view charts upon which the names of some eighty elementary substances appear. For one reason or another more than one half of these elements have remained to the majority of students little more than names; whereas to-day we find many of them contesting positions of importance with the better known elements on account either of industrial utility or of pure scientific interest. May I define then the rarer elements not as those necessarily rare in occurrence but rather as those not always

[1] Address of chairman of the Inorganic Section at the New Haven meeting of the American Chemical Society, June 30, 1908.

taken up in a general course in inorganic chemistry.

In considering briefly the reasons why it would seem best to remove at least a number of these elements from the confines of my definition I shall in general limit myself to the presentation of certain facts and figures gathered from the record of the last half-decade.

Hillebrand in discussing the analysis of silicate and carbonate rocks mentions Ti, Zr, V, Li, Ta, Cb, Be, Th, Ce, and the rare earths as possible ingredients of the silicate rocks, and adds in regard to Th, Ce and the rare earths that "they are probably more common as constituents of silicate rocks than has generally been supposed; and A. A. Noyes and his associates in their new system of qualitative analysis have included Tl, Pt, Au, Se, Te, Mo, Be, U, V, Ti and Zr.

For convenience the periodic grouping will be followed in the consideration of the elements which we wish to discuss.

In group (1) rubidium and cæsium clearly come under our definition, and possibly also lithium. Lithium, as already stated, is an ingredient to be reckoned with in rock analysis, while its importance in water analysis is shown by its presence in over forty samples of water from different parts of the world in amounts varying from traces to one per cent. In Clarke's data of geo-chemistry, from which these figures were taken, we find rubidium mentioned as present in about twenty samples of water, cæsium being more rare.

The last report of the United States Mineral Resources shows an output of about 2,200 short tons of lithium minerals since 1903 with a value of about $40,000.

During the past five years the greater part of the work upon these elements has been concerned with the formation of new compounds. It is perhaps of interest to note in this connection that iron alums of selenic acid containing cæsium and rubidium have been prepared, while the corresponding ammonium and potassium salts have not been successfully produced.

In group (2) we have the elements beryllium and radium. Concerning the former, I need add no word after the masterly paper upon "The Vagaries of Beryllium,"[2] given before this body a year ago by Chas. L. Parsons. To the student of pure chemistry, if not as yet to the technical chemist, the element offers most interesting problems. May we not hope that a more extended study of the production and properties of this metal of low specific gravity will make possible some important application in the arts.

It is not the purpose of this paper to take up the subject of radium and radioactivity more than to mention the stimulus which this branch of work has given to the study of uranium and thorium minerals and of their natural associates.

In group (3) we find yttrium and certain members of the cerium group. These bring us to the consideration of the rare earth group, comprising within its ever-growing boundaries about sixteen names which seem at times to be almost the despair of the chemical housekeeper who may wish to file away each element in its appropriate group-cupboard of the periodic system.

Notable among the aids to the worker in this field during the past few years have been the publication of Böhm's "Darstellung der Seltenen Erden," Leipzig, 1905, in two volumes of about 500 pages each, Schilling's "Vorkommen der Seltenen Erden," Munich, 1904, and Meyer's "Bibliographie der Seltenen Erden," Hamburg, 1905. Among the voluminous papers describing excellent work in this

[2] Science, N. S., Vol. XXVI., No. 670, pp. 569–74, November 1, 1907.

field by many distinguished chemists, we note in particular Urbain's recent separation of ytterbium into lutecium and neoytterbium, a separation previously indicated by Welsbach, and the still more recent work of James upon the bromate separation of yttrium earths, and the arrangement of the rare earth separation methods into a systematic scheme of analysis.[8] This latter piece of work certainly reflects great credit upon this painstaking investigator, and I will venture the prediction that if we keep our eyes upon Urbain and James we shall be rewarded by something more than mere spectacular spectroscopic speculations. Marc in a recent paper upon the "Development of our Knowledge of the Rare Earths and their Significance" calls attention in closing to a reference by Crookes to the rare earth minerals as a cosmic rummage chamber, and significantly adds that often the most important facts concerning the history of a family are to be found in rummage chambers.

Since thorium and zirconium are included by Böhm among the rare earths and are closely associated with them, these elements will be taken up at this point. The mention of thorium in this connection is certainly most appropriate, for it can not be questioned that the use of thorium nitrate in the preparation of the mantles used in incandescent gas lighting, and the development of this great industry have given a mighty impetus to the study of the rare earths.

A few figures will give us some idea of the growing importance of thorium and its chief mineral source, monazite. In 1902 the production of monazite sand in the United States and Brazil amounted to 3,500,000 pounds, with a value of $324,-000; while the last report, that of 1906, shows a production of 10,450,000 pounds, with a value of $630,000—an increase in value of almost 100 per cent. In the United States alone, and almost exclusively from Henderson County, N. C., the value of monazite sand produced has increased from about $65,000 in 1902, to about $153,-000 in 1906. Of interest and importance in this connection is the new mineral thorianite discovered in Ceylon in 1904. It carries from 70 per cent. to 80 per cent. of thorium oxide, and the report of 1905 shows an export of about 18,000 pounds, valued at about $24,000.

Helpful to the student of thorium are the works of Böhm and Schilling already mentioned, as well as the "Index to the Literature of Thorium" by Jouet, published by the Smithsonian Institution in 1903.

In considering zirconium we would note in particular the work of Rosenheim on the zirconyl salts and the investigations of Wedekind, who finds a practical method for the production of zirconium carbide, a compound resistant to air, water, and hydrochloric acid, and said to be an excellent conductor of electricity. Ninety parts of this carbide with ten parts of the metal ruthenium have been made by Sanders into filaments for use in the zirconium lamp. A mixture consisting of eighty-five parts of zirconium oxide and fifteen parts of yttrium earth oxides of the higher atomic weights is used in the manufacture of the Nernst glowers. The production of zircon in this country, much of it obtained as a by-product from monazite concentrates, has not been large; as reported in 1906 it amounted to 1,100 pounds, valued at $248.

In connection with the subject of rare earths it is perhaps of interest to refer to the growing use of ceric and cerous compounds as oxidizing and reducing agents; to Barbieri's statement in regard to cerium salts as catalytic agents, their behavior being similar to that of manganese

[8] *Jour. Amer. Chem. Soc.*, XXX., 979, June, 1908.

salts, and to Weiss's application of "misch metal," a mixture largely of the cerium earth metals, to the reduction of the oxides of Mo, V, Nb and Ta. Since cerium is obtained in large quantities as a by-product in the preparation of thorium salts from monazite, its various applications are of special interest.

Of the elements gallium, indium and thallium little will be said. During the past five years, gallium has been mentioned but once in the *Zentralblatt*, and that on account of its occurrence in a Sardinian blend. Renz and Thiel abroad and Mather in this country have done interesting work upon the properties and salts of indium. Indexes to the literature of these two elements, by Browning, were published by the Smithsonian Institution in 1904 and 1905. Thallium, with its two distinct conditions of oxidation and its ease of detection by means of its characteristic flame spectrum, has offered an attractive field to the student of pure chemistry. Growing interest in it is indicated by an increase of 200 per cent. in the number of reviews dealing with that element in the *Zentralblatt* for 1907 as compared with 1903.

Passing to group (4) we find besides thorium and cerium, already mentioned, the elements titanium and germanium. Germanium, like gallium, seems to have attracted little attention of late. An index to the literature of germanium, by Browning, was published in 1904 by the Smithsonian Institution.

Titanium can not be regarded as of rare occurrence, but I think that most chemists will allow it to be classed as a rare element under our definition. Hillebrand states that as far as his personal experience goes, titanium is entirely absent from no igneous, metamorphic, or sedimentary rock of a more or less siliceous character, and Clarke tells us that of 800 igneous rocks analyzed in the laboratory of the Geological Survey, 784 contained titanium. The element is now generally considered to stand tenth in order of abundance in the earth's crust as far as that has been explored, being more abundant than copper, lead or zinc. Considering these facts it is with satisfaction that we find titanium gradually taking its place among the useful elements. Until quite recently the presence of one per cent. or more of titanium in iron ores was considered sufficient to make them undesirable on account of the formation of pasty slags in the metallurgical process. This difficulty, according to Rossi,[4] can be avoided by judicious regulation of fluxes and temperatures. The addition of titanium to cast iron has been shown to increase its strength, and the presence of the same element in steel seems not only to augment the tensile strength of the steel but also to raise its limit of elasticity. This property of titanium has developed the production of ferro-titanium for use in the manufacture of steel.

According to the last volume of the "Mineral Resources," titanium is being used to a certain extent as a filament for incandescent electric lamps, and has the advantage over tungsten of a higher melting point and higher electrical resistance. Rutile, titaniferous magnetite, and titanium carbide are all finding some use as electrodes with carbon blocks in arc lamps. Other commercial uses of titanium are found in the employment of rutile for giving porcelain tile a yellow color and for coloring artificial teeth; of titanous chloride and titanous sulphate as mordants and of titanous potassium oxalate as a mordant and yellow dye in the treatment of leather. Recently we have seen quite frequent references to the applica-

[4] Rossi, A. J., *Trans. Am. Inst. Min. Eng.*, Vol. XXI., 832.

tion of titanous salts as reducing agents in volumetric analysis.

"Mineral Resources for 1906" reports a small production of rutile, chiefly from Virginia, as against no production in 1903; also large deposits of titaniferous iron ores from North Carolina, Wyoming and the Adirondack region. The constant advances made in the metallurgy of this element seem to assure an advancing prominence.

Passing to group (5) we find first on our list the element vanadium. Few of the elements which we have to consider are of such general interest. Its five distinct conditions of oxidation, with their salts, well-defined in most cases, furnish the chemist with a fascinating field for experimentation, as witness the many volumetric processes which concern themselves with this element, and the voluminous published work upon the salts of tetra- and trivalent vanadium.

Among the uses which have been found for vanadium are its employment in the making of a photographic developer, a fertilizer for plants, coloring material for glass, and with anilin, a black dye. Vanadyl phosphate has been found to behave physiologically like potassium permanganate. Vanadic acid (V_2O_5) is employed as a substitute for gold bronze, in the making of a water-proof black ink with tannic acid, in the manufacture of sulphuric acid by the contact process, and as a catalyzer to accelerate oxidation processes, such as the oxidation of sugar to oxalic acid, of alcohol to aldehyde, and of stannous to stannic salts.

Probably of more importance than any of these uses of vanadium is its employment in the manufacture of steel, as described in the pamphlets written by Mr. J. Kent Smith, of the American Vanadium Co. From these we learn of the remarkable elasticity and tensile strength of steels containing from .15 to .35 of one per cent. of vanadium introduced as ferro-vanadium, an alloy containing about 30 per cent. of vanadium. This important commercial use of the element has stimulated the search for its ores, a search which has resulted in our own country in several discoveries, chief of which is that of carnotite in Routt County, Colorado. Of interest in this connection are the extensive deposits of vanadium ore discovered in Peru less than two years ago, and found to contain a sulphide, essentially VS_4, named by Hewett patronite, and found by Hillebrand to contain from 18.5 per cent. to 19 per cent. of vanadium. Of value to the student of this element are three recent pamphlets, "Das Vanadin und seine Verbindungen," by Ephraim, 1904, "Die Literatur des Vanadins," by Prandtl, 1906, and "Le Vanadium" by P. Nicolardot, published by Gauthier-Villars, Paris.

Probably no one of the elements which we have to consider has made a more phenomenal leap from practical obscurity to comparative prominence than has tantalum. In the index of the *Zentralblatt* for 1903 we find no mention of this element, while the index for 1905, the year of the first application of tantalum to incandescent lighting contains twenty references to it. The use of the tantalum filament as a substitute for carbon is certainly an interesting step in the development of incandescent electric lighting. The tantalum lamp produces a light of one candle power for every two watts of electrical energy, as against three and one tenth watts required by the ordinary carbon filament. Tantalum is said to be as hard as steel and as resistant to chemical action as gold. These qualities are responsible for a patent for its use in pens.

A catalogue[5] of the mineral sources of

[5] *Zeitsch. f. angen. Chem.*, 1905.

the element, prepared by Schilling, shows over three hundred and fifty analyses of tantalum minerals comprising about forty species which occur widely distributed throughout the world. In our own country, South Dakota and Colorado reported a commercial production of the ores in 1906, and fair sized deposits have been found in North Carolina, Texas, and elsewhere. Last year ore carrying 80 per cent. of Ta_2O_5 was sold at from three to four dollars a pound. Since one pound of the metal will make some tens of thousands of lamp filaments, material for the new lights would seem to be plentiful and cheap.

Notable as a matter of purely chemical interest is the work of Edgar F. Smith and his associates upon the compounds of tantalum and columbium or niobium.

In Group (6) we have the elements Mo, W, U, Se and Te. Molybdenum, like vanadium, on account of its many well-defined oxidation stages presents interesting problems in analytical and synthetical chemistry; and the last half decade contains the record of considerable work upon the complex organic and inorganic compounds. The ores are in steady demand, chiefly for the production of ammonium molybdate, which is used in phosphate determinations, in fire-proofing, in coloring pottery glazes, and as a germicide. Molybdic acid is employed to some extent in dyeing. The metal is used in steels, but on account of its low fusing point can not be employed in filaments for incandescent lighting.

Few of the so-called rarer elements occupy so prominent a position at the present time as tungsten. Its production in this country alone has increased from about three hundred short tons, valued at about $44,000 in 1903, to over nine hundred short tons, valued at about $350,000 in 1907—an increase in amount of 200 per cent. and in value of 600 per cent. The principal source of tungsten ore in this country has been the deposits of wolframite in Boulder County, Colorado, while Arizona, Montana, New Mexico, Washington and Idaho have furnished some ore. Recently deposits of hübnerite in the Snake Range, Nevada, and of wolframite near Raymond, Cal., have been investigated. Ores are also mined in Europe, Africa, South America and Australia.

Without doubt, the most spectacular use of tungsten at present is in the filaments of the incandescent electric light bulbs. This metal with its melting point over 3,000° C., a little higher than that of tantalum, makes a lamp which has the advantage of giving one candle power of light per 1.25 watts of electrical energy, as against 2 watts in the case of the tantalum lamp, and which has a life of one thousand or more hours as against about five hundred hours for the carbon and tantalum lamps. The chief disadvantage of the tungsten lamp is the extreme fragility of the filament, which makes losses in transportation large unless the packing is very carefully done. Tungsten-titanium, tungsten-tantalum and tungsten-zirconium lamps have been recently suggested, but so far as I can learn they are still in the experimental stage.

Among the better and longer known uses of tungsten are its employment in ferrotungsten for the hardening of steels, and in sodium tungstate for fireproofing draperies and as a mordant in dyeing. Certain salts are also used in weighting silks. The high melting point of the element has suggested its possible use in the manufacture of crucibles.

Notable among the recent purely chemical work upon this element has been the study of the complex tungstates with titanium, zirconium and thorium, and the double polytungstates of alkali earths with the alkalies. The formation of the silicides of molybdenum and tungsten by treatment with copper silicide or by fusing the oxides with silicon dioxide and aluminum is important. The interest which tungsten has aroused during the past five years is partly shown by an increase of 500 per cent. in the number of articles reviewed in 1907 over 1903.

Uranium and its ores, *i. e.,* pitchblende, carnotite, autunite, etc., seem to owe their chief prominence at present to the radioactive material associated with them, although uranium salts are used in the manufacture of certain velvety-black pottery glazes and greenish-yellow iridescent glasses. An interesting subject for further analytical work is the separation of uranium and vanadium in carnotite; a commercial process with this end in view has recently been developed by Haynes and described in the last volume of "Mineral Resources." The chief source of uranium in this country is the carnotite deposit of Colorado.

The element selenium has the peculiar property of being, under the influence of light, a fairly good conductor of electricity, while in the dark it is practically a nonconductor. In the latest edition of "Mineral Resources of the United States," Hess mentions the following purposes for which this property of selenium has been used in the construction of apparatus, namely: for automatically lighting and extinguishing gas buoys, for exploding torpedoes by a ray of light, for telephoning along a ray of light, for transmitting sounds and photographs or other pictures to a distance by means of telegraph or telephone wire, for measuring the quantity of Roentgen rays in therapeutic applications. Upon a more general demand for any or all of these instruments depends very largely the demand for selenium. Up to the present time there has been practically no production of selenium in the United States outside of small quantities existing in residues resulting from the refining of copper by electrolytic methods. The recent work upon selenium has been largely in the line of the formation of new compounds. A monograph by Marc[6] upon the "Physical and Chemical Properties of the Element" has recently appeared.

If the element tellurium had no other reason for prominence, its anomalous atomic weight and its mineralogical association with gold would serve to give it an important place. Lenher in a recent article has briefly discussed about forty years of combined work by Brauner, Baker and Bennett, Norris and himself upon the "Homogeneity of Tellurium," and has arrived at a conclusion in favor of homogeneity and of an atomic weight of 127.55. About the same time Marcwald reached a similar conclusion regarding homogeneity, but gave as the result of his work an atomic weight of 126.85, a value slightly below the accepted weight of iodine, 126.97. Marcwald's method was the heating of orthotelluric acid (H_6TeO_6) and the weighing of the tellurium dioxide obtained.

The close association of tellurium with gold has, as already intimated, brought about its possibly unenviable prominence. A careful study of the problems connected with the satisfactory handling of telluride ores has recently been published by Hillebrand.

One can scarcely speak of the growing prominence of such elements as gold and platinum, but a few figures in regard to their production in our country may be in point. The output of gold in 1906 was $94,000,000 as against $74,000,000 in 1903, and the output of platinum in 1906 was valued at $45,000 as against $2,000 in 1903.

[6] "Die Physikalisch-Chemischen Eigenschaften des metallischen Selens," Hamburg and Leipzig, Leopold Voss, 1907.

The value of the platinum imported in 1906 was nearly $4,000,000, or double the value of that imported three years earlier.

The platinum deposits in this country are to be found in Oregon, California, Washington, Utah and Nevada.

The separation and the complex compounds of the platinum metals continue to offer interesting problems to the chemist, and the able researches of Howe and of Gutbier have added much to our knowledge of this field. Palladium and iridium have found uses in the construction of fine apparatus. Osmium has long been used as a stain in microscopic work, and more recently as a filament for incandescent electric lamps. Ruthenium, as already stated, has been mixed with zirconium carbide for the filament used in the zirconium lamp.

In conclusion, allow me to refer to an address by Dr. H. Landolt given last November at the fortieth anniversary of the founding of the German Chemical Society upon the "Development of Inorganic Chemistry" during the past forty years.[7] In this address advancement along four lines was especially noted: (1) The discovery of the elements Ga, Sc, Ge, Sm, Gd, Tm, Eu, Nd, Pr, Ar, Xe, Ne, Kr and He; the discovery of radium; and the study of the phenomena of radioactivity, which has taught us that elements are undecomposed but not undecomposable bodies. (2) The realization of a compilation of international atomic weights, a work in which Dr. Clarke of the American Chemical Society has had a large and honorable share. (3) The preparation of elementary substances by the electric furnace and by the Goldschmidt process, and the study of allotropic modifications of elementary substances with special references to colloidal forms. (4) The formation of such compounds as the carbides, hydrides, silicides, complex acids and metal ammonium bodies.

In all of these lines of chemical progress, I am sure you will agree with me that the *rarer elements* have played an important rôle.

Philip E. Browning
Yale University

[7] *Ber.*, XL., 4627, 1907.

SCIENTIFIC NOTES AND NEWS

The Geological Society of America has altered the plan of holding its winter meeting at New Haven and will meet at Baltimore in convocation week in conjunction with the American Association for the Advancement of Science.

The fourth annual meeting of the Southern Society for Philosophy and Psychology will be held in Baltimore during convocation week, December 28–January 2, in affiliation with the American Association for the Advancement of Science, the American Psychological and Philosophical Associations and other societies.

On the occasion of the seventy-fifth anniversary of Haverford College, Dr. Theodore W. Richards, of the class of '85, professor of chemistry at Harvard University, gave an address entitled "The Relation of Modern Chemistry to Medicine." Professor Richards and Dr. James Tyson were among those on whom the honorary degree of doctor of laws was conferred.

President Charles R. Van Hise, of the University of Wisconsin, received the degree of doctor of laws from Williams College on the occasion of the inauguration of President Garfield.

The delegates from the United States to the International Conference on Electrical Units and Standards now in session in London are Dr. Henry S. Carhart, professor of physics at the University of Michigan; Dr. S. W. Stratton, director, Bureau of Standards, Washington, and Dr. E. B. Rosa, physicist of the bureau.

At the general meeting of the German Meteorological Society at Hamburg in September, to celebrate the twenty-fifth anniversary of its foundation, Professor A. Lawrence Rotch, director of the Blue Hill Observatory, Massachusetts, was elected an honorary member of the society and Professor F. H. Bigelow, of the United States Weather Bureau, a corresponding member.

The Italian Society of Sciences has awarded its biennial mathematical prize to M. Giuseppe Picciati, of the University of Padua.

Sir George Darwin and Professor Larmor have been appointed electors to the Isaac Newton studentships at Cambridge University.

Dr. W. Engelmann, professor of physiology at Berlin, will retire from active service at the close of the present semester.

Dr. P. Heinrich has retired from the directorship of the Agricultural Experiment Station at Rostock.

Mr. F. G. Clapp, geologist of the U. S. Geological Survey, engaged in investigations and preparation of reports on coal, oil, gas and artesian waters, has resigned in order to take up expert practise.

Mr. Horace V. Winchell has resigned his position as chief geologist for the Great Northern Railway Co., and has opened an office for general practise.

Miss Wilman, of the South Africa Museum, has been appointed curator of the Alexander McGregor Memorial Museum, Kimberley, and will take up her duties by the end of February next.

Dr. Sven Hedin, the Swedish explorer, sailed from Bombay for Yokohama on October 13. He expects to have finished his book on his Tibetan travels next May.

Professor William James returned on October 16 to Cambridge from England, where he had gone to deliver a series of eight lectures at Oxford on "The Present Position of Philosophy."

Dr. Smith Ely Jelliffe and family have left New York for a year's stay in Europe. Dr. Jelliffe anticipates working in the Psychiatric Clinic with Professor Ziehen while in Berlin and with Dr. Oppenheim, of the same city.

Dr. Daniel Vergara Lope, professor of physiology in the University of Mexico, lectured at the George Washington University, October 16, on "The Physiological Effects of High Altitudes on Man."

There was held at the Sorbonne in Paris, on October 4, a meeting in memory of the great chemist, Marcellin Barthelot. M. Raymond Poincaré made an address on his work, and was followed by M. Fallière, president of the Republic. M. Clemenceau, the prime minister, and M. Domergue, minister of education, were present.

Dr. Francis H. Snow, chancellor of the University of Kansas from 1889 to 1901, and for many years at the head of the department of entomology, died on September 20 at the age of 68 years.

M. Alphonse Boistel, for forty years professor of commercial law in the University of Paris, known to students of the natural sciences for his work in botany and geology, has died at the age of seventy-one years.

We regret also to record the death of Mr. Bennett H. Brough, secretary of the British Iron and Steel Institute, and of Mr. J. T. Cart, an English student of applied chemistry.

The autumn meeting of the Iron and Steel Institute of Great Britain was held at Middlesbrough on September 28 to October 2 under the presidency of Sir Hugh Bell.

Lectures will be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

October 17—"Edible and Poisonous Mushrooms," by Dr. W. A. Murrill.

October 24—"Wild Autumnal Flowers and Fruits," by Dr. N. L. Britton.

October 31—"Letchworth Park and the Falls of the Genesee," by Mr. George V. Nash.

November 7—"Plant Distribution as interpreted by Geology," by Dr. Arthur Hollick.

November 14—"Botanical Cruises in the Bahamas," by Dr. M. A. Howe.

November 21—"The Rubber Plants of Mexico," by Dr. H. H. Rusby.

The following is the provisional program of the Royal Geographical Society for the present session:

November 2—"Unexplored Western Asia," by D. G. Hogarth.

November 16—"Some Aspects of the River Paraná, and its Watershed: an Economic Survey," by W. S. Barclay.

November 30—"The Panama Canal in 1908," by Dr. Vaughan Cornish.

December 7—Possibly Dr. Sven Hedin on his latest expedition in Tibet.

December 14—"Fifty Years of Nile Exploration and some of its Results," by Sir William E. Garstin, G.C.M.G. (The jubilee of Speke's discovery of the Victoria Nyanza.)

Other papers which may be expected after Christmas are the following:

"My Recent Expedition in Central Asia," by Dr. M. A. Stein.

"Survey and Exploration in the Ruwenzori and Lake Region, Central Africa," by Colonel R. G. T. Bright, C.M.G.

"The Danish Northeast Greenland Expedition," by Lieutenant A. Trollé.

"Bhutan: the Results of Two Expeditions," by John Claude White, C.I.E.

"The Western Pacific," by Sir Everard F. im Thurn, K.C.M.G., C.B.

"Across the Sahara from Tripoli to Timbuktu," by Hanns Vischer.

"The Colorado Cañon; Some of its Lessons," by Professor W. M. Davis.

"A Recent Journey in North Central Arabia," by Captain S. S. Butler.

"South America and its Antarctic Relations," by G. F. Scott Elliot.

"Earthquakes and Geography," by R. D. Oldham.

"The Geographical Conditions affecting the Development of the British Empire. II. Australia," by Professor J. W. Gregory, F.R.S.

The New Zealand Shipping Company's steamer *Ruapehu*, which left Plymouth on October 3 for New Zealand, carried a large consignment of stores for the use of Lieutenant Shackleton's Antarctic expedition. The liner will reach Wellington in the middle of November. Other articles will be sent to the relief ship *Nimrod* at Lyttelton, and these, it is expected, will reach the explorer by New Year's Day.

Professor D. W. Johnson, of Harvard University, spent the summer in physiographic studies in Europe. While in France he directed the researches of four students in the volcanic region of the Auvergne. The following topics were treated: the physiographic features of the great fault scarp west of the Limagne basin, by Mr. S. W. Cushing, instructor in physical geography at the State Normal School, Salem, Mass.; drainage modifications due to lava dams, by Mr. W. G. Reed, Jr., assistant in physiography, Harvard University; physiographic features due to glacial erosion, by Mr. J. E. Buchanon, instructor in physical science and geography, State Normal School, Cheney, Washington; and variations in the forms of volcanoes, by Mr. E. W. Schmitgen. After completing the work in Auvergne, Messrs. Buchanon and Cushing continued studies of glacial erosion in Switzerland, northern Italy and Scotland; while Mr. Reed visited portions of Switzerland, spending a week in an investigation of the physiographic features of the Maloja Pass region. Professor Johnson attended the ninth International Congress of Geography held at Geneva July 27–August 6; and August 25–27 he gave three lectures on the physical and economic geography of the western United States before the Vacation School of Geography at Oxford University, England.

The Board of Sanitary Commissioners of Savannah, Ga., announces the opening of a Board of Health Laboratory, to be known as the City Bacteriological Laboratory, under the direction of Dr. V. H. Bassett, recently assistant superintendent and pathologist of the Milwaukee Co. Hospital. J. Van de Vrede has been appointed assistant. The department is established by ordinance and will be supported by the board as an adjunct to the Health Office, as an aid to the control of communicable diseases, and for the study of problems in public health. The rooms include office, laboratory room, preparation room, photographic dark room, animal room, storage room, etc.

The London *Times* states that the question of improving the navigability of the Rhone and thus restoring the city of Lyons to the position it once held as an important inland port is discussed in a recent consular report. At present, although the river is navigable in a direction from Lyons to the sea, it is only navigable upstream as far as Seyssel, so that water communication with the Lake of Geneva is impracticable. A Paris company has made proposals to the French Government for the construction of a barrage across the Rhone below Bellegarde, forming above stream a reach of 14 miles to the lake, and downstream a waterfall which it is estimated would yield 100,000 horsepower for transmission to Paris. The company further offers to construct the necessary facilities to enable vessels to pass through the dam. In this way navigation would be opened direct with Geneva. Associated with this project is one for the construction of a canal from Lyons to Arles. This canal would be 170 miles long, and would cost about $120,000,000, and it is understood that the municipality of Marseilles is considering the advisability of connecting this canal with that town by another canal to cost $16,000,000. If this scheme were put into execution Lyons, Marseilles and the Rhine would be placed in direct communication by means of the Rhone-Rhine Canal.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Grace M. Kuhn, widow of Hartman Kuhn, of Philadelphia, recently filed for probate in the Berkshire courts, Harvard University receives $175,000 to endow a department of biological chemistry in the memory of a son, Hartman Kuhn, who died several years ago.

The general council of Louisville has passed an ordinance which has been signed by the mayor, appropriating $25,000 from the general purpose fund for 1908, for the use of the Medical Department of the University of Louisville. The money is to be expended for laboratory equipment for the consolidated medical schools.

Mr. Jacob Sassoon has given about $330,000 to establish a central college of science in Bombay.

Dr. Henry Julian Hunter has left $70,000 to Sheffield University.

Statistics just compiled at the University of Wisconsin show that 417 graduates and former students have this year received appointments to the faculties of universities, colleges, normal schools, academies and high schools, or as superintendents of schools in 29 states and 7 foreign countries. Of the total number, 116 received appointments to the faculties of colleges and universities; 250 were appointed high school principals or teachers and superintendents of schools; 14 were appointed as instructors in normal schools; and 7 were appointed to college and normal schools in Alaska, Porto Rico, Philippines, Japan, Argentine Republic and Canada. Among the colleges and universities to the faculties of which university graduates were appointed this year are: Cornell, the University of Pennsylvania, University of Chicago, Amherst, Dartmouth, Stanford University, the University of California, Northwestern University, the state universities of Michigan, Georgia, Nebraska, Utah, Illinois, Idaho, Indiana, South Carolina, Oregon, Iowa, Kentucky, Minnesota, Kansas, Washington, Tennessee and Missouri, and the state agricultural colleges of Massachusetts, Georgia, Kansas, Oregon, Minnesota, Michigan, Missouri and Iowa.

It is understood that Dr. James R. Angell, professor of psychology in the University of Chicago, has declined the presidency of Dartmouth College.

Henry Asbury Christian, A.B. (Randolph-Macon '95), M.D. (Johns Hopkins '00), Hersey professor of the theory and practise of physic at Harvard University, has been appointed dean of the medical school.

Professor Francis E. Lloyd will fill the chair of botany in the Alabama Polytechnic Institute after November first. During the past year he has been engaged with the Continental Mexican Rubber Company in the investigation of possible methods for the growth of the Mexican desert rubber plant, *Parthenium argentatum* A. Gray, under conditions of cultivation.

At Cornell College, Iowa, Mr. Layton Gouldin has been appointed assistant in chemistry, C. W. Lounsberry in engineering, and E. K. Mapes, in physics.

At Bryn Mawr College Mr. Chester A. Reeds who, until recently, has held a position in the department of geology at Cincinnati University, has been appointed lecturer in geology to succeed Dr. D. W. Ohern.

At Harvard University, Paul Hayhurst, A.B., has been appointed instructor in economic entomology.

The following appointments have been made in the College of Applied Science, the State University of Iowa: Mr. Sherman Melville Woodward, M.S., Washington University, 1893, M.A., Harvard, 1896, joint author with Mr. Charles E. Lucke of "Tests of Internal-Combustion Engines on Alcohol Fuel," and in collaboration with Mr. John Preston, translator of E. Sorrel's "Carbureting and Combustion in Alcohol Engines," has been made professor of hydraulics and engineering materials, and acting head of the department of mechanical engineering. Professor Woodward at the time of his appointment was supervising engineer in the United States Department of Agriculture. Mr. Arthur Warren Hixson, A.B. (Kansas, 1907), has been appointed instructor in mining and metallurgy, in charge of the department of mining; Mr. John E. Boynton, B.S., M.E. (Wisconsin, 1905), instructor in steam engineering; Mr. John Hoffman Dunlap, A.B. (Dartmouth, 1905), C.E. (Thayer School of Civil Engineering, 1908), instructor in descriptive geometry and drawing; Mr. Wallace Woodman Smith, B.S., C.E. (Pennsylvania State College, 1908), instructor in descriptive geometry and drawing; Mr. George John Keller, instructor in shopwork.

Austin teaching fellows at Harvard University have been appointed as follows: Ralph Ernest Chase, A.M., history; John Detlefsen, A.B., zoology; Warren MacPherson, S.B., A.M., comparative pathology; Frank Linden Richardson, M.D., surgery. Newly-appointed assistants include: Edward Allen Boyden, zoology; Eugene James Cardarelli, chemistry; Edward James Curran, M.D., anatomy; Richard Dexter, A.B., M.D., clinical medicine; Gustavus John Esselen, Jr., Augustus Henry Fisk, A.M., Gorham Waller Harris, A.B., and William Hammett Hunter, A.M., chemistry.

DISCUSSION AND CORRESPONDENCE

THE PROCEEDINGS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS

To the Editor of Science: The *Proceedings* of the Association of Official Agricultural Chemists for 1907 have just been published as bulletin No. 116 of the Bureau of Chemistry, U. S. Department of Agriculture. By order of the printing committee of the department, the portion of the *Proceedings* referring to the report of the committee on the president's address, 1906, has been omitted in the bulletin, as was also the president's address itself in the printed *Proceedings* for the preceding year (bulletin No. 105, Bureau of Chemistry, U. S. Department of Agriculture).

It may be stated in explanation of these omissions that the president's address delivered at the annual convention of the association, October, 1906, among other matters, discussed recent publications of the Bureau of Soils of the U. S. Department of Agriculture and took decided issue with views set forth therein. The president's address having been published elsewhere (see below), it would seem only right that members of the association and men of science in general, who are interested in the questions at issue, or in the larger question of the liberty of free speech, shall be given an opportunity to become acquainted with the report of the committee; on behalf of the committee, I would ask, therefore, that the enclosed portion of the proceedings of the association referring to the report, as prepared by the secretary of the association, be printed in Science.

F. W. Woll

University of Wisconsin,
Madison, Wis.

In the absence of Chairman Woll, Mr. Van Slyke presented the report in behalf of the committee on the president's address:

REPORT OF THE COMMITTEE ON PRESIDENT'S ADDRESS (1906)

By resolution of this association at its last convention it became the duty of your committee, "after consultation with the Secretary of Agriculture, to consider in detail the questions raised" in the president's address.[1] These duties your committee has performed and now desires to present the following report and be discharged.

The character of the work assigned us is new and without precedent. The essential facts appear to be that the president of this association, in his inaugural address, speaking on the duty of science to agriculture in guarding against error as well as in discovering truth, expressed views antagonistic to those published by one of the bureaus of the Department of Agriculture and criticized adversely certain of its published doctrines, designating the publications specifically and the bureau by name. These being the facts, as your committee understands them, there seem to be three pertinent questions to be considered:

First, Is it proper for an officer of this association to criticize the published work or doctrines of an institution or of individuals?

Second, Is the association responsible therefor?

Third, Did the president correctly state and construe the facts, observations or statements upon which he based his criticisms?

As to the first question, your committee is of the opinion that liberty of criticism of this sort is entirely proper and, more than this, is necessary to the existence of a scientific deliberate body. Free discussion, such as obtains the world over among scientific men, spoken in convention and printed in journals, is indispensable to progress. To suppress what one conceives to be the truth, because it does not accord with the views of colleagues, is an enormity hardly conceivable to liberal-minded men. This principle, once admitted to govern our proceedings, would put an end to the association's usefulness.

As to the second question, it is the sense of your committee that the association is not in any degree responsible for the views expressed by its members in debate or public addresses. That, beyond enforcing ordinary parliamentary laws and courtesy, the association does not and should not exercise censorship over debate or other discussion. Views expressed by members are to be understood as their personal opinions. The association is responsible only for that which it has authorized by formal vote.

In attempting to answer the third question we have carefully verified the figures and statements quoted in the address, by comparison with the publications from which they were derived and by correspondence with the persons familiar with the investigations under discussion. We find them accurately stated and properly used in a legitimate scientific discussion of matters of the greatest interest and importance to agricultural chemists. In our opinion, the facts as stated in the president's address are essentially correct.

As supplementary to this report, your committee submits as exhibits to be filed the following documents bearing upon its work and leading to its conclusion:

A. Letter from Chairman Woll to the Secretary of Agriculture.

B. Answer to same from the Secretary, January 19, 1907.

C. Letter of March 25 from the secretary transmitting Circular 22.

D. Circular 22 from the office of the Secretary of Agriculture.

E. Statement of Dr. Hopkins in regard to Circular 22.

F. Letter from Director Thorne explaining his position.

G. Circular 70 of the Ohio Station relative to Circular 22.

H. Circular 105 of the Illinois Station, being the president's address, as published in pursuance of the resolutions of the association.

I. Bulletin 167 of the Ohio Station.

J. Farmer's Bulletin No. 257 of the Department of Agriculture.

K. A detailed discussion of the issues involved under question No. 3 above, prepared by Chairman Woll with the assistance of some other members of the committee.

(Signed)

L. L. Van Slyke,	B. B. Ross,
Jacob G. Lipman,	F. W. Woll,[2]
R. J. Davidson,	A. M. Peter.[2]

Mr. Lipman spoke at some length concerning the necessity of the association fulfilling its duty both to the farmer and to the scientific world in taking no equivocal position in regard to the methods of scientific research,

[1] President Hopkins's address on the duty of chemistry to agriculture, 1906, was published as Circular 105 of the Illinois Station.

[2] The signature of the absent chairman of the committee, F. W. Woll, and that of A. M. Peter were appended subsequent to the meeting, the report having been submitted to them. The other absent member of the committee, Mr. C. L. Penny, signified his agreement to the report in the main, but took exception to one phase of it, and his name, therefore, does not appear.

approving only such as maintain the highest plane of intellectual integrity and conservatism in the deduction of conclusions from the facts.

President Hopkins is in no need of vindication by a committee of this association. The facts in the case speak for themselves and every chemist and student of soils whose opinion is at all worthy of respect will amply sustain him in the interpretation of these facts. The unanimous action of the committee was inspired, above all else, by the desire to discharge a duty to those who rely on the association as an authority as to strictly scientific methods of research, and the practical application of the results of such work to agriculture. The members of the association are not only affiliated with control and research work, but frequently serve also as teachers in our agricultural schools. They should not, therefore, shirk the moral responsibility imposed upon them. A negative attitude could not be assumed in the discussion under consideration, nor could it be honestly ignored.

The report of the committee was adopted by the association.

APPOINTMENTS IN COLLEGES AND UNIVERSITIES

TO THE EDITOR OF SCIENCE: The question raised by Professor Wenley in SCIENCE, August 21, as regards the desirability that each great department of inquiry should establish a "bureau of information to bring men and places together," appears to me to relate to a need which deserves the ventilation suggested by Professor Wenley, with a view to common action. Probably no department feels this need more than that of mathematics in view of the fact that so few people are familiar with the real nature of advanced work in mathematics, or, in the more emphatic words of Sir Oliver Lodge, that "the mathematical ignorance of the average educated person has always been complete and shameless." This fact has too frequently led authorities to accept men at their own avowed estimate, or at the estimate of some friends who did not take the matter very seriously, since they were not held responsible for their advice by the men who really understood the situation.

While publications like "American Men of Science" render valuable assistance, yet this service is far from complete in view of the facts that the grouping in such a work cannot be sufficiently minute, nor can the issues, with up-to-date changes, be sufficiently frequent to afford just the information that is generally needed by those entrusted with the filling of important positions. In considering this question the Carnegie Foundation for the Advancement of Teaching in its Bulletin Number Two, issued May, 1908, calls attention to the method adopted in the choosing of professors in the Italian universities, which has shown excellent results. The main feature of this method is that the professor is finally chosen by a jury of five professors of the same subject or of a kindred subject to that in which the vacancy exists. In the selection of this jury the faculty of each of the twenty-one Italian universities is invited to vote for five men, and the minister of public instruction chooses five names from amongst the ten having the highest votes.

In sharp contrast to this method stands the inbreeding system followed by most of the larger American institutions, and the still more vicious system adopted by many of the smaller institutions as well as by some of the larger ones, according to which the vacancy is made known to only a few trusted individuals in order to avoid the examination of the credentials of a large number of applicants. One of the principal objections to the system of inbreeding is that it does not emphasize sufficiently high scholarly attainments and tends to encourage superficiality, which frequently attracts local attention, but seldom receives national recognition. It is said that chiefs of divisions under the federal government are frequently surprised at finding, by means of the civil service, men of very high ability who had been hitherto entirely unknown outside of their own regions. Such discoveries would be of the greatest importance to the college and the university, and a system of appointments is necessarily defective in so far as it does not insure the finding of the very best available man for the vacant position.

While a system of appointments calling for a national survey by specialists whenever an important position is to be filled would doubtless serve as a great incentive to the younger men, yet the main advantage would result from the fact that men of the greatest energy and ability would be placed in positions where they could work to the best advantage, instead of wasting the greater part of their energies while others are wasting most of their opportunities. It is a question calling for national action, since our system of inbreeding is so well intrenched and works to the advantage of so many persons of mediocre ability, that it is scarcely to be expected that the authorities would be willing to face the storm resulting from a decided change in a single institution.

The natural body to establish a bureau of information, if Professor Wenley's suggestion were to be adopted, would appear to be a national organization of men representing the department of inquiry. If the American Mathematical Society and the American Chemical Society, for instance, would appoint committees representing the various parts of the country, and entrust such committees with the nomination of the best possible men for the positions brought to their attention, they would doubtless render a most important service. As such a committee would feel the great responsibility of having their actions reviewed by a national society of experts, it would doubtless look into the matter much more carefully than individuals do, who are casually asked to express their opinions in regard to the best available men. It seems also likely that appointing bodies would generally be very eager to secure such expert advice and thus remove a part of the responsibility from their own shoulders.

Whether such a bureau of information would be as satisfactory as the Italian system, properly modified to meet our situation, it seems difficult to predict. At any rate, the present haphazard method seems so bad that it does not appear likely that any one resulting from a full discussion of the matter could fail to be far superior. It need scarcely be added that a wise system of appointments would be apt to check the tendency towards czarism on the part of our big institutions—a tendency which has alarmed many of our best men and threatens to serve as a barrier in securing the very best talent for university positions.

G. A. Miller

University of Illinois

ON THE ORIGIN AND AGE OF THE SEDIMENTARY ROCKS

To the Editor of Science: In replying to Dr. Barrell's criticisms[1] I wish, first of all, to make it clear that I have no fault to find with the "detailed studies of the geological record"; the matter in dispute has to do with the *theories* which the geologists have founded on their interpretations of the observations.

Dr. Barrell states that I claim to have demonstrated that the earth was "protected by a cloud envelope until the Tertiary"; herein he disregards my published—qualified—statement that (in view of my results) Manson's hypothesis must now be modified; and the nature of this modification is clearly indicated by my references to "warmer" and "colder" months of the year as still existing at the very beginning of a glacial epoch; in other words, while I accept the theory that the former higher temperature of the ocean was necessary to supply the material for the (now disappearing) ice sheets, I find that climate then, as now, must still have been local, and there seem to be no good reasons why climate should not have been sensibly local in those earlier times for which we have records showing that living organisms then existed; only in the still earlier history of the earth was the cloud mantle so thick that the sun's influence was rendered practically insensible at the earth's surface.

But, considering the comparatively small size of the earth, this condition of things could exist through the hundreds of millions of

[1] Science, pp. 371–3.

years (which geologists claim were required for the formation of the rock layers containing evidences of former terrestrial life) only on the supposition that there was practically no radiation into space of inherent earth-heat; the assumption has been that the earth's surface temperature was kept from falling to a lower temperature because of the assumed high temperature of space (by "temperature of space" I mean the temperature of the solar rays in free space at the earth's distance from the sun).

But, as I have demonstrated that the temperature of space is far below the hitherto accepted value of this constant, the earth must be losing its heat with much greater rapidity than the advocates of a cooling earth have, theoretically, found to be the case for the data used. If, as most geologists claim, the stratified rocks were produced by a rearrangement of the matter previously contained in the older rocks, then, indeed, the hundreds of millions of years might easily be required to produce the rock strata built up since pre-Cambrian times; but, if the building material was obtained and transported in the manner here explained, the geological periods were of very much shorter duration.

To make a fairly comprehensive reply to Dr. Barrell's criticisms a very brief presentation of my theory as to the origin of the main sedimentary rocks will be necessary.

I find that geologists in their studies have regarded as unessential the part which the ancient volcanoes must have played in the formation of rock strata. Without in any way calling in question certain assigned effects produced by the action of water in its various forms and positions, it seems to me that the transporting power of the atmosphere must have been by far the most efficient agent for covering the earth's surface with different layers made up of finely divided matter which was originally ejected into the atmosphere in the form of volcanic dust, the chemical constitution of which varied from time to time and was further modified by contact with the atmosphere and water.

In a recent issue of Science I show, theoretically, that the eastward circulation of our atmosphere is caused by a vertical circulation (the ascending matter being arranged in the form of an expanding spiral having the greatest density near the axis of the spiral), resulting from ruptures of air strata in unstable equilibrium because of the different temperatures due to trapped heat. Now it is known that the gases issuing from certain volcanic vents are not only under very great pressure, but the temperature of these gases is very high, consequently the lighter materials also issuing from the vent will be carried to various great heights along with the expanding gases, and before these materials have time to settle back to the earth's surface differential angular drifts (diurnal) cause this matter to be distributed throughout a broad zone parallel to the equator and completely encircling the earth. Owing to the eastward circulation of the atmosphere, much more matter falls on the east side of the meridian of the vent than on the west side, as the heavier materials settle back to the earth sooner than the lighter ones. In general, therefore, the slope of the accumulated material will be long and gradual on the east side, but short and steep on the west side of a volcanic region. If the surface on which the débris falls is the ocean (or other body of water), most of the matter finally sinks to the bottom and forms stratified layers; but if water currents are present, a different distribution is made.[2] Wind and rain tend to keep the higher land areas swept clear of such matter, so that stratified layers do not, as a rule, accumulate on such a surface.

[2] As the weight of the deposit is much greater on the east side, the weak, severely strained crust on the west is often found dipping into the ocean; and local débris-transporting currents are formed by contact of the water with both the thin crust of the earth and with the heated matter forced into the bed of the ocean through newly-made faults or fractures. The greatest crustal heat is conveyed to the water at the greatest ocean depths; from this it follows that the greatest ocean currents should be formed among the volcanic islands.

According to this theory, then, in pre-Archean times when the crust of the earth had fallen to the temperature at which water would no longer boil, the water-vapor in the atmosphere began to condense to form the primitive ocean; tidal effects produced irregular distribution of crustal tension, causing fractures (most probably along meridian lines), of the solidified crust, thus allowing the seepage of surface-water and the consequent formation of the first volcanic vents. As a result of the constantly increasing weight of a given cone, the supporting crust in the immediate vicinity was depressed deeper and deeper below the general level (and still farther depressed through the additional weight of the now water-filled surrounding valley), causing a series of circular wave-like upthrusts separated by water-filled valleys of decreasing depths as the distance from the vent increased. The linear series of vents, along the line of fracture, through continuous growth finally formed a central serrated ridge bounded on each side by a series of parallel ridges of decreasing height. The eastward motion of the atmosphere caused the valleys on the east side to be filled much more rapidly than those on the west side, and thus produced the conditions favorable for the formation of a continental surface sloping to the east, from the volcanic ridge.[3]

About Archean times the decreased surface temperature—the changed topography of the rock surface (due to the unequal distribution of the volcanic débris, thus causing differential uplifts), and the consequent partial removal of the cloud envelope in certain regions—made possible the advent of other forms of matter, including living organisms.

As the thickness of the crust continued to increase—mostly through the addition of materials from the earth's interior—the number of the then existing vents gradually decreased, through the closing of the seepage channels by the volcanic débris. Later on, fresh fractures along neighboring lines of least surface strength resulted in the formation of new vents, and a new era of a dust-filled atmosphere, with its accompanying consequences, was again inaugurated.

As nearly all the material forming the layers deposited on the primitive crust was taken from the interior of the earth,[4] the accumulated warping of the crust towards the close of the period during which the sedimentary rocks were formed was very great —*much greater than could have resulted from shrinkage due to radiation of heat from the inside-out surface alone!*

If the erupted material for a given rock layer was laid down slowly, through long-continued activity, the evidences of former terrestrial life may be visible throughout the whole thickness of the rock formed; but if the deposition of matter was very rapid, all signs of former life may be wanting, and the total extinction of certain organisms may thus have resulted.

Some of these layers may have been deposited in the course of a few years, or even days, while for the formation of others, centuries may have been required.

With the removal of the lighter constituents of the earth's interior to the exterior surface, and the consequent strengthening of the crust, the number of active volcanoes rapidly diminished, thus practically closing the active period of sedimentary rock formation, leaving, in the main, only the ever-present secondary effects, resulting from surface erosion, to continue in operation.

By far the greatest result of these secondary causes is the topographic change produced by the two ice sheets of recent origin; these ice sheets, now mostly confined to the two arctic regions of the earth, but which only a few

[3] On the area between neighboring fractures extending in an east-west direction more débris was, of course, deposited—forming high table-lands—and the eastward extension of the slope became greater than was the case for fractures extending in a north-south direction. Long-continued local deviation from an eastward motion of the atmosphere caused a corresponding change in the direction of the local slope.

[4] During the past eighteen years I have published a number of short papers which favor the theory that the earth's surface is also continually receiving finely divided matter which has been ejected from the sun.

thousand years ago extended, in certain directions, well into the temperate zones, seem to offer positive evidence that the earth is growing colder. The theoretical (beautifully simple) explanation of the origin, growth and final retreat of the ice, which results from my modification of Manson's hypothesis, is, very briefly stated, as follows:

After the minimum polar-surface-temperature had fallen to 0° C. snow commenced to fall at the two poles during the respective winter months; each year this snow was, for some time, completely melted during the respective warmer seasons of the year; as the earth grew colder, the snow and ice covering became permanent and spread equatorwards with seasonal fluctuations at the ice front; but as the ocean grew colder the amount of evaporation from its surface decreased, so that the available amount of snow to be melted at the ice front continually diminished (while the intensity of the direct solar rays at the surface of the earth was, for a given latitude, continually on the increase);[5] a final retreat of the ice front was, therefore, inevitable. As the snowfall will later on cease altogether, the land ice will continue to retreat and probably disappear at the poles. These results are for ideal sea-level conditions; topographic irregularities, differences of elevation, direction of air and water currents—all act to produce great deviations from the theoretical results here made to depend on latitude and ocean temperature alone; these deviations have, in the past, been so great that evidences of former *local* glaciation should be found throughout nearly the whole series of stratified rocks.

In addition to the theoretical data given on page 415 of the current volume of SCIENCE, I would, in connection with Dr. Barrell's remarks on radiation of heat, call special attention to the fact that, since the publication of my paper demonstrating that Newton's law of radiation is theoretically exact, no less authority than Professor Newcomb has asserted (but not demonstrated) that Stefan's law of radiation has been established; now, as I claim to have demonstrated that "some surprising error in previous methods" has actually developed, Dr. Barrell or some other scientist must show that my demonstrations are erroneous before further intelligent use can be made of laws of radiation established by others and used (to quote from SCIENCE, February 14, 1908, p. 269) as "the formulæ accepted to-day" by scientists.

J. M. SCHAEBERLE

ANN ARBOR, MICH.,
September 29, 1908

[5] Because of this condition of things, it seems extremely probable that formerly, when the arctic climates were less severe, equatorial and temperate regions were for a time actually somewhat colder than they are to-day, for the lowering of the surface temperature resulting from the ever decreasing heat-trapping power of the atmosphere was, for a time, probably more than offset by the increased intensity of the direct solar rays.

CLOUDS OVER A FIRE

TO THE EDITOR OF SCIENCE: In connection with Mr. B. M. Varney's letter on "Clouds over a Fire" in SCIENCE for May 15, 1908, I may say that I have often observed the same phenomenon here. In cutting sugar cane the stalks are stripped of leaves in the field, and when the cutting of a field is finished the leaves are set afire as they lie spread over the field. When the weather is calm there arises a column of dark smoke which is often beautifully capped by a mass of white cloud. I have wondered whether the particles of smoke furnish nuclei for the formation of water drops as the smoke rises to a level of supersaturated air, or whether, as Mr. Varney suggests, the draft carries water vapor to a level of cloud formation.

WM. F. WALLIS

EWA, HAWAII

QUOTATIONS

DANIEL COIT GILMAN

DR. GILMAN was soon called from California to conduct what was, at its inception, a unique undertaking. This was nothing less than the establishment of a university for graduate study, with an equipment and faculty that should make it the rival of the best universities of Europe. On the disappointments and even failures of this enterprise we need not dwell. At one period the Johns Hopkins suffered heavy financial losses, and its resources have always fallen far short of its ideals. But hampered as the university has been by lack of money, of equipment, and of men, it has yet been one of the most potent forces in elevating the intellectual standards of our colleges. The young men who gathered at the Johns Hopkins in the early days under Gildersleeve, Rowland, Remsen, and Sylvester were filled with enthusiasm for exact and extensive learning. There is always, we grant, the danger that vast erudition will not become assimilated and humanized; that it will remain mere pedantry. This peril the graduates of Johns Hopkins incurred; and some of them did not wholly escape it. But in the seventies and eighties our education was less Germanized than now and in an era of slipshod training, Johns Hopkins offered the kind of severe drill that was sorely needed. The graduates carried the gospel of a rigorous scholarship from one end of the country to the other, and made it more and more necessary for teachers, both in college and school, to be masters of their subject. This was perhaps Dr. Gilman's greatest contribution to the cause of education in America. How great it is we can not yet estimate; for the men whom he and his faculty prepared for teaching are yet with us, distinguished in their various callings, and we can not view their labors in proper perspective.

It was Dr. Gilman's fortunate lot also to guide the Carnegie Institution of Washington in its first three years. The conception of foundations for scientific research had made very slight headway in this country. We have had a few laboratories that are endowed, and here and there a university has been willing to maintain a professor—say, in astronomy—who is not expected to teach, but who can devote his energies to extending the limits of our knowledge. But the notion of research, without prospect of return in cash dividends, has not appealed to a utilitarian people. More than that, few colleges, under the pressure of undergraduates demanding instruction, have been able to set aside funds that did not seem immediately productive. The Carnegie Institution, then, like the Johns Hopkins, was established at a moment of need. We can not doubt that in the long run it will do as much, perhaps even more, to raise the standards and the tone of scholarship in America. It was fortunate in receiving its first shaping from the hands of a man of Mr. Gilman's long experience and wide views.—New York *Evening Post*.

SCIENTIFIC BOOKS

The Harvey Lectures. Delivered under the Auspices of The Harvey Society of New York, 1906–7, by Professors A. E. Wright, C. A. Herter, W. T. Porter, J. G. Adami, F. G. Benedict, E. B. Wilson, George S. Huntington, W. T. Councilman, Friedrich Müller and Dr. S. J. Meltzer. Pp. 1–314. Philadelphia and London, J. B. Lippincott Company. 1908.

The appearance of this volume marks the completion of the second year of the Harvey Society. Starting more or less as an experiment based on the assumption that there was a desire on the part of practitioners of medicine to acquire at first hand from men engaged in research more knowledge concerning the scientific problems and principles underlying their profession, the Harvey Society has made for itself a permanent place as a factor in higher medical education. Its usefulness is no longer a matter of doubt, but is now an assured fact. Nor is its sphere a local one, since through the publication of its lectures, these are brought within reach of all.

This paragraph from the preface of the present volume states concisely the position of the Harvey Society. The society was organized in 1905 for the purpose of bringing before medical practitioners the results of important scientific investigation in medical and allied fields. It has a membership of one hundred and seventy-five investigators or practitioners of New York City, and has now held three courses of lectures. Those of the first course were published in 1906, those of the third course are soon to appear, and the present volume includes the ten lectures of the second course. Foreign men of science are represented by two men of distinction: Sir

Almroth E. Wright, of London, whose work on the opsonic index has opened a new field of many possibilities, discusses the principles of vaccine therapy, especially under the guidance of the opsonic index; while Professor Müller, the eminent clinician of Munich, reviews the nervous affections of the heart, from the standpoint of one who is familiar with modern cardiac physiology and pathology. Professor Herter, of Columbia, discusses the common bacterial infections of the digestive tract and the intoxications arising from them —a subject which his researches have made largely his own. Professor Porter, of Harvard, discusses vasomotor relations in animals and men, partly with reference to the theory of vasomotor depression in shock, and presents many results of his own experiments. Professor Adami, of McGill, deals with the myelins and potential fluid crystalline bodies of the organism, showing their wide distribution and their physical and chemical relations. Dr. Meltzer, of the Rockefeller Institute, under the title "The factors of safety in animal structure and animal economy," raises the question whether in the structures and functions of the animal organism considerations of economy or of luxury, the latter involving the factor of safety, are paramount, and demonstrates the wide occurrence of safety mechanisms. Professor Benedict, the director of the Nutrition Laboratory of the Carnegie Institution, presents the results of a long series of observations on the metabolism of human beings during inanition, the work having been done with the aid of the large respiration calorimeter at Wesleyan University. Professor Wilson, of Columbia, summarizes the results of some recent studies of heredity, especially certain researches on the chromosomes, which may prove to furnish a physical explanation of the main facts of Mendelian heredity. Professor Huntington, of Columbia, presents the standpoint of the modern anatomist in an article, accompanied by many illustrations from his own preparations, on "The genetic interpretation and surgical significance of some variations of the genito-urinary tract." Professor Councilman, of Harvard, describes the changes in the lymphoid tissue in certain of the infectious diseases, particularly in diphtheria, scarlet fever and small-pox.

Each lecture represents a valuable summary of present knowledge in its specific field. Furthermore, the lack and uncertainties of present knowledge are often indicated, and the possibilities of investigation along specific lines are emphasized. It is in the element of stimulating suggestiveness that the value and charm of the book largely lie. Each author writes as a master in his own subject, and the reader can not fail to feel this. The whole volume reflects the spirit of the modern scientific method, of which each author is an able exponent.

The Harvey Society has already received wide attention and approbation outside the immediate circle of its auditors. With its annual output from the leaders in the medical sciences it is doing a most important work in bridging the gap, which ought never to exist unbridged, between the laboratory investigator and the medical practitioner. Its annual volume of lectures can not fail to find a wide circle of readers.

Frederic S. Lee

Columbia University

Pollution of New York Harbor as a Menace to Health by the Dissemination of Intestinal Diseases through the Agency of the Common House Fly. A report by Daniel D. Jackson, S.B., to the Committee on Pollution of the Merchants' Association of New York. The Merchants' Association of New York, New York City, N. Y., July, 1908. 22 pp.; maps Nos. 1 and 2, 3 diagrams, 2 plates, 1 table.

This attractive little report of an investigation of the sanitary conditions of the waterfront of New York City made during the breeding season of 1907 deserves attention, especially from the sanitarian and the medical profession if not from the general biologist and the laity.

The investigation consisted of an inspection of the entire water-front of the city in order to show the presence of numerous sources of infection and breeding places for flies, and secondly, of a study of the abundance of flies and their connection with the spread of intestinal diseases of man, and what proportion of these diseases were due to the agency of the common house fly.

The investigation was carried on primarily to obtain evidence for the Committee on Pollution of the Merchants' Association of New York, that unsanitary conditions existed and that these conditions were directly responsible for the prevalence of certain intestinal diseases of man; so that the said committee would have some basis for complaint to the proper authority against the open violation of the health laws by the citizens of the city. The inspection of the water-front (pp. 8–16) revealed large quantities of both human and horse excreta exposed to fly infestation on piers, along the beach, and so forth, as well as sewage and refuse matter of all kinds; in a word an abundance of decomposed matter and filth suitable for the breeding place of flies, and swarming with the latter and their young.

Having obtained evidence by means of inspection that the forementioned unsanitary conditions existed, and that flies were breeding in and frequenting the fecal matter exposed to them, an investigation was also conducted by means of fly traps placed in various parts of the city, to determine what bearing the products (flies) of these conditions had upon the actual transmission of intestinal diseases within the city.

The traps near unsanitary points caught the largest number of flies, showing that these conditions attracted them; those in cleaner portions of the city caught but very few. The flies caught in the traps were counted each day and tabulated by weeks. The weekly totals are then compared by means of a table (p. 17) with the weekly totals of deaths in the city from diarrhoeal diseases, showing parallelism; this is further brought out by means of two diagrams (facing p. 14) showing the coincidence of the maximum abundance of flies and of that of the intestinal diseases of man. Still another diagram (facing p. 12) gives the curves of temperatures, representing fly activity, and of typhoid fever and other intestinal diseases, for a period of the five preceding years, again showing almost exact parallelism. Two maps (maps Nos. 1 and 2) are also introduced as further evidence, showing the location of the individual cases of typhoid fever in the Borough of Manhattan (map number 1) for 1904, and the location of deaths from intestinal diseases for the same area during 1906 (map number 2), and they emphasize the fact that the great majority of the cases of sickness and of death were located at those points found to be most unsanitary in 1907; that is to say, were distributed over the fly-breeding area. A few other minor corroborative facts are recorded, such as the finding of numerous pathogenic bacteria on the appendages of flies during the breeding season, and but little or none at all on them just following hibernation. The conclusion indicated is obvious, but I quote the author's concluding paragraph (p. 19):

> It is to be hoped that the gross defects which we have pointed out in general sanitation as well as in sewage disposal will be remedied before the summer of 1908. We have estimated that proper sanitation along the lines pointed out will reduce the typhoid deaths in New York from 650 to 360 a year and the diarrhœal deaths from 7,000 to 2,000 a year. This latter figure provides that germ-infected flies are not permitted to contaminate the milk supply before it reaches the city or after. This saving of over 5,000 lives a year will also be accompanied by the additional saving of some 50,000 cases of sickness.

While the report establishes no new facts in regard to the transmission of diseases by flies (*Musca domestica* Linnæus), it is an important *exposé* of actual conditions existing in our most crowded city, and is corroborative of previous investigations; besides, it brings out the possibilities of lessening deaths and sickness due to the agency of house flies by proper sanitary measures.

As a contribution to science, the report is very poorly presented; it suffers especially from lack of arrangement and will give trouble to the bibliographer. No new biological facts are recorded about the common house fly, and the author apparently does not distinguish between this species (*Musca domestica* Linnæus) and others, which under certain conditions may have appeared in the traps in considerable numbers, and while having no relevancy, materially affect the results. Such biological facts as are given are compiled without reference to sources, and some of the statements are obviously wrong. For instance, this—"The number of eggs laid by each female fly during the season is about 1,000" (p. 17). Presenting compiled matter in this manner can not be too strongly discouraged, as it forms a stumbling block to future investigators; for appearing to have originated with the author giving them and based on sufficient data, in reality they are statements made by others and should not be accepted unless the sources are given. Otherwise, science would be credulous.

A. Arsène Girault

Urbana, Ill.,
September 23, 1908

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for September begins with an article by T. D. A. Cockerell on "Some Results of the Florissant Expedition of 1908." It notes that the best exhibit of Florissant fossils is now at the University of Colorado and incidentally describes two new species of fossil plants. Leroy D. Swingle describes the "Embryology of *Myosurus Minimus*" and this arouses the query should a specific name be capitalized even in the title of an article? J. A. Allen presents "Another Aspect of the Species Question" showing that the problems of nomenclature are somewhat different in zoology from what they are in botany and that botanists do not always describe their species so that they may be recognized from the descriptions alone. G. H. Parker considers "The Origin of Vertebrate Eyes" casting the weight of his opinion with those who consider that they arose from the internal central nervous system and not on the exterior.

Bird-Lore for September-October contains the following articles, mostly illustrated: "A Raven's Nest," by Francis H. Allen, "Hummingbird Eccentricities," by Mary P. Allen; "A Mockingbird's June," by Albert V. Goodpasture; "The Growth of Young Black-billed Cuckoos," by A. A. Saunders; "Chestnut-sided Warbler," by Mary A. Dickerson, and the sixth paper on "The Migration of Flycatchers," by W. W. Cooke. The "Educational Leaflet," by Mabel Osgood Wright, is devoted to the kinglets. The report of the Audubon Societies notes the establishment of three new Bird Reservations, near Key West, Fla., Klamath Lake, Oregon, and Lake Malheur, Oregon.

The Museums Journal, of Great Britain, for August contains a brief summary of the proceedings at the Ipswich conference, the program followed and lists of officers and members. The papers presented will appear in subsequent numbers. A brief article is devoted to "The British Museum (Natural History)," dealing with the question of the appointment of a keeper of zoology and a director, positions which have been vacant since the retirement of Sir E. Ray Lankester at the end of 1907.

The American Museum Journal for October under the caption "To the Bahamas for Coral" notices the successful expedition made for this purpose and gives some fine pictures of living corals. Additions are noted to the exhibition series of fossil horses and dinosaurs, to the collection of whales, series of heads of game animals, and the exhibit illustrating the motions of the planets.

The Museum News of the Brooklyn Institute notes important changes in the arrangement of the collections and numerous additions to the exhibition series. A novelty is the installation of a large group showing the home of the guacharo bird, so arranged that the visitor can illuminate the cave by pressing a button. Another important group is that of Steller's Sea Lion. An article on the botanical collections calls attention to some important material in the herbarium. The part devoted to the Children's Museum contains a list of material that may be loaned to schools.

THE LOCO-WEED DISEASE

For several decades the loco-weed disease has been a subject of much interest both practical and theoretical—practical because it is the cause of extensive losses of live stock in the western half of the United States, theoretical because to the pharmacologist it has offered an unusually puzzling and tantalizing problem which has hitherto baffled all attempts at solution.

By far the most important contribution ever made to the subject has recently appeared as a bulletin of the Bureau of Plant Industry, United States Department of Agriculture, by A. C. Crawford.[1] In order to appreciate the significance of this piece of work, which is one of the most important contributions to pharmacology ever made in this country, it is necessary to recall the state of knowledge concerning "loco" when Crawford began his investigations. The condition has been known for at least sixty years; the United States Department of Agriculture began to investigate it in 1873 and has returned to the problem at frequent intervals since. In addition it has been the subject of study by a number of state institutions and by many private individuals. The condition has usually been ascribed to the eating of certain plants; most commonly various species of *Aragallus* and *Astragalus* were held responsible for it. All efforts to obtain a poisonous substance from these plants had, however, failed. Most experimentors had been unable to produce any poisonous effects whatever, when the plants or their extracts were administered to animals; Professor Sayre stated that he had sent thousands of pounds of the dried plants to various investigators in America and Europe, but all reports were negative as to pharmacological activity. The condition was ascribed by some to the mechanical action of fine hairs on the plant, by others to bacteria associated with the plants; others denied any causal relation between the plant and the condition and attributed the latter to malnutrition, helminthiasis, etc. The few who had seen poisonous effects from the plants seemed inclined to the belief that a poisonous substance was actually present, but that it was too unstable to admit of isolation except under the most favorable conditions of work.

[1] "Barium, A Cause of the Loco-weed Disease," Bull. 129, Bureau of Plant Industry.

Thus when Crawford began his work in 1905 it was still a matter of controversy whether the plants he was to study were poisonous or not. Field experiments carried out independently by C. D. Marsh and laboratory experiments by Crawford soon showed definitely that it is possible to produce sickness and death by the administration of certain of the plants. The first step having been thus taken, Crawford attacked the problem of the nature of the poisonous substance. Seldom has a pharmacologist been confronted with a more difficult problem; the few clues from the work of the last twenty-five years proved absolutely misleading. It is impossible to give the details, but a brief outline will indicate what an amount of the most painstaking work was necessary before success was finally achieved. Having determined the amount of plant necessary to kill a rabbit of a certain weight, Crawford proceeded to the chemical examination controlling each step by experiments on animals. One group of poisons after another—volatile poisons, alkaloids, glucosides, organic acids, toxalbumins—were excluded. The first encouragement came when it was found that the toxicity was not destroyed by boiling. This was followed by the surprising discovery that the ash of the plant was poisonous; if any conclusion was to be drawn from the work of previous writers it was that the poisonous substance—if such were present at all—was so unstable that it did not withstand even drying!

After the discovery that the ash was toxic there were still many difficulties. The ash was very complex but Crawford systematically separated it into many fractions, testing each physiologically. In this way all of the common heavy metals were excluded; the ash however, contained small amounts of zirconium, titanium, etc. All of these as well as beryllium, thorium, thallium, had to be excluded by various chemical and physiological tests. Search was also made for a radio-active substance. Chemists had called attention to the abundance of calcium in the ash; this and strontium were excluded from being the toxic agents.

Finally Crawford noticed that extracts prepared with sulphuric acid were inactive; further, that active extracts caused a rise of blood-pressure. Both of these observations suggested the presence of barium. After a long series of careful experiments the author reached the following conclusions:

> A close analogy exists between the clinical symptoms and pathological findings in barium poisoning and those resulting from feeding extracts of certain loco plants. Small doses of barium salts may be administered to rabbits without apparent effect, but suddenly acute symptoms set in analogous to what is reported on the range.

Finally barium was found in the ash of many "loco" plants in amounts sufficient to account for the symptoms.

Among the other important conclusions, some of which help to explain the unsatisfactory results of former workers, are the following:

> Loco plants grown on certain soils are inactive pharmacologically and contain no barium. In drying certain loco plants the barium apparently is rendered insoluble so that it is not extracted by water, but can usually be extracted by digestion with the digestive ferments.
>
> The barium to be harmful must be in such a form as to be dissolved out by digestion.
>
> In deciding whether plants are poisonous it is desirable not merely to test the aqueous or alcoholic extract, but also the extracts obtained by digesting these plants with the ferments which occur in the gastro-intestinal tract.

These experiments afford another illustration of how indispensable are animal experiments in all kinds of pharmacological work.

The author conservatively limits his conclusions to the plants he has studied, and recognized that in the plants grown in other localities the toxic action may be due to substances other than barium.

There is an extraordinarily rich and well-selected bibliography of the entire subject of "loco" and also of barium poisoning in both man and the domestic animals.

It seldom falls to the lot of an investigator to carry to such a successful conclusion a problem of such complexity and so baffling; it will long remain as one of the most notable contributions to pharmacology made here or abroad.

Reid Hunt
Hygienic Laboratory,
Washington, D. C.

SPECIAL ARTICLES

THE EFFECT OF LESIONS OF THE DORSAL NERVE ROOTS ON THE REFLEX EXCITABILITY OF THE SPINAL CORD (PRELIMINARY NOTE)[1]

In some preliminary experiments Professor Carlson found that lesions of the dorsal nerve roots appear to have the same effect on the cross reflexes of the spinal cord as transsection of the cord itself. That is, in animals in which the reflexes disappear temporarily after transsection of the cord (spinal shock) the cross reflexes are similarly lost temporarily after lesions of the dorsal nerve roots on one side.

The experiments here reported were undertaken at the suggestion of Professor Carlson in order to determine definitely this parallelism in different animals, because of the important bearing of these results on the theories of spinal shock.

Methods of Experiments.—Section of the dorsal nerve roots to one limb: (*a*) After high section of the spinal cord, (*b*) on the intact animal.

In pigeons, cats and dogs after the high section and recovery from shock and anæsthesia (usually one day) the final operation of cutting the dorsal nerve roots was made without anæsthesia.

Results of Experiments.—The effect on the cross reflexes caused by the cutting of the dorsal roots to a limb is as follows: In snapping turtles, loss of cross reflexes for 5–10 minutes; in frogs, loss of cross reflexes for 15–30 minutes; in pigeons, no loss of reflexes;

[1] From the Hull Laboratory of Physiology, University of Chicago.

in cats (young) loss of reflexes for 30–40 minutes; in cats (old) loss of reflexes for 50–70 minutes; in dogs, loss of reflexes for 75–90 minutes.

In the turtle transverse lesion of the cord usually does not abolish the reflexes except momentarily. This is also true for the pigeon. In other words, lesions of the dorsal roots produce the same shock effects on the spinal reflex mechanism of the limb involved as transverse lesion of the cord itself.

The present theories of spinal shock may be summarized under three heads, viz., (*a*) inhibition due to the trauma; (*b*) loss of tonus impulses to the reflex centers; and (*c*) lesions of the reflex arcs themselves.

The last theory is not applicable to these results. Either one or both of the other two may be applicable to the results here reported. That is the shock may be due to the temporary effect of absence of tonus impulses, or to irritation of inhibitory nerves, or to both of these.

The work is being continued with the purpose of determining this point.

Clyde Brooks

A NOTE ON THE OCCURRENCE OF TWO WEST INDIAN FISHES AT BEAUFORT, N. C.

During August, 1907, the writer collected in the harbor of Beaufort, N. C., two fishes which are for the first time reported from this locality. Both forms are of the tropical and subtropical faunas. A small specimen of *Abudeduf saxatilis* Linn., was seined August 10, 1907, at the Fort Macon jetties. Its length is 2.25 inches. The other form is *Ulæma lefroyi* Goode. A number of these were taken in a dipnet at Pivers Island, August 3, 1907. The smallest fish measured 0.40 inch in length, the largest 0.52 inch.

In order to ascertain the identity of these small fish, which had evidently been hatched only a few days prior to their capture, they were placed in an aquarium of running sea water, and there they were successfully reared. During the first week they were fed on copepods and larval crustaceans which were strained from the tow; this food was then changed to grated oyster on which they thrived vigorously. September 2, 1907, the smallest *Ulæma* measured 0.91 inch in length, the largest 1.12 inches; the rate of increase in length averaged 120 per cent. This method of rearing fry was employed this season for *Fundulus majalis*, which were hatched in the laboratory from eggs which had been artificially fertilized. The young *Fundulus* were reared until they had attained a length of 0.75 inch, when an accidental overflow of the aquarium permitted the fish to escape.

On August 21, 1908, on the landward side of one of the large shoals in the harbor, numbers of small specimens of *Ulæma lefroyi* were collected in a small seine of fine mesh.

For the opportunity of making these observations the writer is indebted to the Hon. Geo. M. Bowers, U. S. Commissioner of Fisheries.

Bartgis McGlone

St. John's College,
Annapolis, Md.,
September 1, 1908

CATALYTIC REDUCTION OF FATS AND OILS

About four years ago it was shown by Paal and Amberger[1] that palladium could be obtained in a particularly active colloidal aqueous solution (hydrosol). Subsequently the senior author demonstrated[2] that this liquid, in presence of hydrogen, was capable of causing the catalytic reduction of nitrobenzene. The work has now been extended to include certain other substances,[3] the most generally interesting of which are oleic acid and a number of oils.[4]

The acid, in the form of its potassium salt, is dissolved in water and mixed with a small quantity of the palladium solution; the liquid being then introduced into a gas-burette containing hydrogen, standing over mercury. Absorption of the gas commences immediately and the reaction is completed in a few hours. No heating is required. Oleic acid, under these conditions, is converted almost quantitatively into stearic acid. Castor oil, dis-

[1] *Ber.*, **37**, 124 (1904); **38**, 1398 (1905).

[2] *Ibid.*, **38**, 1406, 2414 (1905); **40**, 2209 (1907).

[3] *Ibid.*, **41**, 2273.

[4] *Ibid.*, **41**, 2282 (1908).

solved in a mixture of ether and alcohol, is transformed into a crystalline fat, which softens at 69° and melts at 77°.

The behavior of olive oil is very peculiar. It combines with three times the quantity of hydrogen which was anticipated from its behavior with iodine. The product, which in general properties resembles that from castor oil, is still capable of combining with iodine. Unless, therefore, some flaw can be shown to exist in the experiments, it will be necessary to revise our ideas of the processes which take place during the ordinary testing of oils and fats with iodine (Hübl's method).

Train oil absorbed about 30 per cent. more hydrogen than was anticipated. The yield of solid fat was quantitative. Before reduction the train and olive oils were converted into emulsions with water and a little gum arabic.

These results promise to be of great importance to plant physiologists, because the reactions proceed under conditions comparable, in a number of respects, with those under which similar or identical products are formed in nature. To the industrial chemist the results may also prove to be of considerable value; a reasonably cheap method of transforming liquid oils into solid fats has been much sought after.

J. Bishop Tingle

McMaster University,
Toronto, Canada,
August, 1908

SOCIETIES AND ACADEMIES

JOINT MEETING OF GEOLOGISTS OF THE NORTH-EASTERN UNITED STATES WITH THE SECTION OF GEOLOGY AND MINERALOGY OF THE NEW YORK ACADEMY OF SCIENCES

The Section of Geology and Mineralogy of the New York Academy of Sciences in cooperation with the geologists of neighboring institutions held an all-day meeting on April 6. The general invitation sent out by the academy met with a generous response. Representatives attended from Massachusetts Institute of Technology, Amherst, Wesleyan, Universities of Vermont and Pennsylvania, Dartmouth, Lehigh, Rutgers, Harvard, Yale, New York University and Columbia in addition to the local membership. Two sessions were held, one in the rooms of the department of geology at Columbia University, the other in the academy quarters at the American Museum of Natural History. Fourteen papers were presented and eight others were read by title. Abstracts of some of these papers are given below:

The Cambrian Rocks of Vermont: G. H. Perkins, State Geologist of Vermont.

So far as satisfactorily determined, the Cambrian of Vermont occupies a narrow strip from north to south through the state between the Green Mountains and Lake Champlain. In some places they reach the shore of that lake and form the boldest of the headlands.

Northward the Cambrian extends to the Gulf of St. Lawrence and south through New York to middle Alabama.

It is probable that there are derivatives from Cambrian strata in and east of the Green Mountains, but none have been certainly identified. So far as studied, all the beds belong to the Olenellus zone of Walcott, or Lower Cambrian. The very interesting and extensive fault and overthrust by which Cambrian strata were lifted and thrown over the Utica is noticed. In all there are not less than 10,000 feet of Cambrian beds in western Vermont. These beds consist of 1,000 feet of more or less silicious limestone, and the other rocks are shales, sandstones, quartzites, conglomerates, of very diverse color composition and texture. In a few places the red sandrock beds change to a thick-bedded brecciated calcareous rock which when worked is the Winooski or Champlain marble—a mottled red and white stone used in many large buildings in many parts of the country.

Few of the beds are fossiliferous, but some abound in trilobites, Olenellus, Ptychoparia, etc., and a few brachiopods, worm burrows, trilobite and other tracks, etc., are also found. In all the number of species is not large, probably not more than fifty have been found. Of these, trilobites form the larger number, brachiopods coming next. A large portion of the species were described from the Vermont beds and many have not been found elsewhere.

Most of the beds are thin, but there are some several feet thick.

The great beds of roofing slate which are extensively worked in southwestern Vermont are included in the Cambrian.

Newark Copper Deposits of Pennsylvania: Edgar T. Wherry, University of Pennsylvania.

The Newark series in eastern Pennsylvania is divisible into five formations, and attains a total thickness of over 20,000 feet. In the upper part there is a large trap sheet, about 1,500 feet thick, which shows the character of an intrusive sill.

Copper was first mined in this region at Bowman Hill, on the Delaware, by the Dutch, from New Amsterdam, about 1650. But the most important early operation was the Old Perkiomen Mine, at Schwenksville, opened about 1700.

Three types of deposit are known: those connected with trap sills, those in fissure veins and those in unaltered shales. Deposits of the first type show grains and streaks of bornite and chalcopyrite scattered through the metamorphosed shales. In the second brecciated fissures are filled with these ores and various accessory minerals. The magmatic origin of the metals in these cases is clear enough, but the source of the films of malachite and chrysocalla occasionally found in the undisturbed and unaltered sedimentary rocks is obscure. Though perhaps none of these deposits is sufficiently rich to repay working, they are not without their interesting features.

Petrography of the Newark Intrusive Diabase of New Jersey: J. Volney Lewis, Rutgers College.

The intrusive trap that forms the Palisades of the Hudson extends in outcrops several hundred feet thick from west of Haverstraw, N. Y., southward to Staten Island and, somewhat intermittently, westward across New Jersey to the Delaware River, having an aggregate length of outcrop of about 100 miles.[1] It is everywhere a medium to fine-grained dark gray heavy rock, with dense aphanitic facies.

The typical coarser rock contains in the order of abundance, augite, plagioclase feldspars, quartz, orthoclase, magnetite and apatite. The first two occur in ophitic to equant granular textures and the next two in graphic intergrowths which sometimes constitute as much as one third of the rock. In the contact facies micropegmatite disappears and scattering crystals of olivine occur.

A highly olivinic ledge 10 to 20 feet thick and about 50 feet from the base of the sill is exposed in the outcrops northward from Jersey City for about 20 miles. The olivine crystals, which constitute 15 to 20 per cent. of the rock, occur as poikilitic inclusions in the augite and feldspar.

Chemically the trap ranges from less than 50 per cent. to more than 60 per cent. of silica, with a corresponding variation in alumina, ferric oxide and the alkalis, while ferrous iron, lime and magnesia vary inversely. The augite is rich in these latter constituents and poor in alumina, giving a great preponderance of the hypersthene and diopside molecules. The feldspars range from orthoclase and albite to basic labradorite. Doubtless there is always more or less anorthoclase also, since all feldspar analyses show potash.

While there is considerable range in the proportions of the minerals, augite usually comprises about 50 per cent. of the rock, the feldspars about 40 per cent., quartz 5 per cent. and the ores 5 per cent., constituting a quartz-diabase, with normal diabase and olivine-diabase facies. In the quantitative system it is chiefly a camptonose (III., 5, 3, 4), with the acidic *dacose* (II., 4, 2, 4) and *tonalose* (II., 4, 3, 4) and the more basic *auvergnose* (III., 5, 4, 4, 5) facies. The olivinic ledge is *Palisadose* (IV., 1^2, 1^2, 2), the name here suggested for this hitherto unnamed subrang.

Slight basic concentration at the contacts, possibly according to Soret's principle, followed by differentiation by gravity during crystallization of the main mass, especially by the settling of olivine and the ores and the rising of the lighter feldspars in the earlier and more liquid stages of the magma, accounts for the facies observed and their present relations.

The Origin of Beach Cusps: D. W. Johnson, Harvard University.

Two theories have been advanced to account for the origin of beach cusps. According to one theory the cusps result from the accumulation of seaweed along the shore and the breaking of water through the seaweed barrier, removing sand and gravel where the break occurs and molding the remaining deposits into cuspate forms. According to the second theory the cusps are formed where intersecting waves reach the shore. There are serious theoretical objections to both these theories and still more serious practical objections. Experiments show that the cusps can be formed in the laboratory by parallel waves which are in turn parallel to the beach; and numerous observations seem to show that they are generally so formed in nature. The cause of cusp formation is to be found in the physical properties of fluids descending an inclined plane, as will be shown more fully in a forthcoming paper.

The Form of Nantasket Beach: Wm. G. Reed, Jr., Harvard University.

Nantasket Beach consists of several drumlins

[1] J. Volney Lewis, "Structure and Correlation of the Newark Trap Rocks of New Jersey," *Bull. Geol. Soc. of America*, Vol. 18, 66, 195–210; also "Origin and Relations of the Newark Rocks," Ann. Rept. State Geologist of New Jersey, for 1906, pp. 97–129.

tied together and to the mainland by a complex system of tombolos. Some of the drumlins show sea cliffs now abandoned by the waves. From the relations of these cliffs and the more ancient of the beaches, the initial drumlins have been reconstructed. The effect of marine action in cliffing the drumlins and stringing out the eroded material in successive tombolos has been followed through step by step, until the conditions of to-day were reached.

The study shows that Nantasket Beach is not the result of the accidental tying together of a few islands without system, but that it represents one stage in a long series of evolutionary changes, which have occurred in orderly sequence and in accordance with definite physiographic laws.

The Acid Extreme of the Cortlandt Series near Peekskill, N. Y.: CHARLES P. BERKEY, Columbia University.

The rocks of the Cortlandt series are known, through the work of the late Professors J. D. Dana and H. S. Williams. They occupy an area on the Hudson River just south of Peekskill, N. Y., and include a very wide range of granitoid medium to basic types of igneous rocks.

It seems certain that they represent a case of magmatic differentiation that includes not only the Cortlandt series, as outlined by Dana and Williams, but also two or three occurrences of typical granite. The granite area borders basic varieties on the northeast side. Actual contacts of the larger masses are not to be seen, but an occasional dike of granite cuts the adjacent diorite and gabbros, indicating a relationship as one of the latest developments. Furthermore, the granite shows consanguinity by its heavy soda content, soda-lime, feldspar predominating. It is, however, a very acid granite and introduces a considerably greater range of rock variety than formerly credited to the Cortlandt series, becoming its acid extreme.

The Evolution of Bogoslof Volcano in Bering Sea: T. A. JAGGAR, JR., Massachusetts Institute of Technology.

The island consists of four prominent peaks, old Bogoslof at the south, McCulloch Peak steaming actively in the middle, Metcalf Cone (sometimes called Perry Peak) adjacent to McCulloch in the north, and New Bogoslof or Fire Island ("Grewingk"), a flat table rock at the northwest end of the group. These are now all connected by continuous gravel and sand strips, where in one place there was a broad channel and seven fathoms of water a year ago.

McCulloch Peak and Metcalf Cone are both products of the slow pushing up from beneath the waves of a mass of refractory lava, semi-solid, crusting and breaking into blocks as it rises, with only the central portions retaining a semblance of fluidity.

A series of sketches were shown illustrating the remarkable differences in outline of this island at different intervals from 1826 to 1907.

In 1796 Old Bogoslof rose. In 1884 New Bogoslof, Fire Island, came into being and the waves joined the two with bars. In 1891 New Bogoslof was still steaming. In 1906 Metcalf Cone was reported midway between Old and New Bogoslof. In July, 1907, Metcalf Cone had broken in two, and the breaches between the islands were again connected with continuous land. On September 1, 1907, McCulloch Peak exploded and was wholly destroyed.

No such extraordinary story of growth and alteration of an island in the sea has ever been told before, and the changes of the later stages are unique in the annals of volcanology.

This paper is printed in full in the report of the expedition to Bogoslof.

Some Curves illustrating Coincident Volcanic, Seismic and Solar Phenomena: ELLSWORTH HUNTINGTON, Yale University.

In discussions of the possibility of some relationship between sunspots and earthquakes or volcanoes, attention has usually been concentrated upon sunspot maxima. Jenson, an Australian, however, has plotted the most important earthquakes and volcanic eruptions for the last century and more, and on comparing his data with the sunspot curve for the same period finds that there seems to be a grouping of the terrestrial phenomena at or near the time of sunspot minima. In order to test the validity of his conclusions another set of data as to earthquakes and volcanoes, prepared by Mr. R. W. Sayles for quite a different purpose, have been taken and similarly compared with the sunspot curve. In this case, as in the other, the grouping of terrestrial phenomena at times of sunspot minima is evident. In order to get rid of the personal equation, which enters so largely into such studies, and in order to get rid of temporary or local irregularities, all the data of both Sayles and Jensen have been averaged together. By repeated averaging of results as to the frequency and intensity of both earthquakes and volcanoes, the whole body of facts given by the two investigators, for a period of 117 years in one case, and 147 in the other, has been combined into a single curve representing the progress of volcanic and seismic phenomena during the average sunspot cycle for the same period. On comparing this curve with the average sunspot curve, it appears that the minimum of the one coincides exactly with the maxima of the other and *vice versa*, and that times of increase in the one set of phenomena are times of decrease in the other. The coincidence can not possibly be accidental, for the repeated process of averaging would prevent the two curves from agreeing unless there were a genuine cause of agreement. The remarkable nature of the coincidence suggests that there is some common cause at work, producing a maximum occurrence of earthquakes and volcanoes upon the earth and a minimum occurrence of spots on the sun. The data used do not claim to be exhaustive, and the results are advanced as suggestive, rather than conclusive.

This paper appeared in full in the *Popular Science Monthly* for June.

The Volcanoes and Rocks of Pantelleria: Henry S. Washington, New York.

Pantelleria is entirely volcanic. Its geologic structure has been variously interpreted, and the views of the writer differ in some important respects from those of other observers, notably Foerstner and Bergeat. There is supposed to have been formed first a large volcano, covering practically the whole area and submarine in its first stages. This was composed of rather siliceous soda-trachytes and later green pantellerites. The central and upper parts of this cone disappeared, probably by explosion, in analogy with the history of many other volcanoes, leaving a large central caldera, surrounded by an encircling somma with steep inner scarps and gentle outer slopes. Within the caldera arose the cone of the second period, now represented by Montagna Grande, the summit of which is the culminating point of the island, and Monte Gibele on the southeast. The lava of these is a very uniform soda-trachyte. The crater of Monte Gibele seems to have been the original eruptive center for the joint mass, but later the block of Montagna Grande was separated from the Gibele cone by a fault, with considerable tilting of the fault block. On the western and northern sides of this block there were formed several small parasitic cones, which gave vent to flows of black, glassy pantellerite. These and the trachytic flows of the Gibele volcano nearly filled the whole floor of the original caldera, the only portion left uncovered being a small corner at the north, where there is a small elliptical lake, which is thus regarded as a residual of the old caldera floor and not an eruptive center. The next phase of eruptive activity was confined to the northwestern part of the island, and the lavas are entirely feldspar-basalts, forming several small cinder cones, with flows of scoriaceous basalt. Eruptive activity on the island proper seems to have ceased, and is now evident only in some fumeroles and hot springs. The rocks show a wide range in chemical composition, but belong to but few distinct types. They are characterized by high soda, giving rise to the presence of abundant soda-microcline, ægirite and the triclinic cossyrite among the more salic types, and by the high amount of titanium among the basalts.

Other papers presented and those read by title are as follows:

Geology of Long Island: W. O. Crosby, Massachusetts Institute of Technology.

Salt Formations of Louisiana: G. D. Harris, Cornell University.

Certain Silicified Tertiary Rocks of Arkansas: R. Ellsworth Call, New York City.

Recent Advances in our Knowledge of the Magnetite Bodies at Mineville: James F. Kemp, (By permission of the State Geologist of New York.)

Interpretation of the Mineral Constitution of Magnesian Minerals through their Analyses: Alexis A. Julien, Columbia University.

Silicified Woods of the Arkansas Tertiary: R. Ellsworth Call, New York City.

Dwarf Faunas: Hervey W. Shimer, Massachusetts Institute of Technology.

Structure of the Brachial Support of Camarophorella, a Mississippian Meristelloid Brachiopod: J. E. Hyde, Columbia University.

A Revised Classification for the North American Lower Paleozoic: A. W. Grabau, Columbia University.

Marginal Glacial Deposits: R. S. Tarr, Cornell University.

An Erosion Problem in Arid Regions: Richard E. Dodge, Teachers College.

Notes on Recent Mineral Occurrences: George F. Kunz, New York City.

The Gibeon Meteorite and other Recent Accessions at the American Museum: Edmund Otis Hovey, American Museum of Natural History.

Charles P. Berkey,
Secretary of Section

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Friday, October 30, 1908

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 GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF UNIVERSITIES AND COLLEGES

The accompanying table explains the geographical distribution of the student body of thirteen American universities, six New England colleges for men, five colleges for women, two technological schools and one Pennsylvania college for men, for the academic year 1907–1908, the summer session students being in every instance omitted. *Missouri, Bowdoin, Massachusetts Institute of Technology, Purdue, Wesleyan, Bryn Mawr, Mount Holyoke, Smith, Vassar* and *Wellesley* have been added to the table. An effort has been made to group the institutions, instead of arranging them entirely in alphabetical order as heretofore.

Comparing the attendance by divisions of the six eastern universities (*Columbia, Cornell, Harvard, Pennsylvania, Princeton, Yale*) with the corresponding figures for the same universities in a similar table published in Science (N. S., Vol. XXVI., No. 656, July 26, 1907, pp. 97–104), we note in the first place that there has been a gain for these universities taken as a whole in every division, the largest increase in the actual number of students, leaving the North Atlantic division—in which all of these six universities are located—out of consideration, having been recorded in the North Central division, where there has been an increase of 117 students, this being exactly the same gain as was made last year. Foreign countries come next, as they did last year, with an increase of 92

(A) THE UNITED STATES

1907–1908	California	Columbia	Cornell	Harvard (including Radcliffe)	Illinois	Michigan	Missouri (including School of Mines)	Ohio State	Pennsylvania	Princeton	Virginia	Wisconsin	Yale	Amherst	Bowdoin	Brown	Dartmouth	Lehigh	Massachusetts Institute of Technology	Purdue	Wesleyan	Williams	Bryn Mawr	Mt. Holyoke	Smith	Vassar	Wellesley
North Atlantic Division	*5*	*3404*	*2731*	*3426*	*50*	*560*	*41*	*77*	*3343*	*835*	*51*	*68*	*2315*	*402*	*294*	*876*	*1047*	*540*	*1049*	*61*	*287*	*369*	*270*	*645*	*1089*	*657*	*877*
Connecticut	1	67	58	55	1	9	2	5	41	13	2	2	1110	19	2	27	21	5	29	2	110	21	7	99	91	51	39
Maine	....	22	10	94	....	7	....	1	22	....	....	1	16	2	233	14	46	2	23	....	9	5	1	25	40	9	41
Massachusetts	1	73	100	2341	5	20	8	7	76	29	3	4	174	154	40	208	534	16	781	3	37	97	25	264	397	95	348
New Hampshire	....	11	8	79	2	5	1	2	11	3	1	2	15	2	10	40	247	1	27	....	2	2	1	24	33	7	37
New Jersey	....	413	190	60	2	10	1	2	298	266	10	8	117	22	....	25	11	52	17	14	41	41	17	46	101	73	82
New York	2	2673	2025	519	23	326	23	31	168	282	20	33	640	158	5	58	99	56	82	41	60	179	59	131	302	333	160
Pennsylvania	1	122	323	165	13	163	5	28	2717	284	13	16	195	26	....	14	7	407	57	....	23	11	155	33	78	83	127
Rhode Island	....	10	6	85	2	6	....	....	7	6	2	2	27	7	3	476	9	1	28	....	....	2	5	10	22	3	26
Vermont	....	13	11	28	2	14	1	1	3	2	....	....	21	12	1	14	73	....	5	1	5	11	....	13	25	3	17
South Atlantic Division	*2*	*147*	*196*	*146*	*14*	*59*	*11*	*21*	*180*	*106*	*533*	*15*	*100*	*10*	*2*	*9*	*13*	*97*	*48*	*11*	*13*	*6*	*35*	*8*	*24*	*26*	*22*
Delaware	....	8	11	3	....	....	....	....	48	11	5	....	13	....	....	2	1	5	1	1	....	....	2	1	2	6	1
District of Columbia	1	15	51	42	2	26	1	1	27	21	7	4	22	6	2	....	8	16	10	2	7	3	4	3	6	6	5
Florida	....	5	1	5	....	6	1	....	8	5	12	....	7	1	....	....	1	1	3	2	....	2	1	....	2	1	1
Georgia	....	30	10	18	3	3	1	2	16	3	13	3	11	....	....	....	....	....	2	1	1	....	....	....	2	4	4
Maryland	....	16	68	27	1	4	1	4	44	42	27	4	9	2	....	3	2	54	18	2	3	....	19	1	10	2	5
North Carolina	....	27	12	12	1	3	....	....	11	5	20	....	12	....	....	....	....	4	....	....	....	1	1	1	....	2	3
South Carolina	1	17	6	15	1	4	1	....	5	6	13	1	3	....	....	....	....	1	2	....	....	....	3	....	1	....	....
Virginia	....	21	29	16	2	5	2	4	14	10	417	....	14	....	....	2	....	11	9	....	....	....	5	2	....	4	2
West Virginia	....	8	8	8	4	8	4	10	7	3	19	3	9	1	....	2	1	5	3	3	2	....	....	....	1	1	1
South Central Division	*6*	*111*	*96*	*95*	*59*	*82*	*95*	*21*	*62*	*48*	*140*	*17*	*97*	*6*	....	*7*	*5*	*9*	*37*	*84*	*1*	....	*10*	*3*	*16*	*31*	*31*
Alabama	....	21	12	8	2	5	3	....	14	6	22	....	3	1	....	1	....	1	4	3	....	....	1	1	1	4	1
Arkansas	....	6	8	6	15	3	23	1	5	2	12	3	2	....	....	....	....	....	2	7	....	....	2	....	....	5	2
Kentucky	1	20	14	25	14	34	12	7	12	16	45	5	30	1	....	4	5	3	5	46	....	....	....	1	5	6	23
Louisiana	3	9	11	7	1	2	....	1	2	1	6	....	15	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Mississippi	....	9	11	6	4	1	3	2	4	3	14	....	5	....	....	1	....	1	3	4	....	....	2	....	....	1	....
Oklahoma	1	4	4	3	9	18	29	1	....	....	....	5	5	....	....	....	....	....	1	2	....	....	1	....	....	....	1
Tennessee	....	19	12	19	7	4	9	5	7	10	27	....	14	2	....	....	....	2	6	10	1	....	1	....	3	9	....
Texas	1	23	24	21	7	15	16	4	18	10	14	4	23	2	....	1	....	2	16	12	....	....	2	1	7	6	4
North Central Division	*23*	*380*	*445*	*526*	*3765*	*3676*	*1999*	*2070*	*188*	*164*	*35*	*3365*	*579*	*72*	*3*	*18*	*130*	*14*	*142*	*1688*	*9*	*84*	*85*	*50*	*292*	*254*	*217*
Illinois	3	52	108	118	3329	304	44	8	23	40	3	224	148	20	1	5	70	4	31	49	....	35	31	16	93	67	40
Indiana	3	44	34	42	109	190	7	17	19	21	3	32	30	1	....	3	4	1	12	1438	3	3	8	3	18	17	15
Iowa	4	23	23	49	73	72	24	5	33	11	....	86	34	4	....	2	10	....	16	13	....	5	3	4	14	17	25
Kansas	1	17	13	16	27	36	28	3	11	1	1	6	14	....	....	1	1	....	5	4	....	....	2	....	6	3	8
Michigan	....	33	30	31	30	2488	7	7	5	13	4	20	32	6	....	1	5	1	8	30	....	3	4	11	22	31	15
Minnesota	4	31	20	34	19	24	1	2	11	12	1	26	46	3	1	....	9	2	8	8	....	12	4	4	38	9	21
Missouri	....	34	23	59	39	73	1853	....	11	11	11	12	67	13	1	....	1	1	14	9	1	3	5	1	22	13	18
Nebraska	2	11	8	6	16	23	9	....	4	10	....	14	12	7	....	....	4	....	3	6	....	2	7	....	7	6	14
North Dakota	1	11	5	4	1	9	....	1	2	3	....	15	3	....	....	....	3	1	4	....	....	....	....	....	1	3	2
Ohio	2	88	155	138	40	378	20	2021	56	36	8	19	171	16	....	4	21	3	26	115	4	13	14	9	52	58	47
South Dakota	....	5	1	8	13	29	....	....	....	1	1	22	7	....	....	....	2	....	3	5	....	....	....	....	1	2	3
Wisconsin	3	31	25	21	69	50	6	6	13	5	3	2889	15	2	....	2	....	1	12	11	1	8	7	2	18	28	9
Western Division	*2499*	*121*	*91*	*138*	*48*	*203*	*45*	*10*	*39*	*29*	*19*	*53*	*115*	*14*	*1*	*5*	*23*	*6*	*48*	*25*	....	*9*	*11*	*2*	*48*	*29*	*49*
Arizona	3	4	....	1	3	6	3	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	1	....
California	2439	46	18	68	9	30	10	3	2	4	12	5	43	2	....	3	7	....	14	5	....	1	4	1	11	8	13
Colorado	6	18	20	29	9	51	12	3	10	10	3	12	30	4	1	1	11	1	10	10	....	3	2	....	12	9	14
Idaho	4	....	....	1	3	11	1	....	2	1	....	5	2	....	....	....	2	....	....	1	....	....	....	....	1	....	1
Montana	1	14	7	3	3	33	2	1	....	4	1	13	8	....	....	....	....	2	3	1	....	....	2	....	2	3	2
Nevada	4	2	1	....	....	1	1	1	1	....	....	....	1	....	....	....	....	....	1	1	....	....	1	....	....	....	1
New Mexico	2	1	1	5	3	5	7	1	....	....	....	3	1	1	....	....	....	1	1	1	....	....	....	....	....	2	1
Oregon	26	7	19	7	3	22	2	1	3	4	1	3	7	6	....	1	....	....	3	....	....	3	1	....	7	....	6
Utah	1	10	13	9	8	14	5	....	14	4	1	....	4	....	....	....	....	2	3	2	....	....	....	1	3	....	1
Washington	13	18	9	12	7	20	1	....	7	2	....	12	15	1	....	....	3	....	12	4	....	1	....	....	10	5	7
Wyoming	....	1	3	3	....	10	1	....	....	....	1	....	1	....	....	....	....	....	1	....	....	1	1	....	2	1	3
Insular & Non-Contiguous Ter.	*16*	*6*	*32*	*10*	*20*	*13*	*1*	*11*	*9*	*1*	*1*	*17*	*11*	....	....	....	....	*3*	*6*	*12*	....	....	*2*	....	*1*	....	*5*
Alaska	4	1	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Hawaiian Islands	9	3	4	6	....	4	....	....	2	....	....	....	4	....	....	....	....	....	2	....	....	....	2	....	....	....	4
Philippine Islands	3	....	18	1	20	3	1	8	2	....	....	17	5	....	....	....	....	....	1	12	....	....	....	....	1	....	....
Porto Rico	....	2	10	3	....	6	....	3	5	1	1	....	1	....	....	....	....	3	3	....	....	....	....	....	....	....	....
Total	*2551*	*4169*	*3591*	*4341*	*3956*	*4593*	*2192*	*2210*	*3821*	*1233*	*779*	*3535*	*3217*	*504*	*300*	*915*	*1218*	*669*	*1330*	*1881*	*310*	*468*	*413*	*708*	*1470*	*997*	*1201*

students, and the South Atlantic division follows with a gain of 86 students; then comes the western division with a gain of 41, and finally the South Central division with an increase of 36 students. The total increase in divisions outside of the North Atlantic this year is much larger than last (381, against 189 in 1907 and 91 in 1906), and there has also been an increase in the gain of students from foreign countries, while last year a loss was noted (92, against 64 in 1907 and 87 in 1906). These

(B) FOREIGN COUNTRIES

1907–1908	California	Columbia	Cornell	Harvard (including Radcliffe)	Illinois	Michigan	Missouri (including School of Mines)	Ohio State	Pennsylvania	Princeton	Virginia	Wisconsin	Yale	Amherst	Bowdoin	Brown	Dartmouth	Lehigh	Massachusetts Institute of Technology	Purdue	Wesleyan	Williams	Bryn Mawr	Mt. Holyoke	Smith	Vassar	Wellesley
North America	*8*	*59*	*37*	*60*	*10*	*31*	*19*	*8*	*58*	*6*	*1*	*17*	*26*	*1*	*1*	*4*	*1*	*19*	*28*	*10*	*2*	*2*	*4*	*1*		*2*	*4*
Canada	6	39	12	47	4	22	1		19	2		10	20	1	1	2	1	1	9	2	2		4			1	4
Central America		3	4	3				1	16				1					1	3	1							
Cuba		12	14	4				2	15	3		1				1		9	4	2							
Mexico	2	4	7	4	5	7	18	3	6	1	1	5	4					6	12	2		2		1			
West Indies		1		2	1	2		2	2			1	1			1		2		3						1	
South America	*6*	*11*	*32*	*6*	*5*	*3*	*8*	*11*	*37*	*1*	*1*	*2*	*1*					*6*	*10*	*2*							*1*
Argentine Republic	4	1	14	5	5		4	10	8			1						1	2	1							
Brazil		4	7			1			15	1									1								1
British Guiana													1														
Chili	1	2	1			1	2		3										1								
Colombia		1		1		1			8									2		1							
Ecuador	1	2	3						1		1							3	2								
Paraguay								1	1										1								
Peru		1	6				2		1			1							2								
Uruguay			1																1								
Europe	*6*	*48*	*19*	*28*	*8*	*16*	*4*	*9*	*50*	*4*		*10*	*17*	*1*	*1*	*1*			*17*	*1*	*2*	*2*	*2*	*1*		*1*	
Austria-Hungary		2			1				2																		
Belgium		1																	1								
Bulgaria			1	2		2		1																			
Denmark	1	2						1											1								
France		2	2	3					2				2	1		1							1				
Germany	3	9		4	1	3	1		5			5									1						
Great Britain and Ireland	1	8	5	9	1	1	1		12	4		3	5		1				8							1	
Greece																											
Holland		1	1			4			9																		
Iceland																											
Italy		2		3	2				2										2		1						
Norway		1	1									1															
Portugal									1																		
Rumania		1		1			1	2																			
Russia	1	13	2	3		3	1	5	9										3								
Spain		1	1		1															1							
Sweden		2	1	2	2				4			1	3														
Switzerland		1	3						3																		
Turkey		2	2	1		3			1				7						2			2	1	1			
Asia	*36*	*53*	*51*	*40*	*18*	*13*	*5*	*17*	*25*	*9*	*2*	*16*	*42*	*7*	*1*	*1*		*4*	*15*	*6*	*1*	*3*		*1*	*1*		*3*
Burmah																											
Ceylon										1																	
China	10	9	28	25	2	5	1	2	9		1	4	25			1		3	9	2	1						2
Corea				1																							
India	14	3	11	3	5	1	2	7	2				1	3	1			1	1					1			
Japan	10	37	11	8	7	6	2	3	11	7		12	16	4					3	4		2			1		1
Persia		3				1																1					
Siam	2			1																							
Straits Settlements								1																			
Turkey		1	1	2	4			4	3	1	1								2								
Africa		*1*	*1*	*4*			*1*		*1*				*2*						*7*								
Egypt				1					1										2								
South Africa		1	1	3			1						2						5								
Australasia	*2*	*1*	*3*	*4*		*1*	*2*	*1*	*45*				*1*						*3*	*1*					*1*		
Australia	2	1	3	3			1	1	25										3	1							
Caroline Islands																									1		
New Zealand				1		1	1		20				1														
Total (Foreign Countries)	58	173	143	142	41	64	39	46	216	20	4	45	89	9	3	6	1	29	80	20	5	7	6	3	2	3	8
Total (United States)	2551	4169	3591	4341	3956	4593	2192	2210	3821	1233	779	3535	3217	504	300	915	1218	669	1330	1881	310	468	413	708	1470	997	1201
Grand Total	*2609*	*4342*	*3734*	*4483*	*3997*	*4657*	*2231*	*2256*	*4037*	*1253*	*783*	*3580*	*3306*	*513*	*303*	*921*	*1219*	*698*	*1410*	*1901*	*315*	*475*	*419*	*711*	*1472*	*1000*	*1209*

figures contradict the statement often made that the large eastern universities are attracting fewer students from the west and south, the increase being especially noticeable in the North Central division. Calculated on a percentage basis, the total gain of the six universities in the North Atlantic division during the past year amounted to 2.30 per cent., as against a gain of 8.16 per cent. outside of the division mentioned, the figures for 1906–7 being 3.51 per cent. and 5.73 per cent., respectively. In the South Atlantic division all of these institutions show a gain with the exception of

Yale; in the South Central States the exceptions are *Harvard* and *Princeton;* in the North Central division all of them with the exception of *Princeton* show gains, these being quite substantial in the case of *Columbia* and *Cornell;* in the far western states *Pennsylvania* and *Princeton* are the only institutions that show a loss, while all of them have made gains in foreign countries.

Comparing these figures with those of three years ago (1905), we observe that the most substantial gains have been made by *Columbia* (118), *Yale* (73) and *Cornell* (64) in the North Central division: by *Columbia* (39) in the South Central division, by *Yale* (37) in the Western division, by *Pennsylvania* (33), *Harvard* (32) and *Columbia* (29) in the South Atlantic division, and by *Pennsylvania* (90), *Columbia* (56), *Harvard* (48), and *Cornell* (43) in foreign countries. It may be of interest to note in passing that at *Columbia* the number of students in attendance from the North Atlantic division on the corporation only (not including Barnard College, Teachers College and the College of Pharmacy), exclusive of the summer session, has decreased by 6.80 per cent. since 1901–2.

Taking the universities in the accompanying table by divisions, we find that *Harvard* and *Columbia* continue to have the largest representation in the North Atlantic division, *Pennsylvania, Cornell, Yale* and *Princeton* following in the order named. *Michigan's* representation has increased from 394 to 560 in three years, while the other western universities—*California, Illinois, Missouri, Ohio State* and *Wisconsin*—and the *University of Virginia,* attracted comparatively few students from this section of the country, *Ohio State* heading the latter list with 77 students, as against 64 last year. Every one of these western institutions, however, with the exception of *California,* shows gains in attendance in this division over last year. *Harvard,* as usual, leads in all of the New England States, with the natural exception of Connecticut, where *Yale* has the largest following. *Columbia* and *Cornell,* as we should expect, have the largest representation in New York State, *Yale, Harvard, Michigan* and *Princeton* following in the order named, *Michigan,* which has registered an increase in this state from 195 to 326 in three years, having passed *Princeton* since last year. In New Jersey the order is *Columbia, Pennsylvania, Princeton, Cornell, Yale* and *Harvard—Pennsylvania* having passed *Princeton* in this state since last year. The *University of Pennsylvania* naturally leads in its own state, followed by *Cornell, Princeton, Yale, Harvard* and *Columbia—Princeton* having been passed by *Cornell* since last year.

Examining the attendance of the men's colleges and technological schools from these states, we note that the order for the entire division is *M. I. T., Dartmouth, Brown, Lehigh, Amherst, Williams, Bowdoin, Wesleyan—Purdue* naturally bringing up the rear. Of course *Bowdoin* leads in Maine and *M. I. T.* in Massachusetts, with *Dartmouth* second in both instances, while the latter institution, as would be expected, has the largest number of students from New Hampshire and Vermont. *Brown* and *Harvard* are the only institutions that attract students from Rhode Island in any considerable number. In Connecticut *Wesleyan* naturally leads, followed by *M. I. T., Brown, Dartmouth* and *Williams,* and *Amherst,* all of the eastern universities, except *Princeton,* having a larger representation in this state than any of the New England colleges for men outside of *Wesleyan* included in the table. Compared with 1906, all of the colleges included in both tables (*Amherst, Dartmouth, Lehigh* and *Williams*) show an increase in their representation from the

North Atlantic states, while compared with last year *Williams* shows a loss, as does *Brown*.

In New York State the order for the colleges is *Williams, Amherst, Dartmouth, M. I. T., Wesleyan, Brown* and *Lehigh*. Of the four New England colleges included in both this and last year's tables, 30 per cent. of the students of *Amherst* as against 36 per cent. last year and 43 per cent. in 1906, have their permanent home in Massachusetts; 52 per cent. of *Brown's* student body, as against 53 per cent. in 1907, come from Rhode Island; 20 per cent. of *Dartmouth's* students, as against 21 per cent. last year and 24 per cent. in 1906 come from New Hampshire (26 per cent. as against 27 per cent. and 32 per cent., respectively, from New Hampshire and Vermont), and 20 per cent., as against 20 per cent. last year and 21 per cent. in 1906, of the student enrollment of *Williams* hail from Massachusetts. *Lehigh's* percentage of students from the state of Pennsylvania remains uniform at 58 per cent., as against 60 per cent. in 1906, while *Bowdoin* draws 77 per cent. of its student body from Maine, *M. I. T.* 55 per cent. from Massachusetts, and *Wesleyan* 35 per cent. from Connecticut. It is thus seen that of these institutions *Williams* and *Dartmouth* attract the largest percentage of students from outside their own state, followed by *Amherst, Wesleyan, Brown, M. I. T., Lehigh, Purdue* and *Bowdoin*. *Dartmouth* attracts more students from Massachusetts than from all of the other states in the North Atlantic division combined. *Amherst* and *Williams* draw more from New York than from Massachusetts, while *Princeton* draws more from New York and from Pennsylvania than from New Jersey.

Of the eastern universities, *Pennsylvania* continues to have the largest percentage of enrollment from its own state, namely 67 per cent., the same percentage as in 1906; of *Columbia's* student body 62 per cent. come from New York State, as against 66 per cent. in 1906; *Cornell's* percentage of New York students has dropped from 56 per cent. in 1906, to 54 per cent.; of *Harvard's* students 52 per cent., as against 54 per cent. in 1906, are residents of Massachusetts; of *Yale's* students 34 per cent., as against 33 per cent. in 1906, have their permanent residence in Connecticut, and, finally, of *Princeton's* students only 21 per cent., as against 20 per cent. in 1906, are residents of the state of New Jersey. The institutions in this group which exhibit a gain in the percentage of students from outside their own state during the past year are *Columbia, Cornell* and *Pennsylvania* (2 per cent. each) and *Harvard* (1 per cent.), *Princeton* and *Yale* having remained uniform.

Coming to the South Atlantic division and taking into consideration only the six eastern universities, we note that the order is exactly the same as it was two years ago, namely, *Cornell, Pennsylvania, Columbia, Harvard, Princeton, Yale*. The *University of Virginia* naturally has the largest following in this section; *Michigan* continues to be the only one of the western universities represented in the table to make a fair showing in these states, while *Lehigh* is the only one of the colleges with a good representation from this division, its main strength lying in the state of Maryland. So far as the individual states are concerned, *Pennsylvania* naturally leads in Delaware, *Cornell* in the District of Columbia, *Virginia* in Florida, *Columbia* in Georgia, North Carolina, and South Carolina, *Cornell* in Maryland, and *Virginia* in its own state (with *Cornell* second) and in West Virginia. The only change to be noted here since last year is the lead of *Cornell* instead of *Lehigh* in Maryland. Leaving the state of Virginia out of consideration, *Columbia, Cornell, Harvard* and *Pennsylvania* have a larger clientele in the South Atlantic division than *Virginia.*

In the South Central division *Virginia* heads the list, followed by *Columbia* (111, as against 72 in 1905), *Yale* (97–80), *Cornell* (96–76), *Harvard* (95–80), *Michigan* (82–64), *Pennsylvania* (62–44), *Illinois* (59–47) and *Princeton* (48–72). *Purdue* attracts 84 students from this division, and *M. I. T.* 37. The New England colleges for men, and *Lehigh* and *California* have only a small following from this section (*Bowdoin* and *Williams* have not a single student from this division), while the girls' colleges make a far better showing, both *Vassar* and *Wellesley* drawing no less than 31 students each from the South Central States. *Columbia* has made the largest gain in this division, while *Princeton's* clientele shows a falling off. The largest representation from the individual states is found at the following universities: Alabama—*Virginia, Columbia, Pennsylvania;* Arkansas—*Missouri, Illinois, Virginia;* Kentucky—*Purdue, Virginia, Michigan;* Louisiana—*Yale, Cornell, Columbia;* Mississippi—*Virginia, Cornell, Columbia;* Oklahoma—*Missouri, Michigan, Illinois;* Tennessee—*Virginia, Columbia* and *Harvard,* and Texas—*Cornell, Columbia* and *Yale.* Kentucky continues to send by far the largest delegations to the institutions contained in the list, followed by Texas, Tennessee and Alabama.

In the North Central division the five universities and the technological school of that section, *Illinois, Michigan, Wisconsin, Ohio State, Missouri* and *Purdue,* in the order named, naturally have the largest clientele. Of these six institutions, *Michigan* draws the largest percentage of students from outside of its own state, 53 per cent. of its enrollment hailing from Michigan, the corresponding figure for *Purdue* being 76 per cent., for *Wisconsin* 81 per cent., for *Missouri* 83 per cent., and for *Ohio State* 91 per cent. The clientele of the five middle western institutions last mentioned is, therefore, much more local in character than that of any of the eastern institutions comprised in the table, whereas *Michigan* attracts a larger percentage of students from outside of its own state than do *Pennsylvania, Columbia, Cornell, Lehigh,* or *M. I. T.* Of the eastern universities *Yale* still has the largest clientele in this section of the country, followed by *Harvard, Cornell, Columbia, Pennsylvania* and *Princeton,* the last named institution having been passed by *Pennsylvania* since last year. The largest gains in individual states (15 or more) during the past three years have been made by *Columbia* in Illinois, Ohio and Wisconsin, by *Cornell* in Ohio, by *Harvard* in Missouri, by *Pennsylvania* in Iowa, and by *Yale* in Missouri and Ohio. *Columbia's* representation in this group of states has grown from 262 to 380 in three years, *Cornell's* from 381 to 445, *Pennsylvania's* from 139 to 188, and *Yale's* from 506 to 579, while *Harvard's* has remained stationary at 526, and *Princeton's* has dropped from 209 to 164. Of the New England colleges for men, including *M. I. T.,* the last named institution has the largest following in the North Central division (142), with *Dartmouth* second (130), *Williams* third (84) and *Amherst* fourth (72), *Smith, Vassar* and *Wellesley* all drawing a much larger body of students from this section than the men's colleges, in fact, all three of these girls' colleges have a larger clientele from this division than either *Pennsylvania* or *Princeton.* The representation of *Amherst* in these states has grown from 43 to 72 in two years, that of *Dartmouth* from 91 to 130, while *Williams* shows a loss of two students. *Virginia* and *California* have only a small following in this division. Leaving the state institution out of consideration in each case, *Michigan* is seen to have the largest following in Illinois, followed by *Wisconsin, Yale, Harvard* and *Cornell*, each of which has over one hundred students from this state. *Michigan* also leads in Indiana, followed by *Illinois, Columbia, Harvard, Cornell*. In Iowa the order is *Wisconsin, Illinois, Michigan, Harvard, Yale;* in Kansas—*Michigan, Missouri, Illinois, Columbia, Harvard;* in Michigan—*Columbia, Yale, Harvard* and *Vassar, Cornell* and *Illinois* and *Purdue;* in Minnesota—*Yale, Smith, Harvard, Columbia, Wisconsin, Michigan;* in Missouri—*Michigan, Yale, Harvard, Illinois, Columbia;* in Nebraska—*Michigan, Illinois, Wisconsin* and *Wellesley, Yale, Columbia;* in North Dakota—*Wisconsin, Columbia, Michigan;* in Ohio—*Michigan, Yale, Cornell, Harvard, Purdue, Columbia;* in South Dakota—*Michigan, Wisconsin, Illinois;* and in Wisconsin—*Illinois, Michigan, Columbia, Vassar, Cornell, Harvard*. Excluding in each case the respective state university, the state of Illinois is represented by 1,537 students at the institutions mentioned in the list, Ohio by 1,493, Michigan by 351, and Wisconsin by 348, that is, 58 per cent. of the state of Ohio's representatives at all of the institutions included in the table are enrolled at the state university, while the percentage for Illinois is 68 per cent., for Michigan 88 per cent., and for Wisconsin 89 per cent.

In the western division (leaving *California* out of consideration) *Michigan* continues in the lead, with *Harvard, Columbia* and *Yale*, each of which attracts over one hundred students from this section, following; then come *Cornell, Wisconsin, Wellesley, Illinois* and *M. I. T.* and *Smith, Missouri, Pennsylvania, Princeton* and *Vassar, Purdue, Dartmouth*, the remaining institutions drawing only a few students from the far western states. *Michigan's* representation has grown from 134 to 203 in three years; *Harvard's* from 126 to 138; *Columbia's* from 111 to 121; *Yale's* from 78 to 115; *Cornell's* from 76 to 91; *Illinois'* from 41 to 48; *Pennsylvania's* from 22 to 39, while *Princeton's* has dropped from 41 to 29. *Michigan* leads in Arizona, Idaho and Wyoming; in California (leaving the state university out of consideration) *Harvard* continues to lead, with *Columbia, Yale* and *Michigan* following; in Colorado the order is *Michigan, Yale, Harvard, Cornell;* in Montana—*Michigan, Columbia, Wisconsin; California* leads in Nevada, the state which has the smallest total representation of any of the states; *Missouri* leads in New Mexico; in Oregon the order is *California, Michigan, Cornell;* in Utah—*Michigan* and *Pennsylvania, Cornell, Columbia*, and in Washington—*Michigan, Columbia, Yale*. Of the states in the western division Colorado and California continue to send by far the largest delegations to the eastern institutions in the list.

Cornell continues to lead in the number of students from the insular possessions, followed by *Illinois*. There were last year only seven representatives from Alaska at the institutions mentioned in the table. *California* leads in Hawaii, *Illinois* in the Philippines, and *Cornell* in Porto Rico. Taking only the institutions included in the tables both this year and last year, there has been an increase of one student from Hawaii, of fourteen from the Philippines and of five from Porto Rico.

Taking only the six eastern universities, the table shows that *Columbia* leads or is tied for first place in seventeen states and territories, *Yale* in fourteen, *Harvard* in twelve, *Cornell* in ten, *Pennsylvania* in four, and *Princeton* in none, as follows: *Columbia*—New Jersey, New York, Georgia, North Carolina, South Carolina, Alabama, Tennessee, Indiana, Kansas, Michigan, North Dakota, Wisconsin, Arizona, Montana, Nevada, Washington and

Alaska; *Yale*—Connecticut, Florida, West Virginia, Kentucky, Louisiana, Oklahoma, Illinois, Minnesota, Missouri, Nebraska, Ohio, Colorado, Idaho and Alaska; *Harvard*—Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Tennessee, Iowa, South Dakota, California, New Mexico, Wyoming and Hawaii; *Cornell*—District of Columbia, Maryland, Virginia, Arkansas, Mississippi, Texas, Oregon, Wyoming, Philippine Islands and Porto Rico; *Pennsylvania*—Pennsylvania, Delaware, Idaho and Utah.

The total number of students from foreign countries in attendance at the institutions represented in the accompanying table as well as in that of last year has grown from 946 to 1088, an increase of no less than 15 per cent., to which the various continents contributed as follows: North America's representation has grown from 314 to 348; South America's from 103 to 122; Europe's from 200 to 219; Asia's from 272 to 332, and Australasia's from 45 to 58, while Africa's has dropped from 12 to 9. Asia exhibits the largest increase, as it did last year.

Pennsylvania continues to have the largest foreign clientele, followed by *Columbia, Cornell* and *Harvard,* each of which attracts over one hundred foreigners. Of the western institutions *Michigan* is still in the lead, followed by *California, Ohio State, Wisconsin, Illinois* and *Missouri. Virginia,* the New England colleges for men, and the colleges for women attract only a few students resident in foreign countries, while *M. I. T., Lehigh* and *Purdue,* especially the first, all have a fair representation.

Examining the foreign delegations of the different institutions by continents, we note that the order in North America is *Harvard, Columbia, Pennsylvania, Cornell, Michigan, M. I. T., Yale;* in South America—*Pennsylvania, Cornell, Columbia* and *Ohio, M. I. T.;* in Europe—*Pennsylvania, Columbia, Harvard, Cornell, M. I. T.* and *Yale, Michigan;* in Asia—*Columbia, Cornell, Yale, Harvard, California, Pennsylvania;* in Africa *M. I. T.* leads, while in Australasia *Pennsylvania* continues to be the only institution with a good representation. Of the countries that send at least eight students to any one institution *Harvard* leads in Canada; *Pennsylvania* in Central America, Cuba, Brazil, Colombia, Great Britain and Ireland, Holland, Australia and New Zealand; *Missouri* in Mexico; *Cornell* in the Argentine Republic and China; *Columbia* in Germany, Russia and Japan; *California* in India.

Taking the representation of foreigners at all of the institutions mentioned in the list, we find that the largest delegations are sent by the following countries: Canada, 210; Japan, 142; China, 139; Mexico, 90; Cuba, 67; Great Britain and Ireland, 60; Argentine Republic, 56; and India 54. As for individual countries in America, the order for Canada is *Harvard, Columbia, Michigan, Yale, Pennsylvania; Pennsylvania* continues to have the best Central American representation, and also leads in Cuba, with *Cornell* second and *Columbia* third; *Missouri* leads in Mexico, with *M. I. T.* second, and *Purdue* in the West Indies, although the representation from these islands is very small. Of the South American countries the Argentine Republic sends the largest delegation, followed by Brazil.

In the European countries that send eight or more students to any one institution the order is as follows: Germany—*Columbia, Pennsylvania* and *Wisconsin;* Great Britain and Ireland—*Pennsylvania, Harvard, Columbia;* Holland—*Pennsylvania, Michigan;* Russia—*Columbia, Pennsylvania, Ohio State.* England sends the largest number, namely 60, followed by Russia with 40 and Germany with 32. Of the Asiatic countries, counting only the institutions represented in last year's table, Japan sends 131, China 124 and India 49, as against 116, 84 and 39, respectively, last year. *Cornell* draws the largest number of students from China, followed by *Harvard* and *Yale; Columbia* draws more than twice as many students from Japan as the second institution, *Yale*, while *California*, as we have seen, leads in India.

The figures given in the table are intended to represent *not* the birthplace of the students, but their permanent residence, although the absolute accuracy of the table is somewhat impaired by the fact that students occasionally give as their permanent residence the state where the institution at which they are enrolled is located, this being especially true of the state universities, where students take up a temporary residence in the state to escape tuition fees.

Rudolf Tombo, Jr.
Columbia University

THE DUBLIN MEETING OF THE BRITISH ASSOCIATION, SEPTEMBER 2–9, 1908

The meeting proved to be one of the best attended and most successful ever held by the British Association for the Advancement of Science. A total of 2,270 tickets were issued, of which 1,152 belonged to the class of associate members.

The first day, Wednesday, was devoted to registration, the president's address being delivered in the evening in the graduation hall of the university. Owing to the terrific storm that had been raging on the British coasts the previous three days, most members put off crossing the Irish channel as late as possible, but even Wednesday afternoon's crossing was slightly rough. Work in the various sections started on Thursday, September 3. Nearly all the sections were housed in the grounds of Trinity College, and an inter-sectional automobile service, arranged through the generosity of local members, provided swift means for reaching outlying meeting places. The usual post-office information bureau, news stand, excursion counter, and lounge were located in the examination hall, and the daily journal gave prompt information as to the doings of the sections. A welcome and most efficient innovation were the "indicator boards," announcing what papers were being read in each section. The boards contained the letters A to L, representing the various sections, and underneath each letter was hung a card bearing the number of the paper under discussion at the moment. The "indicator boards" were kept up to date by four special operators for each section, telephonic communication proving very helpful. The number of abstracts of the papers read supplied to members proved for once adequate to the demand.

Thursday was ushered in by heavy rains, which marred the success of the Provost's garden party in the afternoon, held in the Fellows' garden. The party was well attended, however, and afforded the usual enjoyable opportunity for meeting old friends whilst listening to the music of the band and taking tea in the marquees.

Guiness's brewery was visited by parties of members on several days, and other works in the vicinity were also thrown open for inspection. A very interesting series of Irish plays was being given at the Abbey theater, and the many who went there enjoyed the novel, excellent and characteristic acting in the native plays. A record crowd attended the conversazione given by the Royal Dublin Society in the evening at Leinster House. Most of the members (about 3,000) of the society attended with friends, and their number was swelled by about 1,500 British Association members. The large house, together with the beautiful rooms in which are placed the collections of the Dublin Museum, accommodated the visitors easily—when once they had passed the all too narrow entrance, from which extended long lines of carriages, some of which had been waiting for two hours to discharge their occupants. The scene in the galleries and down the various flights of steps in the museum was as pretty a one as the writer had ever seen. The guests were received by Lord Ardilaun, president of the society (part owner of Guiness's), the Right Hon. Frederick Trench and Sir Howard Grubb. The Lord Lieutenant of Ireland, accompanied by some of his household, arrived later in the evening.

Friday was occupied with sectional meetings, and the conferring of honorary degrees in the afternoon on Mr. Francis Darwin, F.R.S.; Sir David Gill, K.C.B., F.R.S.; Dr. William Napier Shaw, F.R.S.; Captain Henry George Lyons, F.R.S.; Professor Horace Lamb, F.R.S.; Professor Charles Scott Sherrington, F.R.S.; Professor Ernest Rutherford, F.R.S.; Professor Archibald Byron Macallum, F.R.S.; Dr. Albert Kossel; Dr. Ambrose Arnold William Hubrecht; Sir Thomas Lauder Brunton, Bart., F.R.S., and Sir James Augustus Henry Murray. In the afternoon the general committee met and decided to hold the 1910 and 1911 meetings at Sheffield and Portsmouth, respectively. Professor J. J. Thomson was elected as President for 1909.

Friday afternoon was devoted to garden parties at Dunsink Observatory and Saint Patrick's Cathedral. The Dunsink party was limited to 200, and over 700 applications had been received for tickets. A most enjoyable drive through Phœnix Park and past the Vice-regal Lodge brought the members to the observatory grounds. An old transit circle, last used in 1860, excited particular interest. In the evening a crowded audience listened to a lecture by Professor H. H. Turner, F.R.S., on Halley's comet.

Over 1,000 persons took part in Saturday's excursion, which included the Boyne Valley, Bray, Powers Court, and Kilruddery, Glendalough, the Rock of Cashel and the Shannon Valley. The Boyne Valley excursion provided a seven hours' drive in jaunting cars and included the inspection of the old tumuli at Louth and the ruins of Mellifont Abbey.

Garden parties were given on Monday, Tuesday and Wednesday by Lord Ardilaun, at the Zoological Gardens, and at the Vice-regal Lodge, but the enforced departure of the writer early Sunday morning on the *Lusitania* from Queenstown prevented his attending them.

Professor W. M. Davis, of Harvard, gave a lecture on Monday on "The Lessons of the Colorado Cañon."

All the sectional meetings were well attended. There were present from this side of the water: Professor W. M. Davis, of Harvard University, vice-president of the geological and geographical sections; Professor A. L. Rotch, Blue Hill Observatory, Mass., on committee of mathematical and physical section; Dr. Leo F. Guttman, College City of New York, on committee of chemical section; Drs. W. E. Praeger, Kalamazoo College, Mich.; Carroll Dunham, Harvard; Elizabeth H. Dunn, Chicago University; President E. J. James, Illinois; Dr. W. H. Hale, Brooklyn; N. M. Fenneman, Cincinnati, and Miss M. E. O'Brien, Boston, Mass.

Subjoined is a report of interesting papers read before some of the sections, together with an account of the discussions thereon. Notes had been taken, and an attempt has been made to faithfully reproduce the statements of the speakers, but strict accuracy is not claimed for the remarks quoted.

Abstract of Address to the Chemical Section: Professor F. S. Kipping, D.Sc., Ph.D., F.R.S.

During the past few months we have read in the daily journals—and we sincerely hope it may be true—that there are signs of the commencement of a great development of the resources of this island; as such a desirable event must be closely connected with, and, indeed, may even be dependent on, the vitality of the chemical industries of the country, the moment seems opportune for the consideration of a subject which has a direct bearing on both commerce and chemistry.

Although this section is chiefly occupied with matters relating to pure science, the discussion of industrial questions is also regarded as one of its important functions; it does not attempt to distinguish pure from applied chemistry, and any problem which concerns either is deemed worthy of its attention.

From this point of view I propose to consider whether any steps can be taken to place the chemical industries of the United Kingdom of Great Britain and Ireland in a more prominent position than that which they now occupy in the world of commerce.

The subject is not new; it has been dealt with by many, but principally by those more directly interested—prominent members of the Society of Chemical Industry, who are far better qualified to express opinions on commercial matters than am I. It is perhaps presumption on my part to attempt to add anything to what has been said by such leaders of industrial chemistry, but I propose to deal with the subject from a very different standpoint—namely, from that of the teacher in the class-room and laboratory. Even if I fail to make a single suggestion of immediate practical value, the question is one of such magnitude and so many-sided that I feel justified in bringing it under the notice of this section. It is not merely a matter of money, of a few millions or of a few tens of millions sterling. There are few branches of industry to which chemistry, in one way or another, is not of supreme importance. Whether we look to the great shipbuilding interests, dependent on the progress of metallurgy; to our cotton and linen trades, where cellulose reigns supreme; to our dye-houses or to our breweries, or to any other industry, great or small, there do we find problems in chemistry awaiting solution, and the nation which solves them will not only progress in civilization and contentment, but will also justly claim to have taken a leading part in the advancement of science.

It is unnecessary to trouble you with any detailed comparison of the position which we occupy to-day with that which we have taken in the past. The fiftieth anniversary of the epoch-making discovery of mauve was held only two years ago, and the proceedings are still fresh in our recollection; the pæans of congratulation addressed to the discoverer (now, alas! no longer with us) were marred by a plaintive note, a note of lamentation over our lost industry, the manufacture of dyes. The jubilee of the founder of the color industry in this country was also the occasion for pronouncing its funeral oration. If this were the full extent of our loss we might bear it with equanimity; but it is not so much what has already gone as what is going and what may go that are matters of such deep concern. Those who doubt the seriousness of our condition may find statistical evidence, more than sufficient to convince them, in the technical journals and in the board of trade reports of recent years.

The new Patent Act which came into force this year, and for which the country is so much indebted to the strenuous advocacy of Mr. Levinstein and Sir Joseph Lawrence, seems to many to have inaugurated a new era, and to have removed one of the principal causes of the decline of our chemical industries; if this be so, it is all the more important that the representatives of chemical science should be ready and willing to join hands with the manufacturers in order to assist in the process of regeneration.

The principal changes which have been introduced by the new law are, of course, familiar to all. The most important one, which came into operation on August 28 last, is that which requires that the article or process which is protected by the patent must be manufactured or carried on to an adequate extent in the United Kingdom after the expiration of four years from the date of the patent. If this condition is not fulfilled, any person may apply for the revocation of the patent.

Some of the results of this amendment, and some indications of the great industrial changes which it will bring about, are already obvious. Foreign firms or individuals who hold British patents and who have not sufficient capital to work them in this country, or who do not think they are worth working here, are attempting to sell their British patent rights. Others are building or buying works in Great Britain, and it has been estimated that in the immediate future a sum of at least 25,000,000*l*. of foreign capital will have been thus invested in order to comply with the new law.

We need not stop to consider the economic effects of this transfer of capital on the general trade of this country, but we may well pause a moment in order to try and forecast the consequences of these new conditions in so far as they concern our chemical industries.

The prospective establishment of branches of two of the largest German chemical works at Ellesmere Port and at Port Sunlight, respectively, is already a matter of common knowledge, and it may be presumed that these firms will avail themselves to a large extent of British labor. If this be the case, and if they are successful—as they, no doubt, will be—the complaint that the inferior technical education of our artisans is responsible for our lack of success will thereby be proved to be groundless. Even if we admit that at the present time the British workman is an inferior operative in a chemical works, and only capable of undertaking the less-skilled labor, these firms will gradually raise a considerable number of trained men who will be ready to undertake more responsible duties under our own manufacturers when the good time comes; a school for chemical operatives will be created in our midst, and, as in the past, we shall reap the benefit of knowledge and experience brought to our shores. It also seems reasonable to expect that, as is the case abroad, these works will be equipped with laboratories and staffed by chemists, although possibly only so far as is necessary for routine work. Many of these chemists may settle permanently in our midst, become members of our Chemical Society and Society of Chemical Industry, and thus infuse us with their patience and perseverance. It is not beyond the bounds of possibility that these great firms may even employ British chemists in their works, if we can supply men sufficiently well trained to be of value. On the other hand, as experience seems to have shown that industrial chemistry can not succeed with imported scientific labor, it is not very probable that many posts in the laboratory will be filled by our countrymen, who, in this connection, must be regarded as foreigners.

Now at the present time most chemical products can be manufactured more cheaply abroad than here, otherwise we should not have any reason to consider our position. Even if, owing to inefficient labor, higher wages, freight and other economic conditions, production is more costly here, the superior efficiency and scientific organization of these foreign firms will nevertheless enable them to command our home market with the goods made here.

The conclusion which thus seems forced upon us is that, although the new Patent Act will prove to be of great value in many respects, it will do little to foster British chemical trade and the developments of British chemistry; it places us on an equality with other countries as regards patent rights, and thus remedies an outstanding grievance; but unless we have something to patent, this equality will be valueless and our chemical industries will continue to decline, possibly more rapidly than heretofore.

Among the other causes which have been suggested as contributory to our failure are: (1) The unsatisfactory condition of secondary education; (2) the nature of the training which is given to chemists in our universities and other institutions; (3) the insufficiency of the time and money devoted to research in the manufacturing industries; (4) the lack of cooperation between manufacturers and men of science. There are some of us who believe that the first of these is the primary. . . .

In a presidential address to the Chemical Society last year Professor Meldola discussed the position and prospects of chemical research in Great Britain, and in view of the importance of the subject and the able manner in which it had been treated, the Council of the Society ordered the publication of five thousand copies of his address for distribution among the members of various public bodies. We were told in this address that many of our universities are distinct failures as centers of chemical research, and that the output of original work from our colleges, polytechnics and similar institutions is emphatically not representative of the productive power of the teachers there employed. The causes of the failure of our universities were only lightly touched upon, and I propose to refer to them later; but in the case of our other institutions they were more fully discussed. May I venture to draw attention to one cause, which I believe is by far the most effective drag on research in the vast majority of such institutions not of university rank? It is simply the lack of those more advanced students who, while gaining valuable experience in the methods of research, would also render useful assistance to their teacher. The governing body of the institution may not realize the importance of research; the principal, as, alas! is sometimes the case, may throw cold water on such work; the teacher may be overburdened with routine duties, and he may be most inadequately remunerated; if, however, the research spirit is strong within him, he would overcome all these difficulties were there any prospect whatsoever of success; but what chance has he when he must do everything himself, even to washing out his own test-tubes? Provide him with a few advanced students, and he would doubtless find time to undertake the necessary pioneer research work, which would then be extended and developed with their assistance.

It might be suggested that an efficient and enthusiastic man would soon attract a number of research students. This, no doubt, is true as regards the universities, but it must be remembered that a polytechnic or other institution which does not grant degrees can hardly expect to compete with a university as a center for research; all those students who intend to undergo a so-called "complete" course of study—that is to say, all who are likely to become capable of undertaking research work—naturally proceed to one of the degree-giving universities. There are not enough students to go round, to satisfy the research requirements of the teachers, and the principal reason is—the limited demand for trained chemists on the part of the manufacturers.

Even of the small number of those who leave our teaching institutions fairly well trained in research, how many have a chance of passing into works and directly advancing applied science? A very small proportion indeed. Most of the better ones drift into other posts, become demonstrators, emigrate—anything rather than wait on with the prospect of accepting as works-chemist a salary which, meager though it be, may be stopped altogether if dividends are low.

With whom rests the responsibility for this state of affairs? Is it with the teachers, and, if so, is it because they are incapable of training chemists or because their system is at fault?

To answer this question it is necessary in the first place to arrive at some conclusions as to the kind of training which is required for the future works-chemist. On consulting the opinions of the manufacturers it would seem that they attach great importance to what is called the "practical side"; they believe that, in addition to a knowledge of theoretical chemistry, the prospective works-chemist should also have some acquaintance with engineering, should understand the apparatus and machinery used in the particular manufacturing operations with which he is going to deal, and should have had practical experience in working the given process. It is from this point of view that we build and equip large technological chemistry departments, such as those in the Universities of Birmingham and Leeds and in the Manchester Municipal School of Technology, departments fitted up with complete apparatus and machinery for carrying out operations on a miniature manufacturing scale.

The arguments in favor of this view, that it is a hybrid chemist-engineer who is required in a chemical works, seem to me to be fundamentally unsound, and the kind of training suggested by them for the works-chemist can only result in the production of a sort of combined analytical machine and foreman. A two or three years' course of science, followed by one year's practical work in the dye-house, in paper-making, or in some other technological department, is quite inadequate if the student trained in this way is expected to do anything beyond routine analytical work and supervision. We can not possibly expect such a poorly trained jack-of-all-trades to run a chemical works successfully in the face of competition directed by a large staff of scientific experts in chemistry and in engineering. The conditions in a chemical works can not be successfully imitated in a university or polytechnic; attempts to do so can only lead to mistaken conclusions, and thus have the effect of rendering the works-chemist quite helpless when he passes from the elegant models of his educational apparatus to the workaday appliances of the manufactory.

Here, it seems to me, we touch the bed-rock of our trouble. The state of our chemical industries must be attributed to the erroneous views which have been and still are held as to the functions, and consequently as to the training, of a works-chemist. We have failed to realize that industrial chemistry must be based on a foundation of continuous and arduous research work. In the past we have sent out from our universities and other institutions students who no doubt were qualified to undertake routine analytical work, but the great majority of whom knew nothing of the methods of research. We are doing the same to-day. Just when a student has reached a stage at which his specialized scientific training should begin his course is finished, and whether he has been to a university or to a polytechnic matters little; he joins the band of those who subsist on but who do nothing to advance chemical industry. He enters a works; the manufacturer does not realize exactly what his chemist ought to do, but he expects some immediate results, and in consequence is generally disappointed; the lack of success of the chemist is put down to his ignorance of practical matters, and there is an outcry for technical education; science is most unjustly discredited, and any suggestion of spending money on research work is scouted as a mere waste.

The consequence is that if there is a scientific problem which intimately concerns all the members of some large industry, what course do they adopt? Through their trade journal, and as an association representing a total capital of which I should not like to hazard a guess, they offer a bronze or possibly a silver medal, or may even offer the extravagant sum of 20*l.*, to the happy person who will provide them with a solution. It is difficult to imagine the class of solvers to whom these princely rewards may appeal, more difficult still to believe that any useful result can be attained, and it is almost incredible that such methods should be adopted by any influential industrial organization. This way of attempting to get research work "on the cheap" is certainly not unknown even in more enlightened countries, but that is hardly a sufficient justification for its employment.

Contrast these methods with those adopted by the Badische Anilin- und Soda-Fabrik and Meister, Lucius & Brünig in their attempts to solve the problem of the commercial synthesis of indigo. Could there be a greater antithesis? If five thousand copies of Brunck's Paper on this subject[1] could be circulated among the manufacturers of this country—a task which might be fittingly undertaken by the Society of Chemical Industry—the study of the truly magnificent results attained by the systematic application of pure science, and of the indisputable evidence of their commercial value, might prove an object-lesson far more effective than argument for the accomplishment of a sorely needed reform.

[1] *Ber.*, 1900, I., lxxi.

Now if we are to meet successfully the very formidable scientific and commercial organization opposed to us in chemical industry, we must perforce adopt the methods of our competitors; not only must we learn patience and perseverance, but we must also call to our aid the best brain-power available. We must recognize clearly that the scientific-works chemist, the only man who is likely to make discoveries of commercial value, must be thoroughly trained in the methods of research by those best qualified to do so, and we must not imagine that when he enters the works he should or could immediately become an engineer and a commercial expert; his place is in the research laboratory. The practical man—that is to say, the man who has a thorough and useful knowledge of some particular manufacturing process—must be trained under practical men in the works, and we must not imagine that a course of evening classes will convert him into an expert chemist. The ideal man who combines high scientific training and sound practical knowledge can not be produced unless the period of his education is extended to half a lifetime, and even then only through the cooperation of the chemistry teacher and the manufacturer.

The great proportion of the original work now done in this country, judging from the published records, is absolutely free from any utilitarian bias; the time, brain-power and money devoted to this work are considerable, and the results from a scientific point of view eminently satisfactory. If even a fraction of the same skill and energy were brought to bear under proper conditions on problems of applied science, who can doubt but that the effect on our chemical industries would be one of vast importance? And yet it is the rarest possible occurrence to find any record of research work undertaken with a commercial object even in the natural home of such records, the *Journal of the Society of Chemical Industry*.

One reason for this may be that the discoveries made in the works-laboratories are not given to the world at large, but are quietly and lucratively applied in some secret manufacturing process. Another reason, unfortunately the more probable one, may be that nearly all the principal research workers are completely shut off from any industrial influences.

Now the worker in pure science, unaided by the advice of the manufacturer and business man, has little chance of solving any important technological problem, except as the result of accident; he has not the requisite acquaintance with commercial conditions, does not realize the enormous difference between operations on the laboratory and the manufacturing scales, or, if he does so, is unable to enter fully and with confidence into questions of fuel, labor and so on, which often determine the success or otherwise of a process. Further, much of the research work of direct commercial value concerns methods for reducing the cost of processes already in operation, and demands an intimate practical knowledge of these processes.

It is obvious, therefore, that, even if all the research capacity of the country were henceforth devoted to purely technical matters, any great improvement in our industries could hardly be anticipated without the active cooperation of the manufacturers.

There are other ways in which it might be possible to obtain the active cooperation of the manufacturers. Any individual or firm interested in a problem of applied science might be invited to found a temporary research scholarship at the university or other institution for the definite object of the particular problem in question. The maximum period during which such a scholarship would be tenable might be fixed beforehand, so that the financial liability of the founder would be limited and proportionate to the importance of the object in view. The holder of the scholarship might be nominated by the university, or by the founder and the university jointly, and suitable conditions would be drawn up to insure the interests of the founder; he would, of course, have the benefit of all the results of the work, and would secure the patent-rights of any new invention, subject possibly to the payment of a small percentage of the profits to the university and to the holder of the scholarship. During the tenure of the scholarship the holder, and also the founder, would have the advantage of the scientific knowledge of the university; the scholarship holder would also be allowed to gain practical experience in the works, and, if successful, there is little doubt but that he would have the option of working the process on the large scale and of obtaining permanent employment under satisfactory conditions. After a given period the scientific results of the work would be published through the usual channels in the ordinary way.

This idea of applied research scholarships had taken shape in my mind when I happened to come across a book recently published in the United States, called "The Chemistry of Commerce," in which I found that a similar proposal had been made by the author, R. K. Duncan, professor of industrial chemistry at the University of Kansas. The scheme is there worked out in some detail, and a form of legal agreement to be signed by the university authorities and by the founder of the "Industrial Fellowship" is suggested.

In drawing this address to a conclusion I can not but feel that my suggestions may seem utterly inadequate to the attainment of those important results which are so greatly to be desired. If so, I can only plead that more drastic measures are hardly available, and that even under the most favorable circumstances improvement can take place only very slowly. Whatever differences of opinion may be held as to the details of any scheme for regaining our lost ground, the main lines seem to be clearly indicated. The workers in pure science must recognize that it is their duty to do all they can to promote the industrial welfare of their country; the manufacturers must concede the paramount importance of science and the impossibility of dispensing with its counsels. Guided by these principles and by a spirit of cordial cooperation, a sustained and strenuous effort on the part of the leaders of chemical industry and of chemical science can hardly fail to accomplish the end in view.

A Determination of the Rate of Evolution of Heat by Pitchblende: Horace H. Poole.

A spherical vacuum jacketed vessel with a narrow neck is filled with powdered and carefully dried pitchblende. The neck is filled with cotton-wool and rendered water-tight with sheet rubber, and the whole is buried in ice. The difference of temperature between the layer of pitchblende in contact with the bottom of the vessel and the ice is measured by a sensitive thermo-couple. After about a fortnight this temperature becomes steady, when the heat leakage across the walls of the vessel is equal to the heat generated by the pitchblende. The leakage depends solely on the vessel and on the difference of temperature between inner and outer walls, which is measured by the thermo-couple. The thermal conductance of the vessel is found by substituting water for the pitchblende and determining its rate of cooling. Hence the heat leakage is known, and, knowing the amount of pitchblende present, the heat evolution per gram is found.

The thermo-couple is calibrated by placing one junction in finely broken ice and the other in a mixture of broken ice and water, which can be subjected to a known pressure. The deflection caused by the resulting small change of temperature is noted, and hence sensitiveness of couple is found.

Using 560.7 grs. of pitchblende in an atmosphere of nitrogen, the temperature finally steadied at 0.0092° C. As the thermal conductance of the vessel is 5.8 calories per hour per degree difference of temperature between inside and outside, this corresponds to a heat leakage of 0.053 calorie per hour. Hence heat evolution per gram of pitchblende is 0.000094 calorie per hour. This is about twice the quantity estimated from the known amount of radium present.

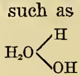
Do the Radio-active Gases (Emanations) belong to the Argon Series? Sir Wm. Ramsay, K.C.B., F.R.S.

The residues of the fractionation of 120 tons of liquid air obtained from Claude were examined in the chemical laboratory of University College by Professor Moore. After removal of oxygen and nitrogen, argon, krypton and xenon remained, and were separated by methodical fractionation. The xenon amounted to about 300 cm.^{3}; it was methodically fractionated at $-130°$, and a final residue of 0.3 cm.^{3} was obtained. The spectrum of this portion was photographed, and differed in no respect from that of xenon. It is practically certain that if this residue had contained 1 per cent. of a denser gas, that gas would have been detected. It follows, therefore, that if there is a heavier constituent in air than xenon, its amount does not exceed 1/25 billionth of the whole. Now, it is certain that if such an element existed, it would be gaseous, and would be found in air. Its non-existence implies either the absence of such elements from the periodic table or their instability. As possible atomic weights for missing elements are 178, 216 and 260, it is rendered probable that they are, respectively, unstable emanations—those of thorium, of radium and of actinium.

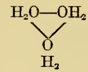
The liquid residue as obtained amounted to about 500 c.c. (500 liters gas) and in order to concentrate the noble gases was blown off into about 100 c.c. of liquid air. This liquid air which contained the accumulated noble gases was again blown off into a smaller volume of liquid air, and this process continued until a manageable quantity of liquid was obtained for fractionation.

The breaking down of the various emanations into members of the argon family was also mentioned. In the discussion that followed Professor Rutherford stated that he was repeating Ramsay's experiments on the production of neon and argon from copper salts by radium emanation and seemed to obtain different results.

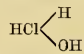
A discussion on the "Nature of Chemical Change" was opened by Professor H. E. Armstrong, F.R.S., who attacked in vigorous terms the theory of ionization in solution, propounding instead a theory of hydrogenation. From the fact that enzymes become associated with the substances they hydrolyze he concluded that acids in solution also acted as true catalysts. Water does not exist as H_2O, but as polymerized molecules, such as



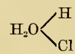
hydronol,



di-, tri- and polyvalohydrone. HCl dissolved in water yields $HCl{=}OH_2$ and

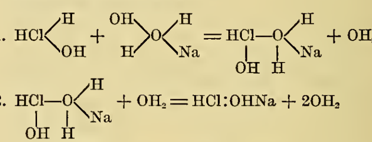


(hydrolation), and in part



which readily hydrolyzes. $H_2O{=}$ and $HCl{=}$ are active because unsaturated. In opposition to the ionic theory Professor Armstrong postulates:

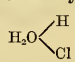
1., 2.



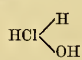
3. $HCl{:}OHNa + 2OH_2 = NaCl + 3OH_2$

and adduced in proof figures showing the volume changes after reaction.

On electrolyzing HCl in concentrated solution there are mostly present



molecules, water exerting a greater hydrolyzing effect when there is less of it present. Hence in weak solution more groups



exist and more O_2 is produced on electrolysis. The tendency for the complex molecules to produce simpler ones $(H_2O)_n \rightarrow nH_2O$ is the cause of osmotic pressure.

Of those who took part in the discussion Sir Oliver Lodge likewise expressed a preference for the attachment of water molecules to the HCl molecule, simply prefer-ring a larger number than one, and pointing out that *then* there was little difference between the ionic theory and Professor Armstrong's.

Sir William Ramsay thought discussion was futile in view of the fact that the compounds formed by the electrons and the parts of the molecules, *e. g.*, the ions and their electric charges, had not been considered. He had thought that measurement of surface tension in mixed liquids might solve the problem, and had made a large number of such measurements, but the figures had been found absolutely inexplicable by Van der Waals and himself. The reason for this was to be found in the difference in composition between the surface layer and the interior.

Dr. Findlay pointed out that although Professor Armstrong condemned existing theories he had nothing to offer in their stead, and that he had no quantitative evidence to support the views put forward by him.

Professor Donnan in some trenchant remarks pointed out that Professor Armstrong's views were antedated by those of Werner, Bruehl and Kohlrausch.

Dr. Wilsmore remarked that according to Armstrong's theory the conductivity of a solution should vary as the square of the concentration, which like other deductions was contrary to fact.

Professor W. J. Pope stated that Professor Armstrong was really only trying to harmonize the ionic theory with the views of chemists, by picturing the process of solution by formulæ like the structural formulæ used in organic chemistry.

Sir James Dewar read a paper on "the production of helium by radium."

Quartz vessels and glass joints were used throughout; the radium was that which had been so carefully purified by Dr. Thorpe (70 mgrs.). The Crookes radiometer was used to measure minute pressures. Solid mercury warmed up to $-23°$ just again starts the Crookes' radiometer, corresponding to a pressure of $\frac{1}{50} \times 10^{-6}$ mm. The radiometer had to be washed out with oxygen prepared from potassium perchlorate.

When a McLeod gauge filled with air was attached to a tube cooled by means of liquid hydrogen to condense the air, the pressure was reduced to 0.015 mm. representing the uncondensable gas at 20° absolute. On again filling with old air (rich in residues) the pressure was 0.00051 mm. which became reduced to 0.00002 mm. on washing out with oxygen prepared from potassium permanganate. Hence it was concluded that helium and neon adhere to glass in the form of a film, and that one can be easily deceived in measuring low pressures.

When 5 milligrams of radium were connected to the radiometer it (the radiometer) became active after a few hours, although an attached tube containing charcoal was cooled by liquid air. The amount of helium produced by 70 mgrs. of radium was measured in this way, the gases produced having to traverse a U tube filled with charcoal and cooled by liquid air before reaching the McLeod gauge. After one month's experiment a yield of 0.43 c.mm. of permanent gas per gram of radium per diem was obtained, but some of the radium emanation had diffused into the McLeod gauge and acted on some organic matter or moisture, producing a higher result. On heating up the charcoal, no helium or other gas was given off.

On repeating the experiment with all care, and under the most favorable conditions (any moisture or organic matter being now evidently eliminated), the radium salt being kept one month in vacuo and the glass containers constantly heated, 0.37 c.mm. of helium per gram of radium per diem was obtained. This corresponded almost exactly to the amount theoretically predicted by Rutherford. Cameron and Ramsay had found eight times as much.

Sir James Dewar also mentioned that some of the calculations of the Hon. J. R. Strutt, regarding the amount of radium in the earth's interior, needed revising, for one well in France produced 30 liters of helium per day, corresponding to 100 tons of radium.

Some Reactions of Dichloro Urea: F. D. Chattaway, D.Sc., F.R.S.

Urea is so well known and has been so much investigated that any new simple substance obtainable from it possesses quite an unusual amount of interest. Such a new substance is found in dichloro urea, which, leaving out of consideration the derivatives of ammonia itself, is one of the simplest possible compounds containing halogen attached to nitrogen. It is produced when chlorine is passed into a cooled saturated aqueous solution of urea. Action takes place without any considerable development of heat, and dichloro urea crystallizes out as a white powder consisting of small transparent plates. Dichloro urea gives all the characteristic reactions of a typical nitrogen chloride; for instance, it liberates iodine from hydriodic acid, chlorine from hydrochloric acid, and reacts with alcohol, forming ethyl hypochlorite, urea being in all cases reformed.

A reaction which indicates the use to which dichloro urea may be put in the synthesis of simple carbon and nitrogen rings is that between it and ammonia.

When ammonia in excess is added to an aqueous solution of dichloro urea, hydrolysis, accompanied by liberation of nitrogen and formation of carbonate, occurs, but in addition diurea is produced, and separates in considerable quantity as a sparingly soluble crystalline powder. This is the first direct synthesis of diurea from urea itself, the compound having been previously obtained from ethyl carbonate and hydrazine.

This adds another to the very few reactions known by which nitrogen atoms can be made to link up together, and further affords an exceedingly simple synthesis of hydrazine.

Diurea, when heated with excess of strong sulphuric acid to a little above 100° C., is easily hydrolyzed, carbon dioxide escapes, and hydrazine sulphate is produced. This crystallizes out perfectly pure in almost theoretical amount on cooling and adding a little water.

The Factors which Influence the Rate of Acoholic Fermentation: Arthur Slator, Ph.D., D.Sc.

The transformation of glucose into alcohol and carbon dioxide by the action of yeast is probably not a single chemical reaction but a series of reactions. If one reaction of the series proceeds relatively much more slowly than the others, then the velocity of the transformation is determined by the rate of this slow reaction.

Evidence is brought forward to show that the initial rate of fermentation by living yeast is controlled almost completely by one single reaction.

The rate of fermentation is exactly proportional to the amount of yeast present. The rate of fermentation of the four fermentable hexoses (glucose, fructose, galactose and mannose) is almost independent of the concentration of the sugar. Glucose and fructose are fermented at approximately equal rates. The fermentation of mannose is similar to that of glucose, but the rates of the two reactions are not equal. The enzyme which ferments mannose seems to be more sensitive to heat than the one which ferments glucose. The influence of temperature on these reactions is almost the same in the case of glucose, fructose and mannose, but rather less in the case of galactose. These results are most easily brought into accord on the assumption that the enzyme combines with the sugar.

Fermentation by yeast-juice differs in many respects from that by living yeast. It is probable that the mechanism of the reaction is the same in each case; but the relative rates of the different steps in the two processes are different. The experiments show that there is an essential step in fermentation in which phosphates in some form or another play a part.

Leo Frank Guttman
The College of the
City of New York

(*To be concluded*)

SIXTEENTH INTERNATIONAL CONGRESS OF AMERICANISTS

The Sixteenth International Congress of Americanists was held in Vienna from Septemper 9 to 15. The congress was well attended, particularly by students from South America. Representatives were also present from Russia, Sweden, Denmark, Germany, England, Holland, Belgium, France, Spain and Italy. The attendance of ethnologists from the United States was not as great as might have been desired.

Owing to the presence of a considerable number of South Americans, many of the subjects discussed before the congress related to the archeology of that continent. Mexican archeology was also well represented; while the ethnology and archeology of North America, which at the Fifteenth Congress of Americanists played a particularly important part, was hardly discussed at all. Following is a list of the papers read before the congress:

Franz Boas (New York), opening address, "The Results of the Jesup Expedition."

Sir Clements Markham (London), "Some Points of Interest in the History of the Incas by Sarmiento."

William Thalbitzer (Copenhagen), "The Angakoks or Pagan Priests of the Eskimos of Ammasalik, East Greenland."

Paul Ehrenreich (Berlin), "Über unsere gegenwärtige Kenntnis der Ethnographie Südbrasiliens."

Franz Ritter von Wieser (Innsbruck), "Die Weltkarte des Pierre Destelier von 1553, im Besitze Seiner Exzellenz des Grafen Hans Wilczek."

Franz Heger (Vienna), "Die archäologischen und ethnographischen Sammlungen aus Amerika im k. k. naturhistorischen Hofmuseum in Wien."

Antonio Sanchez Moguel (Madrid), "Intervención de Fray Hernando de Talavera en las negociaciones de Colón en los Reyes Católicos."

Adela C. Breton (Montreal, Canada), "Exhibition of a Copy of the Ancient Plan in the Museo Nacional, Mexico, supposed to be Part of a Plan of Tenochtitlan."

Jean Denucé (Uccle-Brussels), "Une grande carte de l'Amérique, par les Reinel (vers 1516)."

Manuel M. de Peralta (Paris), "Sur les aborigènes et la cartographie de l'Amérique Centrale et spécialement de la région comprise entre la 8° et le 15° de latitude Nord."

Ignacio Moura (Paris), "Sur le progrès de l'Amazonie et sur ses indiens."

J. Kollmann (Basel), "Kleine Menschenformen unter den eingeborenen Stämmen von Amerika."

Robert Lehmann-Nitsche (La Plata), "Zur physischen Anthropologie der westlichen Chacostämme."

A. Wirth (Munich), "Die Autobiographie Franz Urban Rawiers (um 1720)."

Sir Clements Markham (London), "A Comparison of the Ancient Peruvian Carvings on the Stones of Tiahuanaco and Chavin."

Professor Dr. Capitan (Paris), "Les grands anneaux de poitrine des anciens Mexicains. Comparaisons avec les anneaux japonais, chinois, océaniens et les pièces similaires préhistoriques de la Gaule."—"L'entrelac cruciforme dans l'antiquité américaine, au Japon, en Chine, aux Indes et en Gaule."—"L'omichicahuatzli mexicain et son ancêtre de l'époque du renne Gaule."

J. D. E. Schmeltz (Leiden), "Die niederländische Tumac Humac-Expedition in Surinam."

L. C. van Panhuys (The Hague), "A Remarkable Book on the Indian Mind."—"Communications about Ethnography and History of Surinam."

Heinrich Pabisch (Vienna), "Der Fischfang mit Giftpflanzen in amerikanischen Gewässern."

Marshall H. Saville (New York), "Archeological Researches on the Coast of Esmeraldas, Equador."

Stansbury Hagar (New York), "The Elements of the Maya and Mexican Zodiacs."

K. Th. Preuss (Berlin), "Das Fest des Weines bei den Cora-Indianern der mexikanischen Sierra Madre Occidental."

Eduard Seler (Berlin), "Die Ruinen von Chich'en-Itzá in Yucatan."—"Die Sage vom Quetzalcouatl und den Tolteken nach den in neuerer Zeit bekannt gewordenen Quellen."

George Grant MacCurdy (New Haven, Conn.), "The Alligator in the Ancient Art of Chiriqui."

L. Wollmar (Heidelberg), "Die mexikanischen Bilderschriften und die Zuverlässigkeit ihrer alten und ihrer neueren Interpretationen."

Juan B. Ambrosetti (Buenos Aires), "La question Calchaquie et le travaux de la Faculté de philosophie et lettres de l'Université Buenos Aires."

Max Uhle (Lima), "Uber die Frühkulturen der Umgebung von Lima."—"Zur Deutung der Intihuatanas."—"Uber Muschelhügel in Peru."

Enrico Giglioli (Firenze), "Intorno a due rari cimelî precolombiani dalle Antille; molto probabilamente da San Domingo."—"Di certi singolari pettorali di pietra e di conchiglia precolombiani, dalla Venezuela."

Eduard Seler (Berlin), "Der altmexikanische Federschmuck des k. k. naturhistorischen Hofmuseums. Bericht über eine Untersuchung seiner Konstruktion und Beschaffenheit."

Julius Nestler (Prague), "Ein von dem österreichischen Konsul in Managua (Nicaragua) gefundenes Idol."—"Die Ruinenstätte von Tiahuanaco in Bolivia und ihre Bedeutung."

Professor Sakaki (Kioto), "Une nouvelle interpretation du pays 'Fou-sang.'"

Alberto Frič, "Völkerwanderungen, Ethnographie und Geschichte der Conquista in Südbrasilien."

Adela C. Breton, "Survivals of Ceremonial Dances amongst the Indians in Mexico."

Charles Peabody (Cambridge, Mass.), "Recent Cave-work in America."

C. V. Hartmann (Stockholm), "Some Features of Costa Rican Archeology."—"The Photographon, an Instrument which will replace the Grammophon."

Barbara Klara Renz (Breslau), "Elternliebe bei amerikanischen Stämmen."

Rudolf Trebitsch (Vienna), "Ethnographisches aus Westgrönland, mit Vorführung von Lichtbildern und Phonogrammen."

Richard Wallaschek (Vienna), "Uber den Wert phonographischer Aufnahmen von Gesängen der Naturvölker."

William Thalbitzer (Copenhagen), "Demonstration von Lichtbildern der heidnischen Kultur der Ostgrönländer nebst Erläuterungen."

A. G. Morice, O.M.I. (Kanloops, British Columbia), "Le verbe dans les langues Dénées."

Jean Denucé (Uccle-Brussels), "Note sur un vocabulaire complet de la langue Yahgane (Terre de Feu)."

A. Wirth (Munich), "Die Theorie Trombettis von dem Zusammenhang amerikanischer und asiatischer Sprachen."

P. Fr. Hestermann, S.V.D. (Mödling), "Über die Pano-Sprache und ihre Beziehungen."

P. W. Schmidt (Mödling), "Zur Phonologie der amerikanischen Sprachen und ihrer Transkription."

The Ethnographical Museum of Vienna had arranged a special exhibit of its valuable collections relating to America. Among the specimens shown, the precious relics of the Conquista, which were originally preserved at Ambras Castle, were of greatest interest. The museum had also prepared for the congress a special account of the history of its growth. Among other publications presented to the congress were that of the Islario General of Alonso de Santa Cruz by Dr. Franz Ritter von Wieser; the third volume of the collected essays by Professor E. Seler; the account of the Surinam Expedition of the Dutch Government by C. H. de Goeje, published by Dr. Schmeltz; the first volume of the Publications of the American Ethnological Society, of New York, containing the Fox Texts collected by Dr. William Jones; and the important publications on the archeology of Mitla, by Leopoldo Batres.

The social arrangements were exceptionally good, and enabled the members of the congress to spend the week profitably and enjoyably. On Sunday, September 14, the congress, following an invitation by Count Wilczek, visited Kreuzenstein Castle, with its valuable treasures illustrating the industries and arts of the middle ages.

The general impression left by the congress in regard to the local status of anthropological studies in Vienna is encouraging. The valuable material contained in the Imperial Museum, so far as it is accessible, is well arranged, and a healthy growth of the museum in every direction is apparent. It is particularly worth remarking that the study of the prehistoric remains of Austro-Hungary and that of the folk industries and customs of the empire are closely connected, and that both seem to be pursued with wisdom and energy. The wealth of material exhibited in the Museum für Völkerkunde is a proof of the interest excited by this subject. As in all ethnographical museums of Europe, the room for additional space is keenly felt, and it is understood that a new ethnographical building will be provided in the near future.

Considering the amount of work done in all these directions, it is surprising that the university has not seen fit yet to establish a chair of ethnology and of physical anthropology. It would seem that in a country like Austria, where the problems arising from the conflicting interests and diversity of characteristics of nationalities are ever present, the need of university instruction in the science of ethnology would early be felt, and it seems difficult to understand, at least from the point of view of American university organization, why, in the largest university of Austria, the whole field of anthropology should still be unrepresented.

The program of the congress shows that the restriction of its field of work to America hampers its usefulness to a certain extent; and the question may well be asked, whether the time has not come to expand the program of the Congress of Americanists in such a way as to make it the starting-point for an International Ethnological Congress. The number of students of America is limited, and many of the problems with which we are dealing can be understood only from a wider ethnological point of view. For this reason the meeting of Americanists conjointly with students of Africa, Polynesia and other countries inhabited by primitive people, and arranged in sections analogous to sections of other large congresses, would seem to become a necessity.

The next congress will be held in 1910, the centennial of the establishment of the Argentine Republic and of Mexico. For this reason the congress has deemed it wise to accept the urgent invitations of these two countries, and to have two meetings in 1910—in May, in Buenos Aires; and in September, in Mexico. In order to preserve the continuity of organization, Buenos Aires has been selected as the center of organization of this session.

Franz Boas

THE FOURTH INTERNATIONAL FISHERY CONGRESS

The Fourth International Fishery Congress met in Washington on September 22, 1908, in response to an invitation extended by the Bureau of Fisheries on behalf of the United States government; the American Fisheries Society also joined in the invitation. The official auspices under which the meeting was held were further shown by an appropriation made by congress for defraying the legitimate expenses of the gathering. This series of congresses was organized and inaugurated at Paris in 1900, the intervening meetings being held in St. Petersburg (1902) and Vienna (1905).

The foreign delegates gathered at the Department of State on the morning of the twenty-second, and were greeted by the acting secretary, Mr. Adee. The opening meeting was held at the hall of the National Geographic Society, Hon. George M. Bowers, U. S. Commissioner of Fisheries, presiding. Addresses of welcome were made by Hon. Oscar S. Straus, secretary of commerce and labor, on behalf of the United States; by Hon. Henry L. West, commissioner of the District of Columbia, on behalf of the City of Washington; and by Dr. Hugh M. Smith, president of the American Fisheries Society, on behalf of the society. A response in the name of the foreign delegates was made by Dr. P. P. C. Hoek, scientific fishery adviser of the Dutch government. The nomination of Professor Hermon C. Bumpus as president of the congress and of Dr. Hugh M. Smith as secretary-general was ratified, and fifteen vice-presidents from different countries represented were elected. Thereafter two sessions were held daily, the final meeting being on the afternoon of the twenty-fifth.

The membership of the congress was larger than at the two previous meetings, numbering more than 400. Fifteen countries were represented by official delegates, and 11 other countries by delegates of societies and by private individuals. In addition to a number of delegates at large on behalf of the United States government, four executive departments and the U. S. National Museum and Smithsonian Institution were officially represented. There were also duly appointed delegates from 43 American states and territories and 20 American societies, clubs and institutions. There were in attendance many of the leading fishery workers of the world, and as a whole the gathering was more noteworthy from the standpoint of personnel than any similar meeting ever held in the western hemisphere.

There were presented a large number of papers of exceptional merit and covering nearly every phase of commercial fishing, fishery legislation, aquiculture, acclimatization and scientific investigation of aquatic problems. Many of the papers were submitted in competition for the 18 cash prizes aggregating $2,200 offered by various institutions and individuals. The international jury appointed for the purpose made the following awards:

By the American Museum of Natural History, New York City: For an original paper describing and illustrating by specimens the best method of preparing fishes for museum and exhibition purposes. $100 in gold. Awarded to Dwight Franklin, New York, N. Y.

By the Museum of the Brooklyn Institute of Arts and Sciences, Brooklyn, New York: For the best paper setting forth a plan for an educational exhibit of fishes, the species and specimens that should be shown, the method of arrangement, and suggestions for making such an exhibit instructive and attractive. $100 in gold. Equally divided between Frederic A. Lucas, Museum of the Brooklyn Institute of Arts and Sciences, and Roy W. Miner, American Museum of Natural History.

By the Smithsonian Institution, Washington, D. C.: For the best essay or treatise on "International regulations of the fisheries on the high seas, their history, objects and results." $200 in gold. Awarded to Charles H. Stevenson, Bureau of Fisheries, Washington, D. C.

By the United States Bureau of Fisheries, Washington, D. C.: For a report describing the most useful new and original principle, method or apparatus to be employed in fish culture or in transporting live fishes (competition not open to employees of the bureau). $200 in gold. Awarded to Dr. A. D. Mead, Brown University, Providence, Rhode Island.

By the Wolverine Fish Company, Detroit, Michigan: For the best plan to promote the whitefish production of the Great Lakes. $100 in gold. Awarded to Paul Reighard, University of Michigan, Ann Arbor.

By Mr. Hayes Bigelow, Brattleboro, Vermont, member of the American Fisheries Society: For the best demonstration, based on original investigations and experiments, of the commercial possibilities of growing sponges from eggs or cuttings. $100 in gold. Awarded to Dr. H. F. Moore, Bureau of Fisheries, Washington, D. C.

By Dr. H. C. Bumpus, director of the American Museum of Natural History, New York City: For an original and practical method of lobster culture. $100 in gold. Awarded to Dr. A. D. Mead, Brown University, Providence, Rhode Island.

By Mr. John K. Cheyney, Tarpon Springs, Florida, member of the American Fisheries Society: For the best presentation treating of the methods of the world's sponge fisheries, the influence of such methods on the supply of sponges, and the most effective means of conserving the sponge grounds. $100 in gold. Awarded to Dr. H. F. Moore, Bureau of Fisheries, Washington, D. C.

By Professor Theodore Gill, honorary associate in zoology, Smithsonian Institution, Washington, D. C.: For the best methods of observing the habits and recording the life histories of fishes, with an illustrative example. $100 in gold. Awarded to Dr. Jacob Reighard, University of Michigan, Ann Arbor.

By Dr. F. M. Johnson, Boston, Massachusetts, member of the American Fisheries Society: For the best demonstration of the comparative value of different kinds of foods for use in rearing young salmonoids, taking into consideration cheapness, availability and potentiality. $150 in gold. Awarded to Charles G. Atkins, superintendent U. S. Fisheries Station, East Orland, Maine.

By the New York Academy of Sciences, New York City: For the contribution, not entered in competition for any other award, which shall be judged to have the greatest practical value to the fisheries or fish culture. $100 in gold. Awarded to John I. Solomon, New York City, for a paper describing a process for preserving pearl-oyster fisheries and for increasing the value of the yield of pearls therefrom.

For the other prizes there was either no competition or the papers were not adjudged to be of sufficient merit.

Among the resolutions and views adopted by the congress were the following: (1) Expressing pleasure that the long-standing fishery dispute between the United States and Great Britain affecting waters on the northeast coast of North America is to be submitted to settlement by arbitration; (2) commending the President of the United States for his stand in behalf of the conservation of natural resources; (3) advocating the establishment, in all countries having important fisheries, of national schools of fisheries and fish culture under government auspices; (4) urging the necessity of simplifying fishery laws by the elimination of qualifying clauses which often provide loopholes through which offenders may escape penalties and waters remain unprotected; (5) favoring the formation of the Appalachian Forest Reserve and other similar reserves which embrace the headwaters of important streams; (6) advocating uniform measures on the part of the United States and Canada for the extermination or utilization of the dogfishes, in view of the great injury done thereby to the fishing industry; (7) reaffirming the action of former International Fishery Congresses in recommending an international oceanographic exploration of the Mediterranean in the interests of the fisheries; (8) endorsing the proposition to issue a condensed international dictionary of fisheries and fish culture, in which will be found in twelve or fourteen languages the names of the most important commercial fishes, fishing gear, fishing craft, fishery products, etc., weights and measures used in the fish trade, fish-cultural termini technici, etc.

Among the many pleasant events occurring during the week of the congress were a reception by the President of the United States (who was the honorary president of the congress); a reception by the secretary of Commerce and Labor; a visit to the Library of Congress, where there was a special display of fishery literature; complimentary luncheons tendered by the American Fisheries Society, the Alaska Packers' Association, and the Blue Ridge Rod and Gun Club; special exhibits of fishing craft and of specimens of fishes and reptiles at the National Museum, and of living fishes, hatching operations, and apparatus and products of the fisheries at the Bureau of Fisheries; a display of moving pictures of fishing, hunting, and logging scenes, through the courtesy of the New England Forest, Fish and Game Association, many of the views being then shown for the first time; and a banquet at which the foreign delegates were guests of honor.

The congress accepted the invitations of the Italian Fisheries Society and the City of Rome to hold the next meeting in Rome in 1911, the fiftieth anniversary of the unification of Italy.

MEMORIAL EXERCISES IN HONOR OF WILLIAM F. VILAS

Memorial exercises in honor of William F. Vilas were held in the Armory at the University of Wisconsin on October 20. The audience, which numbered nearly 5,000, consisted of regents, faculty, students and alumni of the university, and citizens of Madison. Ex-Governor W. D. Hoard spoke on behalf of the regents; Chief Justice J. B. Winslow for the state; Professor B. W. Jones for the college of law; and President C. R. Van Hise on behalf of the university.

After reviewing Colonel Vilas's almost continuous connection with the university in one capacity or another from the time that he entered as a preparatory student in 1852, until his death fifty-six years later, and after pointing out the great service which he rendered his alma mater as a regent as well as a professor of law, President Van Hise spoke of the significance of the endowment of over $30,000,000, from the Vilas will. President Van Hise said:

The benefits of Colonel Vilas's will are likely to influence the development of the university long before financial advantages are received. Those who are striving for the construction of the university along the highest as well as the broadest lines now have the powerful moral support of one of the ablest and most distinguished citizens that have ever lived in this state, of the man who by long study of educational problems in the university has the best right to speak as to its future. The will of Colonel Vilas is not merely a deed of gift to the university; it is a gift of his highest thought, matured through years of consideration of the educational problems of this state. It is, indeed, possible that this gift of his mind may be even greater in its influence on the development of the university than the gift of his property. Thus Colonel Vilas's will is not merely a financial bequest; it is a profound state paper which is certain to influence perpetually the development of higher education in this commonwealth.

President Van Hise explained that the will provides: first, for a theater, as a memorial to the beloved son, Henry Vilas, who was graduated at the university in 1894, but who died at an early age; second, after providing for this memorial half of the income goes for scholarships and fellowships, for the support of art and music, and for the maintenance of ten research professorships with adequate salaries and assistants. He said:

There can be no broader statement of endowment for research than that of the Vilas will. "These professorships," the will reads, "are designed to promote the advancement of knowledge rather than to give instruction; not more than three hours a week, nor more than one hour in one day shall be exacted of the incumbent for teaching, lecturing, or other instruction to students or otherwise. Any branch of human learning may be selected as a subject for special study." "The university may best be raised to the highest excellence as a seat of learning and education," the will continues, "by abundant support in pushing the confines of knowledge: the special object of this trust."

As Dr. Van Hise points out:

These research professorships, while not first in order, are placed "first in importance among the purposes of the trust." The provisions for their support, including liberal salaries, assistants, materials, a limited amount of instructional work, and relations with students, are an epitome of the situation in the best German universities, which are admitted to stand first among the institutions of the world in the advancement of knowledge. The accumulated university wisdom of the past century Colonel Vilas has concentrated in this great document for the advancement of knowledge.

THE DARWIN ANNIVERSARY MEETING OF THE AMERICAN ASSOCIATION

The program for the Darwin Anniversary meeting of the American Association is now practically complete. The following have accepted the committee's invitation to present papers on the subjects given:

T. C. Chamberlin: Introductory remarks as president of the association.

Edward B. Poulton: "History of the Theory of Natural Selection since Darwin."

J. M. Coulter: "The Theory of Natural Selection from the Standpoint of Botany."

D. T. MacDougal: "The Direct Effect of Environment."

C. O. Whitman: "Determinate Variation."

C. B. Davenport: "Mutation."

W. E. Castle: "The Behavior of Unit Characters in Heredity."

D. S. Jordan: "The Isolation Factor."

C. H. Eigenmann: "Adaptation."

E. B. Wilson: "The Cell in Relation to Heredity and Evolution."

G. Stanley Hall: "Evolution and Psychology."

H. F. Osborn: "Recent Paleontological Evidence of Evolution."

These papers, which will probably be presented on Friday, January 1, will be published in a memorial volume. A dinner will be held in the evening at which less formal speeches will be made.

SCIENTIFIC NOTES AND NEWS

Professor H. F. Osborn will deliver the third series of the "Norman W. Harris Lectures" before Northwestern University, from December 3 to 11. The subject of the course is "The Age of Mammals in Europe and America." The lectures treat of the Cænozoic period faunistically and from the standpoint of migrations between the old and the new worlds. According to the conditions of the lectureship they will be published subsequently in book form.

Dr. Theobald Smith, professor of comparative pathology in the Harvard Medical School, will give a course of eight Lowell lectures on "Our Defenses against the Microorganisms of Disease." These lectures, beginning March 16, will be given on Tuesdays and Fridays.

The non-resident lecturer in mathematical physics at Columbia University for the year 1908–9 is Professor Max Planck, of Berlin. In the latter part of April and the early part of May, 1909, he will deliver a course of lectures upon "The Present System of Theoretical Physics," dealing particularly with the questions of reversibility, heat-radiation, and the principle of relativity. Details of the dates and subjects of the individual lectures will be published early in March.

Professor Bateson delivered an inaugural lecture at Cambridge University on October 23, on "The Methods and Scope of Genetics."

Dr. William P. Mason, professor of chemistry at the Rensselaer Polytechnic Institute, of Troy, N. Y., gave the annual Founders' Day address at Lafayette College, on October 21, his subject being "A Plea for a wider and better Extension of the Knowledge of Sanitary Science. The degree of LL.D. was conferred upon Professor Mason.

In connection with the visit of the members of the Congress of Electrical Units to Cambridge University, degrees of doctor of science were conferred on Dr. S. W. Stratton, Professor Svante A. Arrhenius, Professor G. Lippmann and Dr. E. G. Warburg.

Mr. W. H. Holmes, chief of the Bureau of American Ethnology, sailed for South America on October 28, as delegate of the United States to the Pan-American Scientific Congress. He will return in February. During his absence Mr. F. W. Hodge will be in charge of the bureau.

In accordance with the current federal agricultural appropriation act, authorizing the establishment of an experiment station in the Island of Guam, Dr. W. H. Evans, of the Office of Experiment Stations, has visited the island and selected a site for the station at Agaña. The station will be conducted under the immediate supervision of the office, with H. L. V. Costenoble as agent in charge.

Sir Daniel Morris, Imperial Commissioner, West Indian Agricultural Department, has resigned.

Mr. Roswell H. Johnson has resigned his position as investigator at the Station for Experimental Evolution of the Carnegie Institution at Cold Spring Harbor, N. Y., to become a consulting geologist. His manuscript on "Determinate Evolution in the Color Pattern of the Lady Beetles" is now in press.

Dr. I. F. Lewis has returned from Europe, where he has been studying at Naples and Bonn, and has resumed his duties as professor of biology at Randolph-Macon College, Ashland, Va.

Sir Jagadis Chandra Bose, M.D. (Cantab.), D.Sc. (Lond.), professor of the Presidency College, Calcutta, addressed the Biological Club of the Massachusetts Institute of Technology on October 22. His subject was "The Plant as a Living Machine," and the lecture was followed by a demonstration of plant responses, mechanical and electrical.

The 347th regular meeting of the Middletown Scientific Association was held in the Scott Laboratory of Physics, Wesleyan University, on October 27, when Professor Herbert William Conn delivered an address on "The Fight against Tuberculosis."

A meeting of the Columbia Chapter of the Society of Sigma Xi was held with the department of physics, on October 29. The lecture of the evening was upon the subject "Modern Practise in Color Photography," and Mr. Alfred Norton Goldsmith, B.S., the lecturer, described and illustrated by apparatus and specimens the present methods of producing color photographs.

Dr. William R. Brooks, director of Smith Observatory and professor of astronomy at Hobart College, lectured recently at Wells College on "Other Worlds than Ours." The lecture was illustrated with stereopticon views and motion slides.

A meeting of trustees, faculty, students and alumni, to commemorate the life and work of the late Dr. D. C. Gilman, formerly president of Johns Hopkins University, will be held in McCoy Hall on the afternoon of Sunday, November 8.

Dr. Adolph Wüllner, professor of physics at Aachen, died on October 6, at the age of seventy-three years.

The deaths are also announced of Dr. A. W. Pöhl, professor of chemistry at St. Petersburg, at the age of fifty-eight years, and of Dr. Lissauer, of Berlin, known for his work in anthropology.

The Astronomical and Astrophysical Society of America will hold its next meeting, in the summer of 1909, probably at the Yerkes Observatory. The exact date has not yet been fixed, but it is expected to precede by a few days the Winnipeg meeting of the British Association for the Advancement of Science, which will open on August 25, 1909.

The steamer *Pourquoi Pas,* with the Charcot Antarctic exploration expedition on board, arrived at Rio Janeiro on October 12, on its way to the South Polar regions, according to press dispatches. The ship will remain there for a week and the Geographical Society will give a reception in honor of the scientific staff. It will then proceed down the South American coast to Buenos Ayres, Punta Arenas and Ushushia, in Patagonia. Dr. Charcot will visit Loubet Land, which he discovered in 1905, and from that point will proceed to Alexander Land.

A meeting of the Geographical Society of Philadelphia will be held at Witherspoon Hall at eight o'clock on Wednesday evening, November 4, when the program will be:

Annual address by the President: Mr. Alba B. Johnson.

"Movement for the Conservation of Natural Resources": Mr. Emory R. Johnson.

"Report on the Ninth International Geographical Congress": Mr. Henry G. Bryant.

The program of the Forest Club of the University of Nebraska for the first semester of the academic year is as follows:

October 6—"Poplars and their Importance": Dr. Bessey.

October 20—"Influence of Windbreaks": C. R. Tillotson.

November 3—"Forest Surveys": Professor Sears.

November 17—"Gypsy and Brown-tail Moths": Professor Bruner.

December 1—"Germination of Forest Seed": Mr. McNeel.

December 15—"Forest Methods in the Rockies": H. Stephenson and H. Greenamyre.

January 6—"Problems in Forest Ecology": Mr. Pool.

At the recent meeting of the British Iron and Steel Institute Professor E. D. Campbell, of the University of Michigan, presented a paper on the constitution of carbon steels. According to an abstract in *Nature* he reviewed the efforts that have been made to interpret the phenomena of the hardening and tempering of steel in the light of the phase rule. The analysis of the carbides obtained from martensite and from troostite in his laboratory appears to indicate marked dissociation, ionic as well as molecular, in the carbides from martensite, while the analysis of the carbides obtained from troostite would seem to indicate almost complete association and polymerization of the dissolved carbides, since the nitro-derivatives of the troostitic carbides are as dark in color as those obtained from equal amount of carbides derived from pearline. These results would indicate the probability that when martensite is heated from 0° C. to 200° C. there is progressive association of ionically dissociated carbides, and polymerization of the carbides of lower molecular weight into those of high molecular weight. This polymerization of dissolved carbides is apparently complete by the time the metal has been converted into troostite. This conception of the changes which take place in the gradual conversion of martensite into troostite offers a simple and rational explanation of the progressive darkening of martensite with rising temperature from 0° C. to 200° C., and for the increase of what Heyn and Bauer term free carbon, but which is probably a condensation product of olefines of high molecular weight. It is suggested that there does not seem to be any inherent reason why the complete substitution of hydrogen by iron should prevent carbon atoms from assuming relations to each other similar to those which they hold in hydrocarbons. The conception of the carbon compounds of iron as metallic derivatives of hydrocarbons suggests a possible explanation of many unsolved problems in the metallurgy of steel, as, for instance, how other elements, too small in amount in themselves to affect profoundly the properties of the steel, may enter into the carbon compounds and, by altering their constitution, bring about effects on the steel as a whole entirely out of proportion to the amount of the element present.

At a convention at the University of Illinois to consider means of combatting tuberculosis in cattle, in session on October 13 and 14, the methods followed successfully by the college of agriculture of the University of Wisconsin will be discussed with a view to adopting them in the state of Illinois. The prevalence of the disease in Illinois is believed to be as great as it was in Wisconsin several years ago when the present plan of testing all dairy herds and segregating or destroying the tuberculous was adopted. Dean H. L. Russell, of the Wisconsin Agricultural College, delivered a lecture and post-mortem demonstration of the effects of the disease upon cattle.

We learn from the London *Times* that with the view of increasing the public utility of the collection of specimens contained in the museum of the Royal College of Surgeons, the council of the college has arranged for a series of demonstrations to be given in the theater of the college during the present session. The demonstrations will be given by the conservator, Professor Keith, and by the pathological curator, Professor Shattock. Specimens from the museum will be shown, and their bearings on general and surgical pathology discussed. The demonstrations, besides being of practical value to medical practitioners and advanced students, should also be of assistance to visitors of the college museum. The first demonstration of the series was to be given by Professor Keith on October 16, which is the one hundred and fifteenth anniversary of the death of John Hunter, the founder of the museum.

The program of the Harvey Society for its course of lectures during the winter of 1908–9 is as follows:

October 24—"Intestinal Infection and Immunity in Tuberculosis": Professor A. Calmette, director of the Pasteur Institute of Lille, France.

November 7—"Fever": Professor W. G. MacCallum, Johns Hopkins University.

November 21—"Metabolism in Diabetes": Professor Graham Lusk, University and Bellevue Medical College.

November 28—"Therapeutics of Diabetes": Dr. Wilhelm Falta, University of Vienna.

December 5—"Anaphylaxis": Dr. M. J. Rosenau and Dr. John F. Anderson, United States Public Health and Marine Hospital Service.

December 19—"Osmosis": Professor A. B. Macallum, University of Toronto.

January 9—"The Relation of the Liver to the Metabolism of Fat": Professor J. B. Leathes, Lister Institute of Preventive Medicine, London.

February 6—"Some Problems in Immunity and the Treatment of Infectious Diseases": Professor Philip Hanson Hiss, Columbia University.

March 6—"Heredity in Man": Dr. C. B. Davenport, Station for Experimental Evolution, Cold Spring Harbor, N. Y.

The lectures are given under the patronage of the New York Academy of Medicine, on Saturday evenings at 8:30, at the Academy of Medicine, 17 West Forty-third Street.

According to a notice in the *Journal of the American Medical Association,* the second meeting of the International Association of Medical Museums was held in Washington, October 1 and 2. Dr. William G. MacCallum, Baltimore, was elected president; Dr. Sims

Woodhead, Cambridge, vice-president; and Dr. Maud E. Abbott, Montreal, secretary-treasurer. It was decided to publish a bulletin and an editorial committee consisting of Drs. Aldred S. Warthin, Ann Arbor, Mich.; Dr. Aschhoff, Freiburg, Germany; and Dr. Frederick F. Russell, Washington, with the president and secretary ex-officio, was appointed. Among the subjects discussed at the meeting were "The Exchange of Specimens," "Elevation of the Medical Museum as a Teaching Medium," "Index Pathologicus," "Classification of Specimens." and "Methods of Technic." The next meeting of the association will be held in Boston in April next, following the meeting of the Association of American Pathologists and Bacteriologists.

Along the lines of the Erie Railroad in western New York a train will be run this fall by the New York State College of Agriculture at Cornell. The train will be known as the "Educational Special." On board will be about a dozen senior members of the agricultural faculty. At each station, where a stop of forty-five minutes will be made, the professors will talk to the farmers and answer any questions that may be asked by seekers for information about improved methods of farming. Circulars and posters will be sent in advance, so that the exact time of the arrival of the train may be known. Towns on the main line, the Rochester division and the Hornell and Attica division and their branches will probably be visited and the party will be on the road about ten days.

As a result of recent cooperative work with the state board of health of Rhode Island, the United States Geological Survey has accumulated a large amount of data in regard to textile and other factory wastes, the processes which produce them, their effects on streams into which they may flow, and methods by which their deleterious effects may be reduced to a minimum. This information will soon be made available to the general public through the medium of one of the survey's water-supply papers. The factory wastes studied in detail are those resulting from wool scouring, cotton-yarn bleaching, cotton-yarn dyeing, and cotton-cloth bleaching, and from the manufacture of fertilizer, glue and oleomargarine. Experimental purification of the wastes was undertaken with varying results. The details of the experiments, with estimates of probable cost and degree of purification, will be given in full in the forthcoming paper. It was found that all the wastes studied can be satisfactorily purified at a reasonable expense. The sewage from the manufacture of fertilizer, glue and oleomargarine contains enough valuable matter to pay the costs of treatment, and the recovery of wool fat and potash from wool-scouring liquor will in many cases result in a substantial profit. The pollution of streams and consequent destruction of natural water resources by such liquid wastes therefore seems to be unwarranted.

UNIVERSITY AND EDUCATIONAL NEWS

A bill has been introduced in the Vermont legislature appropriating $6,000 annually for the establishment of a department of pedagogy in Middlebury College.

Professor Liveing has given to Cambridge University almost the whole of the apparatus and material belonging to him in the chemical laboratory.

The attendance at the University of Cincinnati this year, exclusive of the external students, is as follows: liberal arts, 409; engineering, 191; teachers, 191; medical, 119; law, 82; graduate, 85.

We learn from the *Experiment Station Record* that in accordance with the law passed by the first state legislature of Oklahoma providing for the establishment and maintenance of agricultural schools of secondary grade in each supreme court district of the state, two schools have been established this year, one known as the Murray State School of Agriculture, located at Tishomingo in Johnston County and the other at Warner in Muskogee County. These state schools will offer no courses of instruction other than industrial courses. Each school has an appropriation for the first year of $20,000 for buildings and $12,000 for maintenance. One fourth of the maintenance fund for each school must be expended in developing agricultural experiments in the field, barn, orchard, shop and garden. The Tishomingo School has 120 acres of land and the Warner School, 160 acres. These and the other similar schools in the state will be under the supervision of the state commission of agricultural and industrial education, which consists of the state superintendent of public instruction, the president of the state board of agriculture and the president of the Agricultural and Mechanical College. The Murray School will open this fall and will be in session eight months.

Dr. Albert Ross Hill will be inaugurated as president of the University of Missouri on December 10. The principal speaker will be Dr. J. G. Schurman, president of Cornell University.

Mr. R. J. H. DeLoach, botanist to the Georgia Experiment Station, has resigned to accept a professorship of cotton industry in the State Agricultural College at Athens.

The following appointments have been made in the philosophical department of the University of Michigan: DeWitt H. Parker, Ph.D. (Harvard) to be instructor in philosophy; F. C. Dockeray, A.B. (Mich.), and Elmer C. Adams, A.B. (Mich.), to be assistants in psychology.

Instructors at the University of Cincinnati have been appointed as follows: Harry Louis Wieman, biology; Charles N. Moore, mathematics; Taylor S. Carter, physics; Joseph Eugene Root, civil engineering; Howard A. Dorsey, mechanical engineering, and Murrell Edwards, physical education.

Mr. A. R. Brown, who recently returned from an anthropological expedition to the Andaman Islands, has been elected to a fellowship at Trinity College, Cambridge.

DISCUSSION AND CORRESPONDENCE

THE TEACHING OF MATHEMATICS TO ENGINEERS

To the Editor of Science: Doubtless many physics teachers in our technical schools and universities have followed with great interest the spirited discussion on the teaching of mathematics to students of engineering, recently published in Science, and I have been wondering if any of them had the same uncomfortable feeling which I had while listening to some of the criticisms. Again and again I could not help but think of a well-known biblical quotation about the mote and the beam. Professor Franklin's letter, October 2, shows that I do not stand alone in this matter.

Aside from actual deficiencies in the knowledge of mathematics depending upon local conditions and personal aptitude, it is apparent that our students beginning engineering subjects show often a deplorable lack of ability to express practical problems in mathematical form and to properly interpret the results after the formal operations upon the mathematical equations have been completed. As Professor Slichter says: "They very generally lack the power to do anything with the mathematics they have been taught." The statement that mathematics is nothing but a tool for the future engineer means that it is only the teaching of the mere mechanical operations enabling the student to solve certain equations. Whoever uses the phrase in this sense confounds the tools *of* mathematics which he borrows from it, with the science itself, and it would be better for him to study a little more real mathematics.

I believe, however, that we all agree that it is highly desirable that our students in engineering should obtain a greater skill in handling these tools, falsely called mathematics. But who is responsible for their lack of skill? Considering the small amount of time allotted to mathematics in many of our schools, the blame can not well be placed upon the teachers of this science alone; it is a severe impeachment of the teachers of engineering and—of the teachers of physics.

It seems remarkable that only in a few instances during the whole discussion was any mention made of physics. Do the students pass directly from mathematics to the purely engineering courses? If so, it is a grave mistake. Students taking elementary mathematics have very little knowledge of physical facts and it was well said: "To illustrate a new mathematical principle by an application to a science with which a student is not familiar is to befog and not to illumine the subject."

The transition from mathematics which "develops the quantitative reasoning power and ability to think mathematically" to the application of this power to concrete problems is one of the hardest steps to take and—in spite of the Perry movement—it is the province of physics to help the student to make this step. Realizing this difficulty we have introduced in the course of physics for engineering students of the University of Iowa "problem hours," *i. e.*, the class is divided into small sections spending under the supervision of an instructor one afternoon a week in the solution of concrete problems. The results are highly satisfactory. Of course there are always some "abstract" thinkers who are unable to grasp the meaning of the problems, and the sooner they are made to see that they were not meant for engineers the better.

The only objection to the introduction of the problem hours is that too little time will be left for experimentation and recitations. The engineering courses are so overcrowded with "practical" subjects that the fundamentals, mathematics and physics, are more and more crowded into the background. Make the foundation broad enough to build upon it the increased number of technical courses. Give us more time and, if necessary, lengthen the engineering course. The University of Minnesota has already done so and its good example should be followed in other institutions.

The time given to physics should be one and one half years. Where the entrance requirements are sufficiently high the study of mechanics in physics may well be taken up in the second half of the first year, after the course in trigonometry has been completed and before the students have forgotten what they have learned in it. The whole semester should be devoted to this subject, while the whole of the second year is given to the remaining part of physics, taking advantage, during the latter part of the course, of the training in calculus.

Thus in closely correlating the two necessary elements, (1) the teaching of methods and principles of mathematical thinking, in the courses in mathematics and (2) the application of these methods to concrete problems, in physics, the student will be properly prepared to take the last step, namely, to obtain technical results, in his engineering courses.

K. E. Guthe

Iowa City, Iowa

CONCERNING THE REAL UNICORN

In a certain issue of Science (February 2, 1906, Vol. XXIII., p. 195) Mr. C. R. Eastman contributed an exceedingly interesting article under "Notes on the History of Natural Science," on "The Real Unicorn." In setting forth the facts as to the origin of this fabulous animal, brought to the notice of the western world by Ctesias, Mr. Eastman concludes that the source of this strange creature of the medieval mind is to be traced to certain relief profiles described by Ctesias as graven on the walls of the Persian court at Persepolis and figuring some "Asiatic ruminant new to the Greeks, with the two horns appearing in side-view as one." To the animal so depicted Ctesias gave the name of "unicorn" or "monoceros."

Unquestionably Mr. Eastman's view as to the unicorn's zoological position is probably close to the real facts. It remains to determine, if possible, what species of "Asiatic ruminant" can stand sponsor for the fabulous creature. Some horned beast known to the ancient Persians, the horns of which would appear as a single horn in profile and would point forward when the animal's muzzle was held downward as in the defensive attitude or when grazing, could be the only one so pictured as to give rise to the idea of a "unicorn" or "monoceros." Such a beast, I think, may be seen in the male Nilghai (*Boselaphus tragocamelus*), an Indian antelope, ranging at present from the southern foothills of the Himalaya to beyond Mysore, though most abundant in the central parts of Hindustan. Any one standing alongside of a Nilghai can see at once how the spike-like horns spring straight upward, bending slightly forward, and how the near horn hides its fellow.

The knowledge of this animal would undoubtedly have reached the ancient Persian civilization from the trans-Indus region, and the artists of the period would very naturally have graven but a single horn in bas-relief profile. Further evidence that this animal was known to the ancient Persians is to be found in the name itself—"Nilghai," or "Nylghau," being of Persian origin and meaning "blue bull." The species first became known to the modern world of Western Europe about 1745, and was described and figured in *Philosophical Transactions* for that year by Dr. Parsons, in a paper entitled "An Account of a Quadruped brought from Bengal, and now to be seen in London." In *Philosophical Transactions* for 1770 Dr. William Hunter published a very full account of this animal from living specimens brought to England, and bestowed upon it the native name "Nylghau."

As the unicorn of Ctesias failed to materialize in the fauna of any country, it was relegated to the land of fabulous creatures, and became conventionalized in the art of the ancient and medieval world. If, as Mr. Eastman points out, its origin is to be found in the bas-reliefs on the walls of Persepolis, then, undoubtedly, it must have been a figure from some living prototype, and this prototype could, it seems to me, be none other than the Nilghai, the only Asiatic ruminant with horns so placed as to give rise to such a conception.

Spencer Trotter

Swarthmore College

SCIENTIFIC BOOKS

A Manual of the North American Gymnosperms, exclusive of the Cycadales, but together with certain exotic species. By David Pearce Penhallow, D.Sc., MacDonald Professor of Botany, McGill University, 8vo, pp. viii + 374, with 48 text illustrations and 55 plates. Boston, Ginn & Company, The Athenæum Press. 1907.

The book is prepared for "working botanists," "engineers, and especially foresters." For the latter the author hopes that his histological diagnoses may be of great value in the difficult task of identifying the various species of coniferous woods in the absence of the usual botanical data. The author tells us that

> The present work had its origin in 1880 in an attempt to construct a system of classification for the North American Coniferae based upon the anatomy of the vascular cylinder of the mature stem. The fundamental idea was that such a classification would prove of great value in the identification of material used for structural purposes, but investigations had not been carried very far when it became manifest that some such arrangement was imperatively demanded in other directions and for purposes of a more strictly scientific character.

The author here refers to the value of such data in the study of fossil plants.

The book is divided into two parts, the first, devoted to the general anatomy of the conifers, covering half of the volume. In this the reader or student finds very useful general directions for the preparation of material, discussions of growth-rings, tracheids, bordered pits, medullary rays, wood parenchyma, resin passages, etc. In part second the author arranges and describes the genera and species of North American Gymnosperms (exclusive of Cycadales) under three orders, viz., Cordaitales (including the extinct *Cordaites,* and the surviving *Dammara,* and *Araucaria*), Gingkoales (including the surviving *Gingko*) and Coniferales (including seventeen genera of surviving or recent gymnosperms). Here we have the species of each genus separated by means of a convenient key. Then we have the species arranged systematically, and in each case the scientific name is first given, with a citation of the authority. Next follows a paragraph descriptive of the transverse section, a second for the radial section, a third for the tangential section. For extinct species the mode of fossilization and the geological position are given, while for living species data are given as to specific gravity, fuel value, strength, etc., and geographical distribution.

An appendix in which the anatomical characters are brought together for easy comparison, a list of the literature cited, and a good index close the text, following which are the plates, all excellent half-tone reproductions of photomicrographs of wood sections.

In the chapter on general phylogeny the author gives us his ideas as to the phylogeny of the Coniferales in a suggestive diagram (page 161). Proceeding from the main stem of the Cycadofilices are two considerable branches the Cycadales (including *Bennettitaceae* and *Cycadaceae*), while the other through *Poroxylon* soon subdivides into Cordaitales (*Cordaites, Dammara, Walchia* and *Araucaria*), Gingkoales and Coniferales. In the latter *Taxaceae* and *Podocaepaceae* constitute a primitive side line: later we find *Taxodineae,* then as another side line *Cupressineae,* while the main line terminates in the close group, *Abies, Tsuga, Pseudotsuga, Picea, Larix, Pityoxylon, Pinus.* The last-named genus is regarded as the highest differentiation of the Coniferales.

Charles E. Bessey
The University of Nebraska

Royal Society of London Catalogue of Scientific Papers, 1800–1900. Subject Index, volume I., Pure Mathematics, Cambridge; at the University Press. 1908. Pp. lviii + 666.

This is the first volume of a subject index, which is to be published as "separate index-volumes for each of the seventeen sciences of the schedule of the International Catalogue, viz., mathematics, mechanics, physics, chemistry, astronomy, meteorology, mineralogy, geology, geography, paleontology, biology, botany, zoology, anatomy, anthropology, physiology and bacteriology." This index will complement the great Catalogue of Authors which is being issued by the same society and of which twelve large volumes (1800–1883) have been published, while the volumes covering the period from 1884 to 1900, inclusive, are in preparation. These two catalogues will have close contact with the "International Catalogue of Scientific Literature" which contains an author and a subject catalogue of the scientific publications beginning with 1901. The present work is arranged in accordance with the schedules of the different sciences which form the basis of the International Catalogue.

The preparation of a complete subject index of the scientific papers published during the nineteenth century is an enormous undertaking which can, however, be well justified by the usefulness of such a work when completed. The volume before us is said to contain 38,748 entries referring to 700 serials. While these numbers may appear large, yet they are too small for a complete index of the mathematical papers appearing during the nineteenth century, and it is not difficult to point out omissions. In fact, a number of fairly well-known mathematical periodicals were overlooked altogether, and a complete list of mathematical papers would have demanded reference to about 1,100 periodicals instead of to 700. As instances of omitted periodicals we may mention, *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht* and the *American Mathematical Monthly.*

Although the volume under review exhibits clear evidences of incompleteness, it contains such a large amount of information in a convenient form that it is difficult to see how a live mathematician can afford to get along without it, especially since there is no other work in existence which can take its place. By limiting itself to periodic literature, it complements Wölffing's "Mathematischer Bücherschatz" (1903), which aims to give a complete list of the most important mathematical text-books and monographs published during the nineteenth century. Unfortunately, Wölffing's work, arranged under 313 headings, is still less complete than the one under review, and presents numerous other evidences of hasty preparation.

A very commendable feature of this great bibliographical undertaking of the Royal Society is that it tends to make it easier to keep in touch with the advances that are being made in several great subjects of scientific inquiry. If the volumes devoted to the various subjects are parts of the same set and are arranged according to the same general plan, the scholar is much more apt to acquaint himself with advances outside of his particular field, and thus such an arrangement tends, at least in a slight degree, towards maintaining that community of interest and sympathy which is so helpful in the harmonious development of science. As Darboux pointed out in his recent address before the International Congress of Mathematicians at Rome, there is danger of estrangement even in a single science, and this danger is still more real as regards the various sciences which should be mutually helpful.

In arranging the material of the present volume we are told that it frequently became necessary for a specialist to examine the articles in some detail, as the headings were often too vague to give a definite idea in regard to the results which were reached in the articles. This is especially true of those which appeared between 1884 and 1900, while most of the earlier papers were classified according to their headings. Although great care seems to have been exercised, it is not difficult to find instances where the classifier did not exhibit sufficient knowledge of the subject. For example, it is difficult to see why a note on "Test of a simple group" should be classed under general group theory while such a general article as that of Dyck on "Groups of discrete operations" is classed among the more special articles on discrete groups of finite order. An instance where the classification according to the headings of articles is entirely misleading is furnished by the papers by Cockle which appeared in volumes VI., VII. and VIII. of the *Cambridge and Dublin Mathematical Journal*, under the title of "Method of vanishing groups," although they relate to a species of indeterminate analysis and have nothing in common with what is now regarded as group theory. In the present volume they appear, however, under this general heading.

An instance where the classifier seems to have misunderstood the meaning of a technical mathematical term is furnished by the note on *permutants*, published by Bilenki in *Nouvelles Annales de Mathématiques* (1900). As the heading implies, this note relates to the theory of matrices, but it is classified with substitutions and permutations in the present volume. It may be of interest to observe that the term permutants does not appear in Müller's "Mathematisches Vocabularium," although this valuable work contains more than ten thousand technical terms with their French equivalents.

These instances suffice to make it clear that the scholar can not regard the present index as final authority, either as regards completeness or as regards reliability. On the other hand, extensive historical research among the literature of the historical century will still be richly rewarded. The present volume will, however, be of great assistance in making such research on the part of the mathematician more effective, and it is to be hoped that later editions will be free from many imperfections which could scarcely have been avoided in the first edition of such a very extensive work. The undertaking is a highly laudable one and bespeaks in clear terms a willingness to render an important service, which offers little reward beyond the pleasure in rendering such a service. From this viewpoint the bibliographical activity of the present time exhibits a most inspiring picture of the trend of thought actuating scientific men.

G. A. MILLER
UNIVERSITY OF ILLINOIS

NOTES ON ENTOMOLOGY

THE Germans have always been considered the authorities on forest entomology, and their text-books the standards. Now a most excellent work has been issued in English by A. T. Gillanders.[1] Mr. Gillanders is manager of the forests of the Duke of Northumberland, and so has had much practical experience. The insects are considered under the order to which they belong; there being tables to families, and often to the genera. After each group there is a short bibliography. Many of the illustrations are photographs of injured parts of the tree, and of the insect upon it. The last chapter contains a list of trees with their injurious insects. Perhaps the weakest

[1] "Forest Entomology," pp. 422, figures 351. W. Blackwood and Sons, London, 1908.

part of the volume is the insufficient treatment of larval forms; and the author could have found much information on the life history of many species by consulting the pages of the various English entomological journals.

Recent numbers of the "Genera Insectorum" include the Brenthidæ (fasc. 65, pp. 88, 2 pls., 1908), a family of curious elongate beetles allied to the true weevils. The author is H. von Schönfeldt. He catalogues 111 genera and 624 species, almost all of which are tropical. This part appears to be well prepared. Professor V. L. Kellogg treats of the Mallophaga (fasc. 66, pp. 87, pls. 3, 1908). Although it treats of the species of the world, it is very much less useful than several of the author's previous publications dealing with American forms of this order. Dr. G. Enderlein has reviewed the neuropterous family Coniopterygidæ (fasc. 67, pp. 18, pls. 2, 1908). As before, the author has published, a few years ago, a very much more valuable monograph of the group. Dr. F. Hendel presents the sub-family Lauxaninæ of the dipterous family Muscidæ (fasc. 68, pp. 66, pls. 3, 1908). There is a general account of the biology, and the generic characters seem to be thoroughly elucidated. Albert Bovie is the author of three fascicles on parts of the great family Curculionidæ, or weevils. Fasc. 69—Entiminæ, pp. 7, 1 pl.; fasc. 70, Cryptodermidæ, pp. 3, 1 pl.; fasc. 71, pp. 11, 1 pl.—Alcidinæ. All of the forms are tropical. A useful feature is the figuring of a number of types.

An article of great interest to all entomologists is that by Mr. W. F. Kirby on the length of life of British entomologists.[2] Mr. Kirby has looked up the figures for 309 persons and finds that entomologists live much longer than many other classes. He suggests that the list should induce insurance companies to offer reduced rates to entomologists. The greatest number of deaths (15) occurred at the age of 72; the next (12) at 65; the next (10) at 74; 9 at 58, at 60, at 62, at 66, at 67 and at 70; 8 at 76 and at 82; 9 lived over 90 years. It is hardly possible that figures for American entomologists would produce as favorable results.

Dr. E. Bergroth is the author of a very useful catalogue of the species of the Hemipterous family, Pentatomidæ,[3] that have been described since the catalogue of Lethierry and Severin, which was issued in 1893. These fifteen years have witnessed great activity in this family; no less than 1,000 species have been added, and 140 new genera proposed during this time. Africa has furnished a larger proportion of the new forms than any other continent; South America and Australia are well represented, but the Central American region is scarcely mentioned.

Dr. O. M. Reuter has given a notice of changes in names and synonymy preliminary to a monograph of the Nabidæ.[4] A number of species considered are from the United States. The *Reduviolus limbatus* of Europe he records from Canada and Colorado, and our little *Carthasis*, previously considered as the Mexican species, he describes as *C. contrarius*. He also describes a new species from California. It is with great regret that we learn that Dr. Reuter can not do further original work on insects.

Australian mosquitoes are treated by Thos. L. Bancroft in a recent number of the Annals of the Queensland Museum (No. 8, 64 pages, 1908). He has taken 32 species in Queensland, gives full descriptions of them, and often notes on the habits of the adults. Only four species are common enough to be a nuisance, and two of these were introduced, *Culex fatigans* and *Stegomyia fasciata*.

Mr. R. Demoll has made an extensive attempt to homologize the various parts of the cibarian structure of bees.[5] He gives a comparative account of the morphology of the

[2] "On the Longevity of British Entomologists," *Zoologist* (4), XII., 216–221, 1908.

[3] "Enumeratio Pentatomidarum post Catalogum Bruxellensem descriptarum," *Mém. Soc. Entom. Belg.*, XV., pp. 130–200, 1908.

[4] "Bemerkungen über Nabiden, nebst Beschreibungen neuer Arten," *Mém. Soc. Entom. Belg.*, XV., pp. 87–130, 1908.

[5] "Die Mundteile der solitären Apiden," *Zeitschr. wissensch. Zool.*, XCI., 1–51, 1908.

mouth parts in all of the principal genera of bees. There are chapters on the function of the tongue, and on the adaptation of the mouth parts to the flowers visited by the bees. There are many text-figures, and two fine double plates.

THE British Museum (Nat. Hist.) has issued an illustrated guide to the insects exhibited in its halls; evidently prepared by Mr. Waterhouse.[6] There is a general account of insects, and full treatment of the lower orders. The Coleoptera and Hemiptera are barely mentioned, as the series is not completed in these groups; and of the Diptera only the blood-sucking forms receive attention. A number of the illustrations are photographs of nests of wasps, ants and termites.

MR. M. T. SWENK has given a revision of our species of a part of the large genus of bees —*Colletes*.[7] He treats of the species which have black hair on the thorax of the female; these are 26 in number. Besides the technical descriptions, which appear very complete, there is much matter on the distribution, flower-habits, etc., of the various species. The three plates illustrate the seventh ventral segment of the male. It is unfortunate that the reprint bears no indication of the journal of which it forms a part.

NATHAN BANKS

SPECIAL ARTICLES

ON A COMMUNICATION BETWEEN THE AIR-BLADDER AND THE EAR IN CERTAIN SPINY-RAYED FISHES

A CONNECTION between the air-bladder and the ear in spiny-rayed fishes has been touched upon from time to time since Weber described the elaborate connection between these organs in the Osteriophysi (cat-fishes, minnows, etc.) brought about by the chain of ossicles which bears his name. In the spiny-rayed fishes, however, this connection has usually been through the apposition of the air-bladder to a cartilaginous wall where certain of the lateral cranial bones have failed to come together to complete the bony wall of the lower part of the pterotic capsule. The perilymph which bathes the inner surface of the cartilaginous wall and the auditory organs completes the communication. Such is the case in *Lotella*[1] and in *Myripristis*.

Recently I have found in *Nematistius pectoralis* a more highly specialized connection between the ear and the air-bladder than has been noticed before among the spiny-rayed fishes; the connection in this case being brought about through a long tunnel actually penetrating the basioccipital bone and being confined to that bone at its lower end.

In *Myripristis* (*M. occidentalis*) the lower part of the pterotic capsule is separated off as a special sacculus or otolith chamber in the outer wall of which is a large cartilaginous area between the prootic in front, the basioccipital below and the exoccipital above and behind. To this cartilage a large prolongation from the air-bladder is broadly attached.

In *Holocentrus* (*H. ascensionis*) this condition is somewhat modified. On the side of the cranium the otolith chamber forms an elongate and tube-like prominence, which is extended backwards to the side of the occipital condyle, where it opens widely through a symmetrical, round, smooth aperture. The side of the otolith chamber is mostly formed by the prootic prolonged backwards, though the exoccipital above and the basioccipital below assist materially.[2] The length of the chamber is nearly filled by a very large otolith. This posterior opening, though obviously of a more highly specialized character than in *Myripristis,* still occurs between the same bones. It apparently has no cartilaginous covering homologous with the cartilaginous lateral area in *Myripristis,* but the thin inner membrane of the air-bladder forms a sort of a loose

[6] "A Guide to the Exhibited Series of Insects," with 62 illustrations, 57 pages, London, 1908.

[7] "Specific Characters in the Bee Genus, *Colletes*," pp. 43–102, 3 pls., 1908; University of Nebraska, Contrib. Dept. Entom., No. 1.

[1] Reported on by T. J. Parker, *Trans. N. Zeal. Inst.*, 1882, Vol. 15, p. 234.

[2] For a picture of the cranium of *Holocentrus ascensionis* showing the exterior of the otolith chamber see "The Osteology of Some Berycoid Fishes," Starks, *Proc. U. S. Nat. Mus.*, Vol. XXVII., p. 611.

tympanum over it, while the thicker, more fibrous, outer membrane is attached to the bone around the mouth of the opening. The air-bladder is further anchored anteriorly by a stout Y-shaped ligament firmly attached to the basioccipital. The otolith chamber opens above into the brain chamber at about the middle of its length by a rather small (as compared with other fishes) foramen through which the sacculus communicates with the utriculus and the other auditory elements.

Peculiarly *Holocentrus suborbitalis* Gill, a hitherto supposedly closely related species, has no posterior opening from the otolith chamber, the chamber does not form a tube-like prominence at the side of the cranium, the otolith is comparatively small, and the air-bladder does not extend forward to the cranium. These characters seem of sufficient importance to make *suborbitalis* the type of a distinct genus, for which the name *Adioryx* is proposed.

In a prepared dry cranium of *Nematistius* there appears no long tube-like otolith chamber at the side of the cranium, but at each side and just below the occipital condyle there is a sudden bulging of the basioccipital bone containing the wide-open mouth of a long tunnel leading upward to the brain chamber, and opening into the latter in the same way and at the same place that the otolith chamber of *H. ascensionis* opens into it. In a dissection prepared from an alcoholic specimen a small otolith is found in the upper end of the tunnel. Into the lower part of the tunnel the air-bladder projects, lining it with a delicate membrane; and near the middle of the tunnel, at its narrowest part, the air-bladder closes it, thus forming a delicate membranous pocket.

The auditory connection in the case of *Nematistius*, where a special tunnel is opened through the bone to accommodate it, is obviously of a deeper-seated nature than in any of the other examples where advantage is taken of interossified areas even though these areas have become somewhat specialized. The small taxonomic value of the connection of the air-bladder to the ear is illustrated in *Adioryx* and *Holocentrus*, where in one case the connection is absent while in the other it is present and with the cranial bones modified to accommodate it. It can probably be used only in showing relationship between species or genera at the most. The condition as it exists in *Nematistius* may prove of greater value in this respect.

Edwin Chapin Starks

A NEW SOIL SAMPLER

A laboratory study of the physical characteristics of soils has come to be considered of primary importance in soil investigations. Much has been done within recent years toward studying soils from this standpoint with air-dried samples. Comparatively few attempts, however, have been made to study samples which possessed the texture, structure, moisture content and other features found under field conditions. For many reasons, investigators can not materially add to our knowledge as long as data are secured only from air-dried samples. Real progress in research can begin only with the use of apparatus designed to take samples of adequate volume and of such character as will enable the investigator to deal in the laboratory with samples which possess essentially the same physical properties as are possessed by the soils in the field.

Many devices and methods have been introduced for soil sampling.[1] For general physical and chemical analytical work the standard methods of sampling are all essentially the same and each of them has proven more or less satisfactory for the purpose for which it was devised.

However, with one or two exceptions none of the methods of sampling which have thus far been introduced makes it possible to bring to the laboratory a sample of soil in the condition in which it rested in the field.

In the method of sampling proposed by the investigators at Rothamsted, a steel or brass frame, fitted with a keen cutting edge and open at top and bottom is driven into the soil by repeated blows with a wooden or iron

[1] See Wiley's "Principles and Practise of Agricultural Analysis," Vol. I., pp. 61–85, for a discussion of methods for sampling soils. See, also, Hall's "The Soil," pp. 45–48.

hammer to any desired depth or until its upper edge is level with the surface of the soil. This method has objections. For example, the core of soil within the frame is generally more or less compacted during the process of sampling. For this reason, the sample of soil does not possess unchanged physical characteristics, and hence it can not be used to advantage in a study of many of the more important physical properties of the soil.

A method of sampling which more closely meets the requirements of the soil physicist, who desires to determine the permeability of soil to water or air and to study other physical properties, has been proposed by Whitney, and is described by Wiley in the following words:

> An excavation two feet square and eighteen inches deep is made in the soil. On one side of this hole the sample of soil or subsoil is secured by means of a narrow saw blade and a sharp carving knife. The sample of soil should be two inches square and from three and a half to four inches long. It is placed in a brass cylinder three inches long and three and a quarter inches in diameter. The open space in the cylinder is filled with paraffin heated just to its melting point.

This method, also, is open to objections. In the first place, it is often difficult to secure an unbroken core of soil to a considerable depth, and, further, the sample which is taken by this method is too small for many lines of study.

The writer with the assistance of M. W. Pullen, of the Engineering Division, Iowa State College, has devised a sampler by which he has largely overcome each of the objections referred to in the preceding paragraphs, and is enabled to take, in a comparatively short time, a core of soil, three inches in diameter and of any desired depth up to about fifteen inches, which possesses every physical characteristic of the soil in the field. This apparatus makes it possible for the operator to quickly and easily secure a large sample of soil for mechanical and chemical analyses. For this purpose it promises to prove more useful than some of the devices which are now employed. However, the new sampler is especially adapted for taking samples of soil for the determination of volume weight, moisture content, water-holding capacity, permeability to water or air, capillary movement of water and other physical characteristics. The sampler has been tested in many different types of soil. No particular difficulty has been encountered except in coarse gravel and in heavy soils which were very wet. When the soil is in a condition favorable for crop growth, a sample of soil three inches in diameter and ten or twelve inches in length may easily be secured by two operators within six or eight minutes. A single operator finds it somewhat difficult to get a sample. However, an experienced man, by using a spade two or three times to remove the soil from the sides of the machine, has secured samples without undue exertion.

The total weight of the sampler, exclusive of the wooden frame, is twenty-six pounds and it may be transported from one point to another with little difficulty.

During the past year a large number of laboratory determinations have been made with samples of soils which were taken with the new sampler. The data secured are for the most part very satisfactory and are of such a nature as to justify the conclusion that the sampler will prove of value whenever a study is made of the physical properties of soils.

The new soil sampler is not complicated and may be made by any first-class mechanic in a well-equipped machine shop. The sampler consists of an outer cylinder of steel, fitted at the lower end with two sets of cutting teeth of tool steel; spiral grooves are milled on the outer side of this cylinder which serve to give increased cleaning capacity to the sampler.

A steel cylinder, with an inside diameter of a little more than three inches and with a guide rod nineteen inches in length, fits snugly within the outer cylinder. This inner cylinder does not turn with the cylinder which carries the cutting teeth, but is held rigidly in place by a key. If this cylinder were to turn, the core of soil would be broken and would thus be rendered useless for a determination of certain physical properties of the soil. A cylinder made of heavy galvanized sand screen with eight meshes to the inch is placed inside of the inner steel cylinder. The screen or wire cylinder should fit into position perfectly and there should be no open space between this cylinder and the inner steel cylinder. As the outer cylinder bores into the soil and separates a core of soil from the soil mass, the inner steel cylinder, carrying the wire cylinder is carried downward at a rate uniform with that of the outer cylinder and the core of soil is pushed with but little friction and in an unbroken condition into the wire cylinder. When a sample of soil has been secured to the desired depth, the sampler is withdrawn and the wire cylinder which contains the core of soil is removed from the machine. When the soil sampler is in operation, it is held rigidly in position by a wooden frame which is supported on four legs.

In conclusion it may be said that the advantages which the writer thinks should commend this new apparatus for taking soil samples and particularly those which are used for the determination of the physical characteristics of the soil, are the rapidity with which samples can be secured, and the unchanged physical condition of the core of soil.

The claim is not made for this method that the samples duplicate closely when tests are made regarding the physical properties of a soil type. However, it is the opinion of the writer that the variations are due wholly to factors other than those connected with the operation of securing the samples of soil, and it is not probable that these factors can be eliminated.

W. H. Stevenson

Iowa State College,
Ames, Iowa

NOTE ON THE CRYSTAL FORM OF BENITOITE

Of the thirty-two possible crystal classes deduced mathematically from the empirical law of rational indices by Hessel in 1832, three have no known representative up to the present time. They are the tetragonal bisphenoidal, trigonal bipyramidal and ditrigonal bipyramidal classes. The writer believes that the last-mentioned class, the ditrigonal bipyramidal, has a representative in the new gem mineral, benitoite ($BaTiS_3O_9$) recently described by Louderback.[1]

Several crystals of this interesting mineral obtained through R. M. Wilke were examined and measured, with the following results. The dominant form is a trigonal bipyramid, which determines the habit. If this is taken as the positive unit form, 10$\bar{1}$1, the other forms (taking the axes of reference diagonal to the planes of symmetry as in tourmaline) are: 0$\bar{1}$11 and 01$\bar{1}$2 trigonal bipyramids; 1010 and 01$\bar{1}$0, trigonal prisms; and 0001, pinacoid. Of these 0$\bar{1}$11 is small, 01$\bar{1}$2, a narrow form truncating the polar edges of 10$\bar{1}$1 and only found on one or two crystals. Of the two prisms 10$\bar{1}$0 is invariably the more prominent, but 0$\bar{1}$10 measures a little more in the direction of the $\dot{c}$-axis. The pinacoid 0001 is a small triangular face and on one crystal there were triangular markings parallel to its edges.

Although the general form, *hkīl*, ditrigonal bipyramid, is absent, it is pretty certain that the crystals belong to the class mentioned as there is a horizontal plane of symmetry in addition to three vertical planes of symmetry and three axes of two-fold symmetry as well as a single axis of three-fold symmetry.

Another possibility is that the crystals may belong to the trigonal bipyramidal class in which case the dominant form would be an *hkīl* face, but limit forms are much more common among crystals than general forms. It may also be urged that the crystals may be supplementary twins of the ditrigonal scalenohedral or of the ditrigonal pyramidal class, but as the prism faces show no grooves, nicks, striations or seam through the center, it seems reasonable to regard them as simple crystals.

Sufficient angles were measured to establish the forms as given above. The average of ten values for the angle (0001 $\wedge$ 10$\bar{1}$1) varying from 40° 0′ to 40° 22′, gave 40° 10′ as compared with Louderback's value of 40° 14′.

Austin F. Rogers

Stanford University, Cal.,
September 19, 1908

[1] *Bull. Dept. Geol. Univ. Cal.*, Vol. 5, pp. 149–153, 1907.

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THEORIES OF MANURE AND FERTILIZER ACTION [1]

IT is to Liebig that we owe the first general theory of the nutrition of the plant and the function of fertilizers: although Liebig himself did not add anything to the knowledge of the process of carbon assimilation which had been acquired by Priestley, Senebier and others, nor to the study of the nitrogen and ash constituents which had been begun by de Saussure, he yet drew up from these facts a coherent theory of the course of nutrition and put it before the world with such vividness that it forthwith took its place in the general body of accepted scientific opinion. Liebig argued that since the ash constituents alone are drawn from the soil, it is only necessary, in order to ensure the complete nutrition of the plant, that there shall be no deficiency in the inorganic materials which are left behind when the plant is burnt. According to Liebig the function of the fertilizer is to supply to the soil the materials removed therefrom by the crop, and the fertilizer required can be ascertained beforehand by the analysis of a similar crop, so that the soil can be supplied with the exact amounts of potash, soda, magnesia, lime, phosphoric acid, etc., which would be removed by a normal yield of that particular crop. Neglecting Liebig's misconception of the source of the plant's nitrogen and the long controversy which arose as to the necessity of its artificial supply, we can restate the theory as assuming that

[1] A lecture given at the Graduate School of Agriculture, Cornell University, July, 1908.

the proper fertilizer for any particular crop must contain the amounts of nitrogen, phosphoric acid, potash and other constituents which are withdrawn from the soil by a typical good yield of the plant in question.

In this form the opinion, that the composition of the crop affords the necessary guide to its manuring, prevailed for some time and still survives in horticultural publications, but the course of field experiments, particularly those at Rothamsted, and the accumulation of farming experience soon demonstrated that it was a very imperfect approximation to the truth. Liebig's theory fails because it takes no account of the soil and of the enormous accumulation of plant food therein contained. Water-culture experiments demonstrated that certain elements, *e. g.*, sodium and silica, though universally present in the plant's ash, are unessential to its nutrition; field experiments also showed that other elements—magnesium, calcium, chlorine, sulphur, iron—though essential, are always supplied in sufficient quantities by all normal soils. Thus the elements to be supplied by the fertilizer became reduced to three—nitrogen, phosphorus and potassium—and even the amounts required of each of these are not indicated by the composition of the crop. To take an example—normal crops of barley and wheat would withdraw from the soil approximately the following fertilizing materials:

	Yield of Grain, Bushels	Pound per Acre Removed		
		Nitrogen	Phosphoric Acid	Potash
Wheat......	36	50	21	29
Barley......	48	49	21	36

Now the results of field experiments, which are abundantly confirmed by ordinary farming experience, go to show that the yield of wheat is chiefly determined by the supply of nitrogen; phosphoric acid is of secondary importance and only on exceptional soils will there be any return for the application of potash.

With barley, though its composition is very similar to that of wheat, the results are very different; nitrogen is still the most important element in nutrition, but phosphoric acid has equally marked effects, whilst in ordinary soils potash counts for little or nothing.

This may be illustrated from the Rothamsted experiments, and the part played by the reserves in the soil will be made evident by comparing the results obtained in the first and the fifth series of ten years.

AVERAGE YIELD OF BARLEY GRAIN, HOOS FIELD, ROTHAMSTED

Plot	Manuring	Average Yield of Grain, Bushels: First Ten Years, 1852–1861	Average Yield of Grain, Bushels: Fifth Ten Years, 1892–1901
4 A	Complete fertilizer—Nitrogen, phosphoric acid, potash	46.1	36.3
3 A	Phosphoric acid omitted—Nitrogen and potash	35.0	22.1
2 A	Potash omitted—Nitrogen and phosphoric acid	45.6	28.0
1 A	Nitrogen only	33.6	16.6
4 O	Nitrogen omitted—Phosphoric acid and potash	30.5	12.8
1 O	Unmanured	22.4	10.0

The analysis of the barley plant would indicate that it requires nitrogen in the largest amounts, then potash and least of all phosphoric acid, but if the results for the first ten years of the experiment are considered it will be seen that the omission of either nitrogen or phosphoric acid from the fertilizer causes a big decline in yield in comparison with that of the completely fertilized plot. The omission of potash, however, is of little or no moment, since it only causes the yield to fall from 46.1 to 45.6 bushels per acre. Evidently the soil was able to supply all the requirements of the plant for potash despite the large amounts which the crop removes. In the latter years of the experiment this stock of available potash in the soil had become somewhat depleted, so that the omission of potash from the fertilizer reduced the yield from 36.3 to 28.0 bushels per acre. The exhausted soil in these latter years causes the crop to respond to the constituents of the fertilizer only when they are all present together; taken singly, they increase the yield but little and the omission of any one of them reduces the crop almost to the minimum produced on the unmanured crop. The soil has thus become but a small factor in the nutrition of the crop, whereas as regards potash it was a very large one at the beginning of the experiment, and the defect of Liebig's theory was to neglect it entirely.

These differences in the manurial requirements of wheat and barley, differences which would not be apprehended from their respective compositions, may be correlated with the habits of growth of the two plants: wheat is sown in the autumn after but a slight preparation of the ground, nitrification is thus restricted, especially as the chief development of the plant takes place in the winter and early spring before the soil has warmed up, and as a consequence the crop is particularly responsive to an external supply of some active form of nitrogen. On the other hand, the wheat plant possesses a very extensive root system and a long period of growth, hence it is specially well fitted to obtain whatever mineral constituents may be available in the soil. In ordinary farming the only fertilizer used for the wheat crop will be a spring top-dressing of 100 pounds per acre or so of nitrate of soda or an equivalent amount of sulphate of ammonia or soot.

Barley is a spring-sown crop for which the soil generally receives a more thorough cultivation, in consequence of which and of the rising temperature there will be sufficient nitrates produced for the needs of the crop, often more than enough when the barley follows a root crop that has been liberally manured and perhaps consumed on the ground by sheep. But being shallow rooted and having only a short growing season, the plant experiences a difficulty in satisfying its requirements for phosphoric acid, hence the necessary fertilizer consists in the main of this constituent. Only on sandy and gravel soils, exceptionally deficient in potash and subject to drought, is any benefit derived from a supply of potash to the barley crop.

A still more noteworthy example is provided by the swede turnip crop; the analysis of a representative yield would show it to withdraw from the soil about 150 pounds per acre of nitrogen, 30 pounds of phosphoric acid and 120 pounds of potash. Yet the ordinary fertilizer for the swede crop will consist in the main of phosphatic material with but a small quantity of nitrogen and rarely or never any potash; for example, 400 pounds of superphosphate or 500 pounds of basic slag according to the soil (*i. e.*, 50 to 100 pounds of phosphoric acid), together with 12 to 15 pounds of nitrogen as contained in 50 pounds of sulphate of ammonia will form a very satisfactory mixture. The swede is sown late in the season after a very thorough preparation of the soil, so that the nitrification alone of the nitrogenous residue in the soil is capable of furnishing almost all the large amount of nitrogen it requires; it is very shallow rooted and must be supplied with an abundance of phosphoric acid. It was considerations of this kind which led Ville to suggest that for each crop there is a "dominant" fertilizing constituent, *e. g.*, nitrogen for wheat, phosphoric acid for swedes, and that the particular dominant is the constituent which the plant finds the most difficulty in appropriating from the soil, and hence which is therefore more often indicated by a comparative deficiency instead of abundance in the ash of the plant. Such a theory is, however, not borne out by more general experiments; many plants do not exhibit such idiosyncrasies as are shown by wheat and swedes but require a general fertilizer the composition of which is determined more by the soil than by the plant. Indeed, no theory of manuring can be based upon the plant alone, but must also take the soil into account, so that a fertilizer may be regarded as rectifying the deficiencies of the soil as far as regards the requirements of the crop in question. What those special requirements are can only be decided by experiment, just as the soil conditions are ascertainable by trial rather than from *a priori* considerations of analysis. If an analysis be made of any soil in cultivation it will be found to contain sufficient plant food for the nutriment of a hundred or more full crops: the soil of the unmanured plot on the Rothamsted wheat field contained in 1893, after 54 years' cropping without fertilizer, 2,570 pounds per acre of nitrogen, 2,950 pounds of phosphoric acid and 5,700 pounds of potash. Of course much of this material is in a highly insoluble condition, but though attempts have been made by the use of weak acid solvents to discriminate between the total plant food in the soil and that portion of it which may be regarded as available for the plant, no proper dividing line can be thus drawn. The availability of a given constituent, say of phosphoric acid, will depend, as has already been seen, upon the nature of the crop; a given soil may contain sufficient easily soluble phosphoric acid for the needs of the wheat plant and yet fail to supply swede turnips with what they require. Again, the mechanical texture of the soil may be such as to limit the root range of the plant, so that a richer soil is necessary to produce the same result as is obtained in a poorer soil of more open structure; the state of the microflora of the soil may also have much to do with the amount of a given nutrient which can reach the plant.

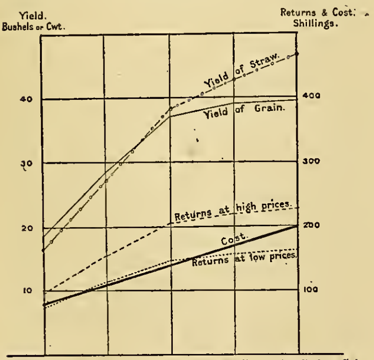
Perhaps the best general point of view of the action of fertilizers is obtained by extending the "law of the minimum" originally enunciated by Liebig, according to which the yield of a given crop will be limited by the amount of the one particular constituent which may happen to be deficient; if the soil, for example, is lacking in nitrogen the yield will be proportional to the supply of nitrogen in the fertilizer, and no excess of other constituents will make up for the shortage of nitrogen. To take an example from the Rothamsted experiments, the following table shows the yield of wheat,

EXPERIMENTS ON WHEAT, BROADBALK FIELD, ROTHAMSTED

Averages over Thirteen Years (1852–64)

Plot	Manures per Acre	Dressed Grain: Produce per Acre	Dressed Grain: Increase for each Additional 43 lb. N in Manure	Straw: Produce per Acre	Straw: Increase for each Additional 43 lb. N in Manure
		Bush	Bush.	Cwt.	Cwt.
3	Unmanured	15.6	—	14.6	—
5	Minerals alone	18.3	—	16.6	—
6	" and 43 lb. N as ammonium-salts	28.6	10.3	27.1	10.5
7	Minerals and 86 lb. N as ammonium-salts	37.1	8.5	38.1	11.0
8	Minerals and 129 lb. N as ammonium-salts	39.0	1.9	42.7	4.6
16	Minerals and 172 lb. N as ammonium-salts	39.5	0.5	46.6	3.9

grain and straw, from the unmanured plot and from a series of plots, all of which receive an excess of phosphoric acid, potash, etc., but varying amounts of nitrogen, ranging from 43 pounds to 172 pounds per acre. That the nitrogen was deficient is shown by the almost negligible increase produced by the mineral constituents without nitrogen; from this point the increase of yield is roughly proportional to the supply of nitrogen, until it reaches an excessive amount. The table also illustrates the generalization which is familiar to economists under the name of "the law of diminishing returns"—that the first expenditure of fertilizer or other factor of improvement is the most effective, each succeeding application producing smaller and smaller returns, until a further addition causes no increase in the yield. If the cost of the fertilizer, added to a prime outlay of 80 shillings per acre for the cultivation, and the value of the returns in cash, are expressed in the form of a diagram, the law is clearly expressed by the series of curves in the figure, where the cost of production forms a straight line that is always intersected by the curves expressing the value of the returns, which begin by rising more rapidly than the cost of production, but



Relation between cost of production and returns with varying quantities of manure

tend to become horizontal. The point of intersection when profit ceases is nearer the origin the lower the range of prices obtainable for the crop, as shown by the two curves representing the returns at low and high prices, respectively; this demonstrates that the expenditure on fertilizers or anything else required by the crop must be reduced when prices of produce are low, or, as expressed by the late Sir John Lawes, high farming is not remedy for low prices.

Liebig's law of the minimum must, however, be extended to all the factors affecting the yield as well as to the supply of plant food, *e. g.*, to such matters as the supply of water, the temperature, the texture of the soil. Any one of these may be the determining factor which limits the yield, or two or more of them may act successively at different periods of the plant's growth. On poor soils the water supply is very often the limiting factor, on very open soils because the water actually drains away, on extra close soils because the root range is so restricted that the plant has but little water at hand and the movements of soil water to renew the supply are very slow; in either case for comparatively long periods the plant will be sure to have as much nutriment as is required for the small growth permitted by the water present. It is only when the water supply is sufficient that the resources of the soil as regards all or any of the constituents of a fertilizer are tested, and may become in their turn the limiting factors in the growth of the crop. Hence it follows that fertilizers may often be wasted on poor land, where growth is limited by the texture of the soil, by the water supply or some other factor hardly controllable by the farmer: it is a truism that poor land can not be converted into good by manuring and that fertilizers give the best returns when applied to a good soil.

One fundamental difficulty still remains in considering the action of fertilizers: it has already been pointed out that a soil by no means notably fertile may contain enormous quantities of plant food, which is, however, combined in so insoluble a form as to reach the plant in quantities insufficient for the requirements of the crop; for example, a soil may contain 0.1 per cent., or 2,500 pounds per acre, of phosphoric acid and yet yield a very indifferent swede crop unless it be supplied with an additional dressing of 50 pounds per acre of soluble phosphoric acid. It is usually assumed that the effect of this phosphoric acid manuring is due to the soluble nature of the fertilizer, because of which the additional plant food is directly available for the crop. But a little consideration of the reaction set up in the soil will show how insufficient such a theory must be; the phosphoric acid is very rapidly precipitated within the soil, as is shown by the fact that on many soils it remains close to the surface for many years and is never washed out into the drains. Bearing in mind this precipitation of the phosphoric acid in an insoluble condition, Whitney and Cameron proceed to argue that previous to the addition of the fertilizer a certain amount of phosphoric acid exists in solution in the soil water, this amount being in equilibrium with the various phosphates of calcium, iron, aluminium, etc., making up the great store of phosphates in the soil. This particular state of equilibrium would be but little disturbed by the addition of the soluble fertilizer in quantities which are small compared with the great mass of undissolved phosphates in contact with the soil water; the added phosphoric acid would only displace an almost equivalent amount of the phosphoric acid already in solution, and the concentration of the new solution would only differ from the old in the same degree as the ratio the phosphoric acid in the soil plus fertilizer (2,500 + 50 pounds of phosphoric acid) bears to the phosphoric acid originally in the soil (*i. e.*, 2,500 pounds phosphoric acid). In other words, before the fertilizer was added the soil water was as fully saturated with phosphoric acid as the amount of calcium, iron, aluminium and other bases would permit, and as these bases are present in enormous excess, the soil water must remain at the same saturation point after the fertilizer has been added, just as water will only hold 35 per cent. of the common salt in solution with however large a quantity of salt it may be in contact. Just in the same way the soil contains certain double silicates of which potassium is a constituent and these hydrolize to a slight extent in contact with the soil water, to yield a solution containing potassium ions. The addition of a soluble potassium salt, as in a fertilizer, will diminish the dissociation and therefore the solubility of the double silicate, the potassium of which is thrown out of solution until, as Whitney and Cameron argue, no more potassium ions remain in solution than were present before the addition of the fertilizer.

According to this point of view, the concentration of the soil water for a given plant food, such as phosphoric acid, must be approximately constant for all soils of the same type, however much or little phosphatic fertilizer may have been applied, and since water-culture experiments show that this low limit of concentration attained by the soil water is more than sufficient for the needs of the plant, no soil can be regarded as deficient in this or any other element of plant food. It therefore follows that the action, if any, of a fertilizer must be due to some other cause than the direct supply of plant food, with which the soil water must always be saturated to a degree which is quite unaffected by the supply of fertilizer.

This view of the interactions between the sparingly soluble phosphates of the soil, the soil water and the added soluble fertilizer, can hardly be regarded as valid in theory, even if the conditions under which the reagents exist in the soil are the same as those which prevail in the laboratory when such conditions of equilibrium between sparingly soluble solids and water are worked out. It has no bearing whatever on the amount of nitrates in the soil water, since they come into a dissolved state as fast as the nitrifying bacteria produce them, and are not in equilibrium with any store of undissolved nitrates in the background. As regards phosphoric acid the theory assumes such an excess of bases that all soils behave alike and immediately precipitate the phosphoric acid, in practically the same form; while as regards potash the argument seems to forget that though the addition of a soluble potassium salt may throw some of the other sparingly soluble potassium compounds out of solution, the total amount of potassium remaining in solution is still greatly increased. The function of the carbonic acid in the soil water is ignored, as again the fact that the processes of solution in the soil must be in a constant state of change, so that it is the dynamic rather than the static solubility which is of importance. The soil is too complex a mixture to permit as yet of attaching great weight to theoretical deductions as to the actions taking place in it, and that the state of affairs postulated by Whitney and Cameron does hold in the soil has not however, been verified by experiment; the analyses, given by the authors of the theory, of the cold water extracts from a number of soils show great variations in their concentration, in nitrates, phosphoric acid and potash; nor is any evidence forthcoming that such concentrations are not immediately raised by the addition of fertilizers. Indeed, when the Rothamsted soils, with their long-continued difference in fertilizer treatment, are extracted with water charged with carbon dioxide, the nearest laboratory equivalent to the actual soil water, the amount of phosphoric acid going into solution is closely proportional to the previous fertilizer supply, and this proportionality is maintained if the extraction is repeated with fresh solvent, as must be the case in the soil. In the field it is not merely the initial concentration of the soil water in plant food which determines the supply of nutriment to the crop, it is also the capacity of the soil to keep renewing the solution as the plant withdraws from it the essential elements.

In one essential respect again the conditions prevailing in the soil are very different from those of the laboratory; in the soil all reactions are extremely localized, since they take place in the thin film of water normally surrounding the soil particles, in which movement of the dissolved matter takes place very slowly and mainly by diffusion. Of the extreme slowness of the diffusion of soluble salts in the soil the Rothamsted experiments afford some good examples; for instance, on the grass plots only an imaginary line divides the pots receiving different fertilizers, the manure is sown right up to the edge of the plot, a screen being placed along the edge to prevent any being thrown across the boundary, then immediately on the other side of the boundary the different treatment begins. In two cases plots receiving very large amounts of soluble fertilizer, *e. g.*, 550 pounds per acre of nitrate of soda or 600 pounds per acre of ammonium salts, march with plots receiving either no fertilizer or a characteristically different one, yet in neither case is there any sign in the herbage of the soluble fertilizer having diffused over the boundary. Although the treatment has been repeated now for 52 years, the dividing line between the two plots remains perfectly sharp and the rank herbage produced by the excess of nitrogenous fertilizer on one side does not stray six inches over the boundary. Again, on the Rothamsted wheat field the plots are 20.7 feet in breadth and were separated by unfertilized strips only about a foot in breadth; in 1893 each plot was sampled down to a depth of 7.5 feet and the amount of nitrates was determined in each successive sample of nine inches in depth. The amount of nitrates found was in each case characteristic of the supply of nitrogen to the surface of the plot, and right down to the lowest depth there were no signs of the proportions approximating to a common level, as they would have done had any considerable amount of lateral diffusion been taking place. Considering that the plots are only separated by a foot or so of soil and each had been receiving its particular amount of nitrogen for forty and in some cases for fifty years, the sharp differentiation of plot from plot in the amount of nitrates at a depth of seven feet is sufficiently remarkable and is evidence that the movements of the soluble salts in the soil are confined to up and down motions due to percolation and capillary uplift, and take place laterally only to an insignificant extent.

From these considerations we may conclude that when a fertilizer is mixed with the soil each particle will establish round itself a zone of a comparatively concentrated solution to which the plant's roots will be drawn by the ordinary chemiotactic actions, and that these zones will extend but a little way into the generally much less dilute mass of the soil water, because of the slowness of the diffusion process.

That some such state of things prevails in the soil may be surmised from the common farming experience of the benefits derived from sowing the fertilizer close to the seed in such a case as superphosphate and turnip seed, where the fertilizer is not injurious to germination and the young plant is specially dependent on being rapidly pushed into growth in the early stages. Again, the intimate way in which the feeding fibrous roots of a plant will surround and cling to a fragment of fertilizer in the soil, such as a bone or a piece of shoddy, shows that some other actions are at work in the soil than the mere feeding of the plant upon the nutrients contained in the soil solution.

Whitney and Cameron's theory also supposes that the plant itself exerts no solvent action, whereas it has often been supposed that the roots excrete substances of an acid nature which exert a solvent action upon the soil particles. In this direction an experiment of Sachs's has become classical: he took a slab of polished marble and set it vertically in a pot of soil in which beans or some kindred plants were grown. After the plants had been growing for some time the contents of the pot were turned out and the slab of marble washed, whereupon the polished surface was found to be etched wherever the roots had been growing in contact with it. A polished slab of gypsum similarly treated shows a raised pattern wherever the roots have protected the surface from the solvent action of the general mass of water in the soil. Although Sachs himself attributed the etching to the action of the carbon dioxide which is always being given off by the roots, it has also been set down to fixed acids excreted by the root hairs, and determinations have been made of the acidity of the sap of the roots with the idea of differentiating between the solvent power of various plants. The roots of germinating seedlings are also found on occasion to redden blue litmus paper and undoubtedly may excrete substances of an acid character, but the behavior of seedlings, which are building up their fresh tissue out of the broken-down reserve materials contained in the seed, is essentially different from that of plants leading an independent existence, so that nothing is thereby proved as to the source of the etching in Sachs's experiments.

Czapek instituted a fresh series of experiments with smooth slabs prepared by floating on to glass plates mixtures of plaster of paris and various phosphates of calcium, iron and aluminium; since only the calcium phosphate was etched, most of the possible acids were excluded and the etching action of the plant's roots was restricted to carbon dioxide or acetic acid. This latter was again excluded by a further experiment in which the slab was colored with congo red, and as this was not affected, the sole remaining solvent body the plant could have excreted was carbon dioxide. Again it has already been shown that water cultures containing nitrates, where the plant is growing in such solutions as exist under normal soil conditions, tend to become alkaline instead of acid, so that the balance of evidence is against the idea that plant roots excrete any fixed acids exerting a solvent action upon the soil particles. The carbon dioxide, however, probably exerts a considerable action, especially in the immediate vicinity of the root from which it is given off, for as it passes through the cell wall it must momentarily form a solution of considerable concentration, possessing a proportionally increased solvent power, and it is to this supersaturated solution that may be attributed the highly localized attack of the roots upon the soil particles. An experiment of Kossowitsch's illustrates the part played by the roots in attacking the insoluble materials in the soil: two pots of sand were prepared, each mixed with the same quantity of calcium phosphate in the form of ground rock phosphate; a third pot contained sand only. In this latter, and in one of the pots containing the calcium phosphate, seeds of mustard, peas and flax were sown. The growing plants were then furnished with a slow continuous supply of water containing appropriate amounts of nitrates, potash and other nutrient salts except phosphates. Before, however, this nutrient solution reached the pot containing the sand only it was made to percolate through the second pot containing sand and calcium phosphate, but it was applied directly to the pot containing calcium phosphate. In the pot containing calcium phosphate the growth was much greater than in the other pot, where the nutrient solution only contained what phosphoric acid it could dissolve in its passage over the calcium phosphate in the pot where nothing was growing, although this solution was continually renewed. The only factor determining the supply of phosphoric acid and the consequent difference in growth was the solvent action of the roots where they were actually in contact with the calcium phosphate, and this solvent action, as has already been shown, may most probably be attributed to the carbon dioxide excreted by the roots.

Following up their conclusions that the soil water possesses an approximately constant composition under all circumstances and always contains more of the constituents of plant food than would be required for the nutrition of the plant, Whitney and his colleagues have suggested another theory of fertilizer action. According to this point of view a soil falls off in fertility and ceases to yield normal crops, not because of any lack of plant food brought about by the continuous withdrawal of the original stock in the soil, but because of the accumulation of injurious substances excreted from the plant itself. These toxins are specific to each plant, but are gradually removed from the soil by processes of decay, so that if a proper rotation of crops be practised, to ensure that the same plant only recurs after an interval long enough to permit of the destruction of its particular self-formed toxin, its yield will be maintained without the intervention of fertilizers. The function of fertilizers is to precipitate or to put out of action these toxins, and various bodies such as lime, green manure and ferric hydrate are also effective in this direction; the same result of destruction of the toxins excreted by the plant may even be brought about by minute quantities of certain bodies like pyrogallol. According to this theory the function of fertilizers is to remove toxins rather than to feed the plant; they are only required when the same crop is grown continuously and the need for them may be obviated by a judicious rotation which permits of the destruction of the toxins by natural causes. Careful consideration will show that this theory can be made to fit a good many of the phenomena of plant nutrition; it would also explain the difficulties experienced in growing certain crops continuously on the same ground; it is, in fact, an elaborated revival of one of the earliest explanations of the value of rotations, originally suggested by de Candolle. Furthermore, Whitney's colleagues have succeeded in extracting certain substances from the soil—oxystearic acid, pyridin derivatives, tyrosin, etc., which when introduced into water cultures are toxic to seedling plants. The compounds isolated are, however, all of them products of the oxidation and decay of proteins, fats and other compounds contained in plant residues; there is no evidence to show that they are specific excretions from particular plants or that they are more abundant in soil impoverished by the growth of a particular crop than in soil which would be usually termed rich. Again, it has not been demonstrated that such substances, although harmful to young plants in water culture, are toxic under soil conditions; it is well known how exceedingly sensitive are plants in water culture, where growth, for example, is inhibited by traces of copper not to be detected by ordinary methods of analysis. A body like ammonia, itself a product of protein decay and present in the soil, is exceedingly toxic to water cultures, yet when applied to the soil it increases the growth of the plant. Turning to the fertilizer side of the theory, evidence is yet lacking to show that fertilizers in such dilute solutions as they form in the soil water can exert any precipitating or destructive action on such toxic substances as have been extracted from the soil; particularly it is the specific action of fertilizers which is difficult to explain. Why should substances so dissimilar as nitrate of soda and sulphate of ammonia exert the same sort of action on the same toxin? Why should phosphates cause all classes of plants to develop in one direction, or why should it be appropriate to the toxins of all plants on one particular type of soil, whereas potash answers on another soil type? Lastly, there is a lack of evidence for the fundamental thesis that the rotation will take the place of fertilizers and that the yield only falls off when a particular crop is grown continuously on the same land.

On the rotation field at Rothamsted the yield of wheat on the unfertilized plot has been remarkably maintained; for the last five courses (tenth to fourteenth of the whole series) it has averaged 26.2 bushels per acre, but it is below the yield of the fertilized plots on the Broadbalk field, which averaged 35.7, 32 and 39.7 bushels for the same years, and also below the fertilized plot on the same rotation field, which averaged for the same period 37.1 bushels per acre, although the fertilizer is only applied once in four years to the swedes, which are followed by barley and either clover or a bare fallow before the turn of the wheat comes round. But with other crops than wheat no such maintenance of yield is to be seen on the unfertilized plot of the rotation field—the barley yield has been reduced to 15.8 bushels against 27.7 on the fertilized plot, the clover yield to 940 pounds against 3,780 pounds on the fertilized plot, and the turnips to as little as 1,600 pounds against 40,000 pounds on the fertilized plot. Here we see that with the barley, clover, and particularly with the turnip crop, a rotation is quite unable to do the work of the fertilizer, the yield of turnips is reduced to a minimum on the impoverished soil, even though the crop only comes round once in four years and then grows so poorly that it can do little specific excretion to harm the succeeding crop. Many instances could be given of the incapacity of certain plants to grow in soil the fertility of which had been exhausted by other crops; for example, at Rothamsted in 1903 swede turnips were sown on Little Hoos field, which was known not to have been cropped with swedes or any kindred crop for more than forty years—and the average yield from thirty-two unmanured plots was only 9.3 tons per acre, although an exceptionally good start was made by the plant. In the following season barley was grown and the unmanured plots averaged 24.2 bushels per acre, a relatively much higher yield than the swedes had shown—yet barley had been repeatedly grown on the field in the years immediately before it was brought under experiment.

As it stands at present Whitney's theory must be regarded as lacking the necessary experimental foundation, no convincing evidence has been produced of the fundamental fact of the excretion of toxic substances from plants past the autotrophic seedling stage, nor is there direct proof of the initial supposition, that all soils give rise to soil solutions sufficiently rich in the elements of plant food to nourish a full crop did not some other factor come into play. If, however, we give the theory a wider form, and, instead of excretions from the plant, understand débris of any kind left behind by the plant and the results of bacterial action upon it, we may thereby obtain a clue to certain phenomena at present imperfectly understood. The value of a rotation of crops is undoubted and in the main is explicable by the opportunity it affords of cleaning the ground, the freedom from any accumulation of weeds, insect or fungoid pests associated with a particular crop, and to the successive tillage of different layers of the soil, but for many crops there remains a certain beneficial effect from a rotation beyond the factors enumerated.

The Rothamsted experiments have shown that wheat can be grown continuously upon the same land for more than fifty years and that the yield when proper fertilizers are applied remains as large in the later as in the earlier years of the series, any decline that is taking place is hardly outside the limits of seasonal variation and can easily be accounted for by the difficulties of tillage and the increase of one or two troublesome weeds. Mangolds again in the Rothamsted experiments show no falling off in yield, though they have now been grown upon the same land for thirty-two years, but with the barley crop, despite the application of fertilizers, there is a distinct secular decline in the yield. Again, it was found impossible to obtain satisfactory crops of swede turnips upon the same land for more than ten or twelve years in succession, and clover is well known to render the land "sick" for its own renewed growth for a period of from four to eight years on British soil. In this last case the persistence of the resting stages of the *sclerotinia* disease in the land may be the determining factor, but there are other crops, *e. g.,* flax, hemp and strawberries, which are considered by the practical cultivator to render the land more or less "sick," so that their growth can not profitably be renewed until an interval of some years has elapsed.

Again it is well known that when a plant is sown upon land which has not carried that particular crop for many years beforehand it starts into growth with a vigor it rarely displays upon land where it forms an item in the regular rotation, even though the new land is so impoverished that the final yield is indifferent. In the instance quoted above, where swedes were sown on Little Hoos field, Rothamsted, after a very long interval, although the yield was poor on the unmanured plots, yet the seeds germinated and made their early growth in a very remarkable fashion, incomparably better than did the same seed sown upon adjoining land in a high state of fertility, but which had been cropped with swedes from time to time previously. There is thus some positive evidence that most plants—some to a very slight degree, like wheat and mangolds, others markedly, like clover, turnips, and flax—effect some change in the soil which unfits it for the renewed growth of the crop. The injurious action may even arise from the growth of a different crop, as in the well-known experiments at the Woburn Fruit Farm, where Pickering has shown that the roots of grasses exert a positively injurious effect, distinct from competition for food, water or air, upon fruit trees growing in the same soil.

Assuming that the persistence in the soil of obscure diseases appropriate to the particular plant can be neglected as the cause of these phenomena, there still remains some unexplained factor arising from a plant's growth which is injurious to a succeeding crop, and this may either be the excreted toxins of Whitney's theory or may be some secondary effects due to the competition of injurious products of the bacteria and other microflora accumulating in the particular soil layer in which the roots of the crop chiefly reside.

Experimental evidence is as yet wanting as to these highly complex interactions between the higher plants and the microflora of the soil, but Russell and other observers have shown how greatly a disturbance of the normal equilibrium of the flora of the soil may affect its fertility, as measured by the yield of a higher plant. Partial sterilization, such as is brought about by heating the soil to 98° for ten hours, will double the yield of the succeeding crop and will show a perceptible beneficial effect up to the fourth crop after the heating, and exposure to the vapors of volatile antiseptics like toluene or carbon bisulphide, which are afterwards entirely removed by exposure, will increase the yield in a similar but smaller degree; even drying the soil appears to have an influence upon its fertility.

It is in this direction, perhaps, that the clue may be found to the unexplained benefits of the rotation of crops, and to some of the other facts difficult of explanation upon the ordinary theories of plant nutrition, which have been advanced by Whitney and his co-workers. The soil, however, is such a complex medium—the seat of so many and diverse interactions, chemical, physical and biological—and is so unsusceptible of synthetic reproduction from known materials, that experimental work of a crucial character becomes extremely difficult and above all requires to be interpreted with extreme caution and conservatism.

A. D. Hall
Rothamsted Experiment Station

THE DUBLIN MEETING OF THE BRITISH ASSOCIATION—II.

The Metabolism of the Plant Considered as a Catalytic Reaction[1]

After outlining the three fundamental principles of reaction-velocity, the law of

[1] Address by Professor F. F. Blackman, M.A., F.R.S., president of the botanical section, on "The Manifestations of the Principles of Chemical Mechanics in the Living Plant."

mass, and the catalytic acceleration of reaction velocity, Professor Blackman proceeded to consider the broad phenomena of metabolism or chemical change in the living organism from the point of view of these principles of chemical mechanics.

Plants of all grades of morphological complexity, from bacteria to dicotyledons, have this in common, that throughout their active life they are continually growing. Putting aside the *qualitative* distribution of growth that determines the morphological form, as a stratum of phenomena above the fundamental one that we are about to discuss, we find that this growth consists in the assimilation of dead food-constituents by the protoplasm, with a resulting increase in the living protoplasm accompanied by the continual new formation of dead constituents, gaseous CO_2, liquid water, solid cellulose, and what not. This continual flux of anabolism and katabolism is the essential character of metabolism, but withal the protoplasm increases in amount by the excess of anabolism over katabolism.

Protoplasm has essentially the same chemical composition everywhere, and in the whole range of green plants the same food materials seem to be required; the six elements of which proteids are built are obviously essential in quantity as building material, but in addition small amounts of Fe, Ca, K, Mg, Na, Cl and Si are in some other way equally essential. What part these secondary elements play is still largely a matter of hypothesis.

Regarding metabolism thus crudely as if it were merely a congeries of slow chemical reactions, let us see how far it conforms to the laws of chemical mechanics we have outlined.

If the supply of any one of these essential elements comes to an end, growth simply ceases and the plant remains stationary, half-developed. If a *Tropæolum* in a pot be watered with dilute salt-solution, its stomata soon close permanently, and no CO_2 can diffuse in to supply the carbon for further growth of the plant. In such a condition the plant may remain for weeks looking quite healthy, but its growth may be quite in abeyance.

In agricultural experience, in manuring the soil with nitrogen and the essential secondary elements, the same phenomenon is observed when there is a shortage of any single element. If a continuous though inadequate supply of some one element is available, then the crop development is limited to the amount of growth corresponding to this supply. Agriculturalists have formulated the "law of the minimum," which states that the crop developed is limited by the element which is minimal, *i. e.*, most in deficit. Development arrested by "nitrogen-hunger" is perhaps the commonest form of this. All this is, of course, in accordance with expectation on physical-chemical principles. The quantity of anabolic reaction taking place should be proportional to the amount of actively reacting substances present, and if any one essential substance is quite absent the whole reaction must cease. It therefore seems clouding a simple issue and misleading to say of a plant which, from the arrested development of nitrogen-hunger, starts growth again when newly supplied with nitrogen that this new growth is a response to a "*nitrogen stimulus.*" It would appear rather to be only the removal of a limiting condition.

Let us now move on a stage. Suppose a growing plant be liberally supplied with all the thirteen elements that it requires, what, then, will limit its rate of growth? Fairy bean-stalks that grow to the heavens in a night elude the modern investigator, though some hope soon to bring back that golden age with overhead electric wires and underground bacterial inoculations. If everything is supplied, the metabolism should now go on at its highest level, and quantities of carbon, nitrogen, hydrogen and oxygen supplied as CO_2, nitrates and water will interact so that these elements become converted into proteid, cellulose, etc. Now this complex reaction of metabolism only takes place in the presence of protoplasm, and a small amount of protoplasm is capable of carrying out a considerable amount of metabolic change, remaining itself undestroyed. We are thus led to formulate the idea that metabolism is essentially a catalytic process. In support of this we know that many of the inherent parts of the protoplasmic complex are catalytic enzymes, for these can be separated out of the protoplasm, often simply by high mechanical pressure. We know, too, nowadays that the same enzymes that accelerate katabolic processes also accelerate the reverse anabolic processes.

In time a small mass of protoplasm will, while remaining itself unchanged, convert many times its own weight of carbon from, let us say, the formaldehyde (HCHO) of photosynthesis to the carbon dioxide (CO_2) of respiration.

If metabolism is a complex of up-grade and down-grade changes catalyzed by protoplasm we must expect the amount of metabolism to obey the law of mass and to be proportional to the masses of substances entering into the reaction. The case when any one essential element is a limiting factor we have already considered. When all are in excess, then the *amount of the catalyst present* becomes in its turn the limiting factor. Transferring this point of view to the growing plant, we expect to find the limited mass of protoplasm and its constituent catalysts setting a limit to the rate of metabolic change in the extreme case where all the materials entering into the reaction are in excess. When once this supply is available further increase in supplies can not be expected to accelerate the rate of growth and metabolism beyond the limit set by the mass of protoplasm. This, of course, is in accordance with common experience. The clearest experimental evidence is in connection with respiration and the supply of carbohydrates—this, no doubt, because the carbohydrate material oxidized in respiration is normally stored inside plant-cells in quantity and can be estimated. When the supplies for an internal process have to be obtained from outside, then we have the complications of absorption and translocation to obscure the issue, especially in the case of a higher plant.

Let us first take a case where the carbohydrate supply is in excess and the amount of catalytic protoplasm is small and increasing. Thus it is in seeds germinating in the dark: respiration increases day by day for a time, though carbohydrate reserves are steadily decreasing. Palladine[2] has investigated germinating wheat by analyzing the seedlings and determining the increase of the essential (non-digestible) proteids day by day. The amount of these proteids he regards as a measure of the amount of actual protoplasm present. Assuming this to be so, he finds an approximately constant ratio between the amount of protoplasm at any stage and the respiration.

As germination progresses in the dark the supplies of reserve carbohydrate presently fail, and then the respiration no longer increases in spite of the abundant protoplasm. According to our thesis the catalyst is now in excess and the CO_2 production is limited by the shortage of respirable material.

This second type was more completely investigated by Miss Matthæi and myself in working on the respiration of cut leaves of cherry-laurel kept starved in

[2] *Revue gén. de botanique*, Tome VIII., 1896.

the dark. For a time the CO_2 production of these non-growing structures remains uniform, and then it begins to fall off in a logarithmic curve. We interpret both phenomena in the same way: in the initial level phase the respirable material in the leaf is in excess, and the amount of catalytic protoplasm limits the respiration to the normal biological level; in the second falling phase some supply of material is being exhausted, and we get a logarithmic curve controlled by the law of mass, as much, it would seem, as when cane-sugar is hydrolyzed in aqueous solution.

After these two illustrations of the action of the law of mass from the more simple case of respiration we return to the consideration of the totality of metabolic reactions as exemplified in growth.

What should we expect to be the ideal course of growth, that is, the increase of the mass of the plant regarded as a complex of reactions catalyzed by protoplasm? Let us consider, first, the simplest possible case, that of a bacterium growing normally in a rich culture solution. When its mass has increased by anabolism of the food material of the culture medium to a certain amount, it divides into two. As all the individuals are alike; counting them would take the place of weighing their mass. The simplest expectation would be that, under uniform conditions, growth and division would succeed each other with monotonous regularity, and so the number or mass of bacteria present would double itself every n minutes. This may be accepted as the ideal condition.

The following actual experiment may be quoted to show that for a time the ideal rate of growth is maintained, and that at the end of every n minutes there is a doubled amount of protoplasm capable of catalyzing a doubled amount of chemical change and carrying on a doubled growth and development.

From a culture of *Bacillus typhosus* in broth at 37° C. five small samples were withdrawn at intervals of an hour, and the number of bacteria per unit volume determined by the usual procedure. The number of organisms per drop increased in the following series: 6.7, 14.4, 33.1, 70.1, 161.0.[3] This shows a doubling of the mass of bacteria in every fifty-four minutes and actually represents a strictly logarithmic curve.

We may quote some observations made by E. Buchner[4] of the rate at which bacteria increase in culture media. Bacillus coli communis was grown at 37° C. for two to five hours, and by comparison of the initial and final numbers of bacteria the time required for doubling the mass was calculated. Out of twenty-seven similar experiments a few were erratic, but in twenty cases the time for doubling was between 19.4 and 24.8 minutes, giving a mean of 22 minutes. This produces an increase from 170 to 288,000 in four hours. No possible culture medium will provide for prolonged multiplication of bacteria at these rates.

Cohn[5] states that if division takes place every sixteen minutes, then in twenty-four hours a single bacterium 1 μ long will be represented by a multitude so large that it requires twenty-eight figures to express it, and placed end to end they would stretch so far that a ray of light to travel from one end to the other would take 100,000 years. The potentialities of protoplasmic catalysis are thus made clear, but the actualities are speedily cut short by limiting factors.

[3] For this unpublished experiment on bacterial growth I am indebted to Miss Lane-Claypon, of the Lister Institute of Preventive Medicine.

[4] Buchner, *Zuwachsgrossen u. Wachsthumsgeschwindigkeiten*, Leipzig, 1901.

[5] Cohn, *Die Pflanze*, Breslau, 1882, p. 438.

For a while, however, this ideal rate of growth is maintained. At the end of every n minutes there is a doubled amount of protoplasm present, and this will be capable of catalyzing twice the amount of chemical change and carrying on a doubled amount of growth and development. This is what common sense and the law of mass alike indicate, and is exactly what the logarithmic curve expresses.

This increase of the amount of catalytic protoplasm by its own catalytic activity is an interesting phenomenon. In Section K we call it growth, attribute it to a specific power of protoplasm for assimilation (in the strict sense), and leave it alone as a fundamental phenomenon, but are much concerned as to the distribution of the new growth in innumerable specifically distinct forms. In the chemical section they call this class of phenomenon "autocatalysis," and a number of cases of it are known. In these a chemical reaction gives rise to some substance which happens to catalyze the particular reaction itself, so that it goes on and on with ever-increasing velocity. Thus, we said that free acid was a catalyst to the hydrolysis of cane-sugar; suppose now that free acid were one of the products of the hydrolysis of sugar, then the catalyst would continually increase in amount in the test-tube, and the reaction would go faster and faster. Under certain conditions this actually happens. Again, when methyl acetate is hydrolyzed we normally get methyl alcohol and free acetic acid. This free acid acts as a catalyst to the hydrolysis, and the rate of change continually accelerates. Here, if the supply of methyl acetate were kept up by constant additions, the reaction would go faster and faster with a logarithmic acceleration.

For a clear manifestation of this autocatalytic increase in the plant it is, of course, essential that the supply of food materials to the protoplasm be adequate.

ACCELERATION OF REACTION-VELOCITY BY TEMPERATURE

We now turn to consider the fourth and last of the principles of chemical mechanics which we might expect to find manifested in metabolism.

It is a universal rule that rise of temperature quickens the rate at which a chemical reaction proceeds. Of course in some rare conditions this may not be obvious, but be obscured by superposed secondary causes; but almost always this effect is very clearly marked.

Further, the nature of the acceleration is a peculiar one. Rise of temperature affects nearly all physical and chemical properties, but none of these is so greatly affected by temperature as is the velocity of chemical reaction. For a rise of 10° C. the rate of a reaction is generally increased two or three fold, and this has been generalized into a rule by van't Hoff. As this increase is repeated for each successive rise of 10° C. either by the same factor or a somewhat smaller one, the acceleration of reaction-velocity by temperature is logarithmic in nature, and the curve representing it rises ever more and more steeply. Thus keeping within the vital range of temperature a reaction with a temperature factor of $\times 2$ per 10° C. will go sixteen times as fast at 40° C. as at 0° C., while one with a factor of $\times 3$ will go eighty-one times as fast.

This general law of the acceleration of reactions by temperature holds equally for reactions which are being accelerated by the presence of catalysts. As we regard the catalyst as merely providing for the particular reaction it catalyzes, a quick way round to the final stage by passing through the intermediate stage of forming a temporary addition-compound with the catalyst itself, so we should expect rise of temperature to accelerate similarly these substituted chemical reactions.

If this acceleration is a fundamental

principle of chemical mechanics it is quite impossible to see how vital chemistry can fail to exhibit it also.

ACCELERATION OF VITAL PROCESSES BY TEMPERATURE

At present we have but a small number of available data among plants to consider critically from this point of view. But all the serious data with which I am acquainted, which deal with vital processes that are to be considered as part of the protoplasmic catalytic congeries, do exhibit this acceleration of reaction-velocity by temperature as a primary effect.[6]

Let us briefly consider these data. On the katabolic side of metabolism we have the respiratory production of CO_2, and opposed to it on the anabolic side the intake of carbon in assimilation.

As a measure of the rate of the metabolic processes constituting growth we have data upon the division of flagellates; and finally there is the obscure process of circulation of protoplasm.

The intensity of CO_2 production is often held to be a measure of the general intensity of metabolism, but any relation between growth-rate and respiration has yet to be clearly established. Our science is not yet in the stage when quantitative work in relation to conditions is at all abundant; we are but just emerging from the stage that chemistry was in before the dawn of physical chemistry.

Taken by itself the CO_2-production of an ordinary green plant shows a very close relation with temperature. In the case of the cherry-laurel worked out by Miss Matthæi and myself the respiration of cut leaves rises by a factor of 2.1 for every 10° C. This has been investigated over the range of temperatures from 16° C. to 45° C. At this higher temperature the leaves can only survive ten hours in the dark, and their respiration is affected in quite a short time, but in the initial phases the CO_2 output has the value of .0210 gr. per hour and unit weight of leaf, while at 16°.2 C. the amount is only .0025 gr. CO_2. Thus the respiration increases over a range of tenfold with perfect regularity solely by increase of temperature. No reaction in a test-tube could show less autonomy. At temperatures above 45° C. the temperature still sooner proves fatal unless the leaf is illuminated so as to carry out a certain amount of photosynthesis and compensate for the loss of carbon in respiration. Thus, with rising temperature, there is at no time any sign of an optimum or of a decrease of the intensity of the *initial* stage of respiration.

Here, then, on the katabolic side of metabolism we have no grounds for assuming that "temperature-stimuli" are at work regulating the intensity of protoplasmic respiration, but we find what I can only regard as a purely physical-chemical effect. The numbers obtained by Clausen[7] for the respiration of seedlings and buds at different temperatures indicate a temperature coefficient of about 2.5 for a rise of 10° C.

To this final process of katabolism there could be no greater contrast than the first step of anabolism, the assimilation of carbon by the protoplasm as a result of photosynthesis. We must, therefore, next inquire what is the relation of this process to temperature.

This question is not so simple, as leaves can not satisfactorily maintain the high rate of assimilation that high temperatures allow. The facts of the case were clearly

[6] A collection of twenty cases, mostly from animal physiology, by Kanitz (*Zeits. für Elektrochemie*, 1907, p. 707), exhibits coefficients ranging from 1.7 to 3.3.

[7] *Landwirtschaftliche Jahrbücher*, Bd. XIX., 1890.

worked out by Miss Matthæi,[8] the rate of assimilation by cherry-laurel leaves being measured from — 6° C. to + 42° C. Up to 37° C. the curve rose at first gently and then more and more steeply, but on calculating out the values it is found that the acceleration for successive rises of 10° C. becomes less and less. Between 9° C. and 19° C. the increase is 2.1 times, the highest coefficient measured, and exactly the same coefficient as for respiration in this plant, which in itself is a striking point, seeing how different the processes are. The decrease of the coefficient with successive rises is a state of things which is quite general among non-vital reactions. A critical consideration of the matter leads one to the conclusion, however, that this failure to keep up the temperature acceleration is really due to secondary causes, as is also the appearance of an optimum at about 38° C. Some of these causes have been discussed by me elsewhere,[9] and I hope to bring a new aspect of the matter before the section in a separate communication. The conclusion formerly come to was that probably in its initial stages assimilation at these very high temperatures started at the full value indicated by a theoretically constant coefficient, but that the protoplasm was unable to keep up the velocity, and the rate declined. It must be borne in mind here that quite probably no chloroplast since the first appearance of green cells upon the earth had ever been called upon for anything like such a gastronomic effort as these cherry-laurel leaves in question. It is not to be wondered that their capacities speedily declined at such a banquet, and that the velocity-reaction of anabolic synthesis traces a falling curve in spite of the keeping up of all the factors concerned, to wit, temperature, illumination and supply of CO_2. This decline is not permanent, but after a period of darkening the power of assimilation returns. Physical-chemical parallels can easily be found among cases where the accumulation of the products of a reaction delays the apparent velocity of the reaction, but this complicated case may be left for further research.

In relation to assimilation, then, we must say that owing to secondary causes the case is not so clear over the whole range of temperature as that of respiration, but that at medium temperatures we have exactly the same relation between reaction-velocity and temperature.

We may consider now some data upon the combined net result of anabolic and katabolic processes. Such total effects are seen in their clearest form among unicellular saprophytic organisms for which we have a few data. Mlle. Maltaux and Professor Massart[10] have published a very interesting study of the rate of division of the colorless flagellate *Chilomonas paramœcium* and of the agents which they say stimulate its cell-division, in particular alcohol and heat.

They observed under the microscope the time that the actual process of division into two took at different temperatures. From 29 minutes at 15° C. the time diminished to 12 minutes at 25° C., and further to 5 minutes at 35° C. The velocities of the procedure at the three temperatures 10° C. apart will therefore be in the ratio of 1 : 2.4 : 5.76, which gives a factor of 2.4 for each rise of 10° C.

Now we are told by the investigators that at 35° C. Chilomonas is on the point of succumbing to the heat, so that the division rate increases right up to the death point, with no sign of an optimum effect.

[8] *Phil. Trans. Roy. Soc.*, Ser. B, Vol. CXCVII., 1904.

[9] "Optima and Limiting Factors," *Annals of Botany*, Vol. XIX., April, 1905.

[10] Maltaux and Massart, *Recueil de l'Institut botanique Bruxelles*, Tome VI., 1906.

Below 14° C. no observations are recorded.

Here, then, we have throughout the whole range exactly the same primary temperature relation exhibited by the protoplasmic procedure that we should expect for a chemical reaction in a test-tube.

This division phase is only a part of the life-cycle of the flagellate, and between division it swims about anabolizing the food material of the medium and growing to its full size ready for the next division. One wishes at once to know what is the effect of the temperature upon the length of the life-cycle. Is the whole rate of metabolism quickened in the same way as the particular section concerned with actual division? Of course a mobile flagellate can not be followed and its life-cycle directly timed, but the information was obtained by estimating carefully what percentage of individuals were in a state of actual division at each temperature. It was found that always 4 per cent. were dividing, whatever the temperature. This proves that the whole life-cycle is shortened in exactly the same proportion as the process of division at each temperature, and that it is just twenty-five times as long. Therefore, the life-cycle is 125 mins. at 35° C. and 725 mins. at 15° C., so that here, again, we have the physical-chemical relation with a factor of 2.4 for each rise of 10° C.

In this paper of Maltaux and Massart these relations are not considered as the manifestation of physical-chemical principles, but are regarded as reactions to stimuli; and the paper contains a number of experiments upon the effect of sudden changes of temperature upon the occurrence of division. As far as one can make out from inspection of the scattered literature, it does seem established that sudden changes of temperature act as stimuli in the strict sense of the word. In many investigations one finds it stated that a quick change of temperature produced a certain reaction which a slow change of temperature failed to evoke. Usually all the phenomena are treated in terms of stimulation, and the absence of reaction with slow change of temperature is regarded as secondary. Were it not for the specific stimulatory effects of quick change, which are not difficult to comprehend as a phenomenon *sui generis*, I hardly think so general a tacit acquiescence would have been extended by botanists to the view that all enduring changes of velocity of metabolism brought about by lasting changes of temperature are stimulatory in nature.

No determination of the rate of development of bacteria through a very wide range of temperature seems to have been made. There are various incidental experiments which indicate values about 2 for the coefficient of increase of metabolism for a rise of 10° C.

CONCLUSION

In this attempt to assert the inevitableness of the action of physical-chemical principles in the cell, I have not ventured upon even the rudiments of mathematical form, which would be required for a more precise inquiry. Bio-chemistry is indeed becoming added to the ever-increasing number of branches of knowledge of which Lord Bacon wrote:

> Many parts of nature can neither be invented with sufficient subtility, nor demonstrated with sufficient perspicuity, nor accommodated unto use with sufficient dexterity, without the aid and intervening of the mathematics.

To me it seems impossible to avoid regarding the fundamental processes of anabolism, katabolism, and growth as slow chemical reactions catalytically accelerated by protoplasm and inevitably accelerated by temperature. This soon follows if we once admit that the atoms and molecules concerned possess the same essential properties during their brief sojourn in the living nexus as they do before and after.

In his address to the geological section, Professor John Joly, F.R.S., dealt with the effects of the presence of radium in the earth's crust and rocks on the distribution of the temperature gradients. By exhaustive determinations of the radium contents of various rocks and oceanic sediments, as well as by a systematic examination of the rocks of the Simplon and Central St. Gothard tunnels he found the change in temperature gradient observed to correspond exactly with the radium content of the rock. Space will not permit a proper abstract of this interesting address.

Leo Frank Guttman

THE OFFICIAL INSPECTION OF COMMODITIES

The adulteration of articles of commerce is distinctly an evil of civilization. In the primitive state of man, nature supplied directly to the consumer the materials for food and raiment. There was no commerce and, therefore, none of the attending frauds. The savage vented his evil nature in murder, rapine and other of the grosser forms of crime, but he had no opportunity to practise the more intellectual frauds which civilization has made possible.

As soon as commerce came into existence, merchants began to cheat in weight and measure and to practise other commercial frauds, but at first they had comparatively few opportunities for adulteration, as the articles exchanged were for the most part crude products, such as grain and wool, which could not be successfully imitated. It was at a later period, when flour, cloth and other adulterable articles were bought and sold, that sophistication began to be a serious menace to the public welfare, and the evil, having once gained a foothold, increased as civilization advanced.

In recent times adulteration has increased enormously, particularly during the past half century.

There are several reasons for this alarming growth of fraud. In the first place, the number of commercial articles which can be successfully imitated greatly increased during the past century and is still increasing. We have to-day on the market an endless variety of foods, drugs, paints, oils, chemicals and fabrics which can be readily debased by the addition of foreign materials, without having the fraud evident to the purchaser.

The second reason is that the manufacture of butter, lard, cheese, starch, yarn, cloth and other articles, which formerly was carried on in the household, has been transferred to the mill and the factory. It can not be disputed that the cost of production has been reduced by this centralization of labor, and the housewife, incidentally, has been saved a deal of hard work, but the genuineness of the products has suffered as a consequence.

Still another cause for the increase of sophistication in recent years is to be found in the variety of materials adapted for use as adulterants which are now obtainable. Some of the materials which are commonly used for fraudulent purposes are products of the highest scientific research. I will mention as examples—oleo oil, cotton-seed oil, stearine and petroleum products, used for mixing with higher-priced fats and oils; glucose syrup, the common adulterant for molasses; artificial vanillin and coumarin, used in vanilla extracts; salicylic acid, benzoic acid and other food preservatives; coal-tar dyes, which serve as a mask for other food adulterants; wood alcohol, acetanilid and other coal-tar products, also morphine, cocaine and other habit-forming drugs, used in illegal medicinal preparations; artificial silk, often substituted for true silk, and so on. These products properly used are of great benefit to mankind, but altogether too often they have been parties to frauds and have thereby gained bad repute.

The extent to which adulteration is practised to-day is certainly cause for alarm, although too often the matter is overlooked or considered only from the humorous standpoint. The man who milks the cow with the iron tail, like the boy who steals watermelons, is looked upon as having perpetrated a good joke on the community, when in reality he is committing a criminal offense. All those who manufacture or knowingly sell adulterated products should be regarded as a menace to the welfare of the community, whether or not they are so declared by the laws of the land in which they live. If the article is merely fraudulent and causes no injury to health, the offender belongs in the same class with those who cheat in weight and measure and with common thieves; if, however, it is a menace to the safety or health of the community, he is several degrees lower in the moral scale.

The evil is not one which corrects itself, but, like other crimes, calls for vigilance on the part of both the individual and the state. The consumer should learn to distinguish, as far as possible, the pure from the false, and the state should enact and properly enforce laws for the further protection of the consumer. The necessity of legislative measures has been generally recognized and, as a consequence, inspection laws have been enacted in nearly every civilized country.

In the United States the inspection of milk, in a primitive way, was carried on in some of the large cities as early as the middle of the last century, and perhaps earlier; but it was not until a generation later that milk inspection was placed on a sound chemical basis, and not until still more recently that it has been carried out with the cooperation of the bacteriologist.

The first really extensive movement to prevent adulteration by official inspection and analytical control was the agitation among agriculturists which led to the establishment of experiment stations and the enactment of state fertilizer laws. On this occasion it is of special interest to recall that the first experiment station was established in Connecticut in 1875, largely through the efforts of Professor S. W. Johnson, of the Sheffield Scientific School of Yale University; and after two years' probationary existence at Wesleyan University, was permanently located in New Haven.

Following the example of Connecticut, other states, one by one, established experiment stations and enacted suitable fertilizer laws, until the movement had extended to all the states using commercial fertilizers in considerable quantities.

The official inspection work of the states for some years after the establishment of experiment stations was largely confined to plant foods, disregarding foods for man and the lower animals. It is hard to find an adequate explanation for this early solicitude for the rights of the vegetable kingdom, and the years of almost complete neglect of the dietary grievances of man and beast. Certain it is that the adulteration of foods for animate beings was quite as general as that of fertilizers, and the welfare of the community suffered to a much more alarming extent thereby; however, it is gratifying to note that this inconsistency in the laws has been remedied by more recent measures.

Massachusetts in 1883 and Ohio in 1886 enacted comprehensive food and drug laws.

and, one by one, other states have fallen in line as "Pure Food States." Most of the food laws first enacted affected only dairy products, and their passage was secured chiefly through the efforts of dairymen to protect their interests; later, these laws were amended, or new laws were enacted, so as to include all articles of food and drink, and with the special view of protecting the consumer as well as the honest producer.

The enforcement of food laws, in most states, devolves on a Food Commission, but in a number of states it is in the hands of the Experiment Station or the Board of Health.

The passage of the National Food and Drugs Act in 1906 marked an important era in legislative measures for the protection of the public against fraudulent foods, beverages and medicinal preparations. This law not only renders more effective the state laws by checking the interstate shipment of fraudulent products, but also is proving a stimulus to the enactment of the laws in states previously without food inspection, and an important influence in bringing about uniformity in state laws.

In certain states the inspection of commodities has been carried a step farther. For example, the Maine Experiment Station inspects field and garden seeds with reference to their purity and vitality, and the stations in several other states exercise a semi-official control over the insecticides and fungicides on the market. In North Dakota a paint law is doing much to prevent such gross frauds as the substitution of fish oil and mineral oils for linseed oil, of whiting, barites and other cheap mineral powders for white lead and zinc white, etc. Ever since the discovery of petroleum, efforts have been made to protect the public from illuminating and fuel oils with low flash points and to-day more or less effective laws providing for the inspection of these products are in force in most of the states. Laws against substituting inferior alloys for standard alloys of gold and silver have also been enacted in some states, although, so far as I know, no official inspection of precious metals is in force.

From the foregoing brief statement of the growth of inspection in this country, it is apparent that the sentiment in its favor is wide-spread and the classes of commodities concerned are on the increase. Under the conditions of trade that now prevail inspection is almost a necessity and there appears to be good reason for making the official control of the commodities already named universal throughout the country and extending the system so as to cover still other commodities.

If petroleum is inspected, why not coal; if paints and oils, why not lime and cement; if foods, why not raiment?

The fact that all coal sold for the same grade is not of equal value is well known to those chemists who have studied coal analyses, and also to consumers who have observed the occurrence of slate in the coal itself and clinkers in the ashes. The government inspects and analyzes the coal it buys and it seems not unreasonable that the consumer should also be protected. Such an inspection of coal, if feasible, would be a matter of public economy, not, as in the case of illuminating oils, of public safety.

Building frauds concern both the safety and the pecuniary welfare of the community. It frequently happens that the cupidity or ignorance of the builder leads him to use poor lime and cement, or mix an undue amount of sand with his mortar, thus weakening his structures and imperiling life. The rigid inspection of buildings in the cities does much to protect the public from these dangers, but this inspection is local and seldom as comprehensive as could be desired. The analytical control of certain building materials may not be impracticable.

The last class of commodities which we will consider is one which, next to foods and drugs, is perhaps most in need of inspection. I refer to textiles and other materials for wearing apparel.

The frauds in woolens have been notorious. Sixty years ago when my father started in business as a country merchant, he learned the value of the match test for cotton, and throughout his life whenever purchasing woolens for personal use he never failed to draw out threads and apply this test, often to the chagrin of the seller. Twenty years ago in this very city I purchased a suit of clothes of splendid appearance at a price which was almost, if not quite, beyond my means. In a few weeks the so-called "all wool" material of the suit showed the characteristic faded appearance of cotton, and was hardly fit for the garb of even a struggling chemist. During the past year one of my friends made a similar purchase in the heart of the shopping district of Chicago. At his request I examined the goods and reported that the warp was all cotton and the woof a mixture of cotton and shoddy. Needless to say there was no redress for this gross imposition.

Frauds in other textiles are not uncommon. So-called linen often contains cotton, hemp and tow; "all silk" often has a cotton back, and much that appears like silk is so-called artificial silk or even mercerized cotton.

There are also glaring frauds in shoes, gloves and other leather goods, felts and furs. Split leather is sold for calf skin, lamb and other inferior leather for kid, wool felt for fur felt, imitation furs for the genuine, and so on.

The more the subject is investigated, the more wide-spread and ingenious appear to be the frauds practised.

Opponents of paternalism will doubtless find cause for alarm in the mere suggestion of the further extension of inspection. They will feel that the rights of the merchant class are threatened and that the dangers from indiscreet and corrupt officials are greater than those from adulteration.

It can not be denied that there are difficulties in the way, and great care should be exercised in framing new laws, but if the present inspection of commodities is, on the whole, an advantage to the public, it seems but logical to extend the system so as to cover other necessities of life liable to adulteration. The inspection should be primarily in the interest of the consumer.

The manufacturer and dealer can usually take care of themselves, as their knowledge of the trade enables them to buy wisely, and in case of doubt submit samples to the chemist for analysis. For years sugar refiners, packing houses, iron and steel works, fertilizer manufacturers, cement works and other manufacturing industries have maintained laboratories for the examination of their raw material, and have proved themselves quite able to look after their own interests.

With the consumer the case is different. He is usually ignorant of trade practises and of the steps necessary to secure chemical evidence of adulteration and redress in the courts. Even if he can afford to seek the advice of the chemist and the lawyer, he is at a disadvantage in fighting large houses with their array of professional advisers. He needs the protection of a system of legal inspection which follows up and punishes a fraud in a five-cent purchase with as much care as a thousand-dollar swindle.

Incidentally, the honest producer is the gainer by inspection, as the prevention of dishonest competition is distinctly to his advantage. In the past reputable business houses have been among the first to favor adulteration laws, and it is not improbable that they would welcome further measures. It should be remembered, however, that the trade is ever jealous of its rights and is quick to resent any unnecessary interference.

The chemist has been an important factor in inspection, as on him has devolved the important task of securing evidence as to the character or purity of products and presenting this evidence either in official reports or by testimony in court.

The Association of Official Agricultural Chemists, since its inception, has been preeminently a body of inspection chemists and doubtless would never have existed had it not been for laws affecting the sale of fertilizers and foods. The same may be said of the Section of Agricultural and Food Chemistry of this Association. Of the 28 papers to be read at this meeting before the section, at least 19 relate directly or indirectly to inspection, and a great majority of the listeners will doubtless be inspection chemists.

The extension of inspection is continually opening up new and fascinating realms of investigation, and it will be a long time before the analyst need cry for new worlds to conquer.

A. L. Winton

Chicago Laboratory of
Bureau of Chemistry,
U. S. Department of Agriculture

THE AMERICAN SOCIOLOGICAL SOCIETY

The third annual meeting of the American Sociological Society will be held at Atlantic City, N. J., from December 28 to 31, inclusive, in conjunction with the annual meetings of the American Economic Association, the American Statistical Association and the American Association for Labor Legislation.

The Sociological Society will hold seven sessions, one of which will be a joint meeting with the Economic Association and another of which will be a joint meeting with the American Statistical Association. All seven sessions, however, will be devoted to a discussion of some aspect of the general topic "The Family in Modern Society." This general topic has been divided as follows:

1. Relation of the family to social change. (President's address.)
2. How do home conditions react upon the family?
3. Are modern industry and city life unfavorable to the family?
4. How does the woman movement react upon the family?
5. Has the freer granting of divorce proved an evil?
6. How far should the state go in individualizing the members of the family?
7. How far should family property be conserved and encouraged?

Detailed programs can be had by applying to the Secretary, Professor C. W. A. Veditz, George Washington University, Washington, D. C.

THE "UNIVERSITY TABLE" AT THE NAPLES ZOOLOGICAL STATION

For a number of years in the past a table was maintained at the Naples laboratory under the above title, half the cost being met by the late William E. Dodge in the name of Columbia University, and half by contributions from other sources. Owing to lack of regular support the subscription for this table unfortunately lapsed for several years. Friends of the university have now made it possible to renew the subscription, and it is hoped that the table may now be permanently maintained under the name of the "Columbia Table." Its use is open to all qualified Americans and applications may be sent to Professor E. B. Wilson, Columbia University, New York City.

SCIENTIFIC NOTES AND NEWS

The Nichols Medal of the American Chemical Society has been awarded to Professor William A. Noyes, of the University of

Illinois, and Dr. H. C. P. Weber, for their researches on the atomic weight of chlorine. The medals will be awarded at a meeting of the Chemists' Club, New York City, on the evening of November 26, when Dr. Noyes will give a very brief résumé of the work on chlorine, and Dr. Weber will announce further results on work which has been done along the same line on the atomic weight of bromine.

The Bisset Hawkins medal, of the Royal College of Physicians, of London, awarded triennially to a British medical man who had distinguished himself in sanitary science and the promotion of public health, has been presented to Sir Shirley Murphy, medical officer to the London County Council, in recognition of his services to the public and to preventive medicine.

At the annual meeting of the American Mathematical Society, to be held in the last week of December, President H. S. White will deliver his retiring address, the subject of which will be "Bezout's theory of resultants and its influence on geometry."

In the vote for the Lord Rectorship of Edinburgh University, Mr. George Wyndham received 826 votes, Mr. Winston Churchill 727 votes and Dr. William Osler 614 votes.

Professor Bashford Dean will represent Columbia University at the inauguration of the monument to Lamarck, in Paris, on November 19.

Professor Charles R. Barnes and Dr. W. J. G. Land, of the University of Chicago, are spending four months (September–December) in tropical Mexico, primarily to investigate the Bryophytes, and incidentally to secure other research material for the department of botany.

The Geological Survey has issued a report on the prevention of mine explosions, submitted by three foreign experts, Victor Watteyne, inspector-general of mines, Belgium; Carl Meissner, councilor for mines, Germany, and Arthur Desborough, H. M. inspector of explosives, England. These engineers have been in the United States for six weeks, coming at the invitation of the government to assist the federal authorities in beginning the investigations authorized at the last session of congress.

Mr. Henry Leighton, instructor in geology, Cornell University, has resigned to take a position as assistant in economic geology in the New York State Museum, Albany.

Mr. V. Bleininger, of Champaign, Ill., has been appointed ceramic chemist of a new section of the U. S. Geological Survey devoted to clays and clay products.

Professor John M. Macfarlane, of the University of Pennsylvania, is chairman of a committee of the Bartram Association, which will plant a tree annually in Bartram's Gardens, either at the June or October meeting of the association. At a meeting of the society held on Saturday, October 24, Henry R. Edmunds, president of the board of education, was elected president.

Mr. H. L. Telegdi is at present visiting this country in the interests of the agricultural department of the Hungarian government.

G. Suto, professor of veterinary science in the Agricultural College at Tokyo, has passed through the United States on his way home, after a visit to Germany.

D. Shono and Professor Gamoh, of Tokyo, are in this country, having been appointed by the emperor of Japan to investigate industrial conditions in America, particularly in connection with industrial education in our secondary schools and colleges.

Dr. Joseph S. Chamberlain, chief of the cattle food and grain investigation laboratory of the Bureau of Chemistry, U. S. Department of Agriculture, has been granted leave of absence for a year's study abroad. He expects to work under Professors Fischer and Abderhalden at the University of Berlin.

Dr. Nicolas Achúcarro, physician to the General Hospital at Madrid, Spain, has been appointed and has taken up his duties as histopathologist at the Government Hospital for the Insane, Washington, D. C. Dr. Achúcarro was granted a year's leave of absence by the Spanish government for this purpose.

Captain C. C. Carter, U. S. M. A., 1899, has been detailed by the War Department to spend the current year at the Massachusetts Institute of Technology studying electrical engineering. Captain Carter is attached to the Coast Artillery Corps, and for the past few years has been an instructor in the Fortress Monroe Artillery School and the Fort Totten School of Submarine Defence.

The inaugural lecture of Professor Albrecht Penck, of the University of Berlin, as Kaiser Wilhelm professor at Columbia University, was given on November 4, the subject being "The Face of the Earth."

Professor William James will repeat the series of eight lectures, which he gave recently at Oxford University, in Emerson Hall. The course is entitled "The Present Situation in Philosophy."

At the Dublin meeting of the British Association for the Advancement of Science, September 2–9, Professor A. Lawrence Rotch discussed, before the Physical Section, the warm stratum in the upper air. At the jubilee meeting of the German Meteorological Society, which was held at Hamburg, September 28–30, Professor Rotch read a paper entitled "Die warme Schicht der Atmosphäre oberhalb 12 Km. in Amerika."

The lectures on certain fundamental problems in physiology common to animals and plants to be given by Dr. W. M. Bayliss, F.R.S., at University College, London, will be devoted to the permeability of cells and membranes and the phenomena connected therewith, such as plasmolysis, secretion, nature of the nerve impulse, etc. The lectures, which began on October 21, are given on Wednesdays at 5 P.M.

Dean Leonard Pearson, of the veterinary medical department of the University of Pennsylvania, delivered an address at the milk and dairy exhibit in the Chamber of Commerce at Pittsburg, Pa., under the auspices of the United States Department of Agriculture on October 22.

The three hundredth anniversary of the election of Francis Bacon as treasurer of Gray's Inn, which took place on October 17, 1608, was celebrated October 17 by a luncheon at the inn, at which the benchers entertained a number of distinguished guests. It is the intention of members of the inn to observe the first night of term (November 2) as a Bacon anniversary, and, at a later date, a permanent memorial will be placed in one of the open spaces of the inn—probably south-square. This memorial will consist of a marble statue of Bacon by Mr. F. W. Pomeroy, A.R.A. A sketch model of it was on view October 17, as well as a collection of Baconian manuscripts and printed books.

A bronze tablet to the memory of the late Major James Carroll will be unveiled in the main medical building of the University of Maryland, on November 11. Dr. William H. Welch will deliver the principal address.

F. A. C. Perrine, A.B. (Princeton '83) and D.Sc. ('85), from 1893 to 1900 professor of electrical engineering at Stanford University, and since then a consulting engineer, died at Plainfield, N. J., on October 20, aged forty-six years.

Professor Berger, the eminent French surgeon, who was seized with an attack of apoplexy while about to perform an operation at the Neckar Hospital, on October 10, died without recovering consciousness. He was born in 1845.

There will be a civil service examination on November 16 and 17 for the position of assistant (male) in the U. S. Naval Observatory at a salary of $1,000.

The National Association of State Universities will meet in Washington, D. C., on November 16 and 17.

The eighth annual meeting of the American Philosophical Association will be held at Baltimore, on Tuesday, Wednesday and Thursday, December 29, 30 and 31, 1908.

The second regular meeting of the southwestern section of the American Mathematical Society will be held at the University of Kansas, Lawrence, Kansas, on Saturday, November 28.

The twenty-sixth stated meeting of the American Ornithologists' Union will be held in Cambridge, Mass., beginning on the evening of November 16, at 8 o'clock. The evening session will be for the election of officers and members, and for the transaction of other routine business. The meetings, open to the public and devoted to the presentation and discussion of scientific papers, will be held at the University Museum, Oxford Street, commencing on Tuesday, November 17, and continuing for three days. Information regarding the meeting can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

The Salters' Company, London, has voted £100 a year for a period of three years to the cancer research laboratories of the Middlesex Hospital as a research scholarship.

Lieutenant-Colonel Burland, of Montreal, has given $50,000 to the Montreal League for the Prevention and Treatment of Tuberculosis. In the heart of Montreal, Colonel Burland has presented a building for dispensary purposes and the gift of $50,000 is on the condition that the league raises an endowment of a similar amount.

A Royal Commission has been appointed in Great Britain to make an inventory of the ancient and historical monuments and constructions connected with or illustrative of the contemporary culture, civilization and conditions of life of the people in England from the earliest times to the year 1700, and to specify those which seem most worthy of preservation. The commission is constituted as follows: Lord Burghclere (chairman); Earl of Plymouth, C.B.; Viscount Dillon; Lord Balcarres, M.P.; Sir H. H. Howorth, K.C.I.E., F.R.S.; Sir John F. F. Horner, K.C.V.O.; Mr. E. J. Horniman, M.P.; Dr. F. J. Haverfield, Camden professor of ancient history in the University of Oxford; Mr. L. Stokes, vice-president of the Royal Institute of British Architects; Mr. J. Fitzgerald, assistant secretary to H.M. Office of Works; and Mr. J. G. N. Clift, hon. secretary to the British Archeological Association.

Professor Seneca Egbert will give a series of free public lectures at the Academy of Natural Sciences, Philadelphia, on "The Prevention of Disease and the Preservation of Health," at 8 p.m. on the following dates:

November 5—"The Economic Loss due to Preventable Diseases—What they cost and how they Affect the People, Individually and Collectively."

November 12—"What is being done to prevent Disease—Results already Achieved—The Outlook for the Future."

November 19—"Methods of Prophylaxis, and their Efficiency—The Value of Sanitation, Quarantine, Vaccination, etc."

November 27—"The Importance of Personal Health in Preventing Disease—Necessity of Fostering and Increasing One's Vital Resistance—The Influence of Extraneous Factors as Pure Air, Pure Water, Pure Food, etc."

December 3—"The Importance and Need of Popular Education in Public Health—Available and Practical Means for Securing It—Missionary Work Imperative for the Immediate Future."

The following is a series of lectures which has been arranged by the Museum of the University of Pennsylvania, for the month of November. They are to be given in the Widener Lecture Hall, at three o'clock on the afternoons mentioned.

November 7—C. Leonard Woolley, A.M.: "Results of the Second Eckley B. Coxe Egyptian Expedition" and "Excavations in Nubia."

November 11—Sir Harry Johnston, G.C.M.G., K.C.B., D.Sc.: "The Congo State—Its Fauna and Its Peoples."

November 18—Professor Oscar Gustaf Monetilius, Royal Antiquary of Sweden: "The Mycenean Period."

November 25—C. Leonard Woolley, A.M.: "A Roman Town in Britain" and "Roman Britain in the Light of the Present Excavations at Corbridge on Tyne."

THE ADMINISTRATION OF THE UNIVERSITY OF ILLINOIS

At a meeting of the senate of the University of Illinois on October 15, called at the request of the committee on educational policy, the following resolutions were adopted:

Whereas, There is ground for apprehending that recent articles in the press may lead the public to think that academic freedom is suppressed or interfered with at the University of

Illinois by the president, or that tenure of office is insecure because of autocratic administration; therefore, without entering at all into a discussion of the case referred to in said articles, be it

Resolved, by the senate of the University of Illinois (a body which includes all heads of departments and full professors in the university), that it is our belief that each member of the faculty has entire freedom of opinion, that he is free to express his opinions on all matters of university administration and educational policy to his colleagues and to the president without interference and without fear that it will endanger his position.

Resolved, That we hereby express our confidence in the president of the university and our conviction that he administers his high office as a colleague rather than as a superior.

Resolved, That in the opinion of the university senate the course of the administration has been such as to stimulate to a marked degree the higher scientific and educational interests of the university.

Resolved, That as members of the faculty we assure the president of our loyal and hearty support in the varied and difficult responsibilities imposed upon him as the executive head of this university.

UNIVERSITY AND EDUCATIONAL NEWS

The Draper's Company will erect for Oxford University an electrical laboratory at a cost of £22,000 and will give an additional sum of £1,000 for its equipment.

The H. K. Cushing Laboratory of Experimental Medicine at Western Reserve University will be dedicated on Friday, November 20, at 2 o'clock, when Professor William H. Welch, of the Johns Hopkins University, will make the address.

Cornell University has bought within the past year for the benefit of the College of Agriculture and the Veterinary College approximately 500 acres of ground lying contiguous to its other holdings.

Mrs. Mary Fiske Spencer, of Oberlin, has presented to the botanical laboratory at Oberlin College a collection of seven thousand European plants, gathered during twenty-five years of residence in Munich.

The council of the Royal College of Surgeons, of London, has adopted resolutions which will in future admit women to the examinations of the conjoint examining board in England, to the examination for the diploma in public health, to the examinations for the fellowship, and to the examinations for the license in dental surgery.

Dr. Florian Cajori, head professor of mathematics in Colorado College, has again accepted the deanship of the Engineering School.

Dr. Daniel Starch, instructor in experimental psychology in Wellesley College, has been appointed instructor in psychology in the University of Wisconsin.

Dr. T. H. McHalton has resigned as horticulturist of the Georgia Experiment Station, to take the position of adjunct professor in charge of the Horticultural Department of the Georgia State College of Agriculture at the University of Georgia, Athens.

DISCUSSION AND CORRESPONDENCE

DR. O. P. HAY ON THE SKULL OF DIPLODOCUS

My attention has been called to-day to an article in Science from the pen of my friend, Dr. O. P. Hay, in which he indulges in certain criticisms of my paper on the "Osteology of Diplodocus" published in the *Memoirs* of the Carnegie Museum, Volume II., page 225 *et seq.*

"*Humanum est errare*," and it is quite possible I have made mistakes. I shall be glad to accept corrections when I am convinced they are well founded. Until, however, I have time to reexamine the whole subject I am not inclined to adopt Dr. Hay's opinion as final. His *ipse dixit* does not carry conviction with it, especially as I am aware that he is only beginning his studies in this difficult field of investigation. We all acknowledge him to be a competent student of the Testudinata, but his investigations as to the skulls of the dinosauria are of quite recent origin.

Leaving out of sight difficult questions which relate to the interpretation of the foramina of the skull intended to give exit to the nerves issuing from the brain, which require careful reexamination at leisure, and passing over as not worthy of comment the *lapsus calami* on page 235 to which he calls attention, and the importance of which he magnifies, as it is abundantly corrected elsewhere, I wish to protest against the misrepresentations contained in his article, founded upon a total failure to understand my meaning and attitude.

Dr. Hay labors to make it appear that I suggest that *Diplodocus* was an animal "with three pairs of nostrils." I never suggested such a thought and no fair interpretation of my words could lead to it. In my paper I simply called attention to the obvious fact that two openings in the bones of the skull apparently leading into the narial cavity occur on either side in advance of the large posterior opening, which Professor Marsh interpreted as the nasal aperture. *They are there!* Dr. Hay is at liberty to amuse himself at his leisure in endeavoring to explain them as he pleases. I did say of the foramina, which I named "the mesial foramina of the maxilla," that they might possibly have had "a function supplementary to the function of the true narial opening." This does not necessarily imply that they were nostrils opening from the nasal cavity into the outer air. Whether they were nares, or were covered by tegument in life, I did not venture to say. It is quite conceivable that the large opening which Professor Marsh has interpreted as the true narial opening may have been covered by tegument and that one or the other of the smaller pairs of anterior openings may have been the true functional nares, as was long ago suggested, if I remember correctly, by the late Dr. Baur. In attempting to make me to have suggested that *Diplodocus* had three pairs of functional nares Dr. Hay is traveling quite beyond my text, and this "fanciful proposition," as he is pleased to call it, is the creature of his own imagination. I object to have him thus misinterpret me.

Dr. Hay devotes a paragraph to a foot-note on page 245 which he does not quote, but which he garbles. This foot-note is as follows: "*Sphenodon* has no external ear, agreeing in this respect with many other recent reptilia and ophidia. It is possible that *Diplodocus* had no external ear." I might have omitted the word "many," and have written the word "probable" instead of the word "possible," but then I do not claim omniscience. Omniscience is not one of my fads; and besides I know, as Dr. Hay should also know, that we have in some of the batrachia and lacertilia folds of skin partially covering the tympanum, suggesting and apparently to a certain extent functioning as rudimentary outer ears, and that in the crocodilia there is provided an opercular flap, which distinctly functions as an outer ear. I think my temperate statement may stand as I left it. It does not imply, as Dr. Hay tries to twist it into implying, that I held the ridiculous opinion that there exist reptilia with outer ears fully developed, as for instance, in the mammalia. Dr. Hay in his article is evidently making an attempt to be "funny." He ought first to be sure that he understands what he is talking about.

W. J. Holland

Carnegie Museum,
Pittsburg, Pa.,
October 20, 1908

ON THE ENCOURAGEMENT OF MR. CHARLES D. SNYDER

In a recent paper[1] Charles D. Snyder has published the following statement:

> If we believe that any given physiological activity is due to some particular physical change, we need only to determine at which velocities the action proceeds under various temperatures and then compare these results with the velocities of (probable) physical processes under similar changes of temperature in order to test for ourselves the correctness of our view.

He here refers to a foot-note which reads as follows:

> See the author's *original* communication, *Archiv für Anatomie und Physiologie, Physiol. Abh.*, 1907, p. 113. In this paper the idea of comparing temperature coefficients for possible physical causes underlying physiological actions, as outlined above, was clearly expressed. It was

[1] Snyder, Chas. D., *Am. Jour. Physiol.*, Vol. 22, No. 3, p. 309, August, 1908.

clearly stated in the abstract of the present paper, as published first at the Congress in Heidelberg, August, 1907, and later in the proceedings of the same which appeared in the various journals and archives of physiology during the fall of the same year. Since that time it is encouraging to note that J. Loeb (*Journal of Biological Chemistry*, October, 1907) and J. Bernstein (*Pflüger's Archiv*, 1908, CXXII., p. 129) have both thought well enough of the idea to use it as a basis for investigations in their own laboratories.

The italics in the above quotation are inserted by the writers of this note, since the word italicized renders the sentence in which it occurs a deliberate misstatement. Mr. Snyder's original communication, to which, through some curious oversight, he omits to refer either in this paper or in his paper in the *Zentralblatt für Physiologie* (22: 1908, s236), appeared in the University of California publications in 1905.

We think it advisable to draw attention to the fact, doubtless forgotten by Mr. Snyder in the stress of scientific production, because the statements quoted above would lead the reader, unacquainted with the history of this phase of physiological investigation, to suppose that members of this laboratory had utilized Mr. Snyder's results and views without giving him the full credit which he deserves. The true situation is, however, exactly the reverse, and it is for the purpose of removing the stigma which has thus been placed by Mr. Snyder upon the workers in this laboratory, that this short note is written.

It can not fail to strike an observant reader of Mr. Snyder's paper as very curious that he does not in his "conspectus of the temperature coefficients of the velocities of all the physiological actions determined up to the present time" refer to the paper by S. S. Maxwell entitled "Is the Conduction of the Nerve Impulse a Chemical or a Physical Process?" published in the *Journal of Biological Chemistry*, October, 1907, and this fact will appear the more strange when the reader observes that in the foot-note quoted above, on page 310 of Snyder's paper, this very publication is alluded to as one of the investigations from the laboratory of J. Loeb, which "it is encouraging to note" has been based upon the ideas of Mr. Snyder. From the wording of this footnote it would appear that Maxwell overlooked Snyder's publications and, in particular, omitted to refer to his publication upon the transmission of the nerve impulse published in April, 1907. So far is this from being the case that a considerable proportion of Maxwell's publication was devoted to a criticism of this publication of Snyder's. The most damaging criticism was, however, omitted from Maxwell's paper out of regard for Mr. Snyder. Should Mr. Snyder desire it, however, that criticism can still be published.

The actual succession of events which led to the appearance of this series of publications was, as far as this laboratory is concerned, as follows:

In 1903 Martin H. Fischer, at that time a member of this department, translated Cohen's "Physical Chemistry." In the fourth chapter of this work Cohen reviewed the work of Arrhenius and van't Hoff upon the temperature coefficients of chemical reactions, and showed that the temperature coefficient of various life-processes was that of a chemical reaction-velocity. He also suggested that the same principle might be found to apply in many other physiological processes.

The ideas thus expressed by Cohen led Loeb to consider it advisable that a series of investigations upon the temperature-coefficients of life-processes should be undertaken, with the view of ascertaining whether these processes are determined primarily by physical or chemical agencies.[2] For this reason he assigned to Mr. Snyder, at that time a candidate for the degree of Ph.D., the problem of ascertaining the temperature-coefficient of the heart-beat, and urged him to present his results as his thesis for the degree. This origin of his investigation is very clearly stated by Mr. Snyder in his own words, as follows:[3]

In his book on "Brain Physiology," Loeb mentioned the possibility that the heart beat might be caused by a fermentative process which is going

[2] Cf. Loeb, *Univ. of Calif. Publ., Physiol.*, 3, 1905, p. 3.

[3] *Univ. of Calif. Publ., Physiol.*, 2, 1905, p. 126.

on constantly in the heart. He suggested to me that this idea could be tested by exact quantitative determinations of the influence of temperature upon the rate of the heart beat. We know through Arrhenius how the velocity of a chemical reaction varies with the temperature. If the heart beat were, as supposed, a function of a reaction velocity, then the law of Arrhenius should also hold for the influence of temperature upon the rate of the heart beat.

While Mr. Snyder was preparing his thesis for the degree of Ph.D., Loeb suggested to Maxwell that he should undertake the investigation of the influence of temperature upon the velocity of the nervous impulse: Maxwell, however, started work upon another problem, and consequently Loeb asked Burnett to undertake this investigation. Burnett's investigation had not proceeded far when he found it advantageous to study the influence of temperature upon the latent period of striated muscle. The result of this investigation was published early in 1906.[4] Afterwards, on account of pressure of other work, Burnett was unable to continue the investigation, and, at Loeb's request, Maxwell carried it through, and the results were embodied in the paper to which Mr. Snyder refers, in the foot-note quoted above, as an encouraging example of the extent to which his ideas have been appropriated by members of this laboratory. Meanwhile Loeb had published his observations upon the temperature coefficient of artificial maturation in *Lottia*,[5] and of the production of artificial parthenogenesis by the action of hypertonic sea water,[6] and Robertson had published his observations upon the temperature coefficient of the heart beat in the crustacean *Daphnia*.[7] In his "conspectus of the temperature coefficients of the velocities of all the physiological actions determined up to the present time," however, Mr. Snyder does not refer to any of these papers, and, with remarkable consistency, also fails to refer to all papers upon the temperature coefficients of life processes which contain extensive references to these publications, as, for example, the paper on the influence of temperature upon the refractory period in the sartorius muscle of the frog, published by Bazett in the *Journal of Physiology*, February, 1908. Mr. Snyder is, however, undoubtedly familiar with some of these publications, inasmuch as he has inserted references to that of Loeb upon the temperature coefficient of artificial maturation and to that of Robertson upon the temperature coefficient of the heart beat in *Daphnia*, in a previous publication of his own.[8]

Since Mr. Snyder's "conspectus of the temperature coefficients of the velocities of all the physiological actions determined up to the present time" is singularly defective in other respects, we here insert a list of the literature on this subject which, to the best of our knowledge is complete up to the present date. Save those containing results originally utilized by Cohen in calculating the temperature coefficients of life processes published in his "Physical Chemistry," all references to papers not actually regarding the influence of temperature upon life phenomena from the point of view of its influence upon chemical reaction velocity, are omitted. We publish this list in the hope, not only that it may be of use to the student of this department of physiological research, but also that it may serve to further encourage Mr. Snyder by demonstrating to him how widely his ideas have been adopted, how many laboratories have thought well enough of them to use them as a basis for investigations and in how many cases these ideas were, with remarkable prescience, utilized before Mr. Snyder had ever published his "original communication,"[9] in which they were so "clearly expressed":

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Hertwig, O.: *Arch. f. Mikrosk. Anat.*, 51, 1898, p. 319.

Cohen, Ernst: "Physical Chemistry," trans. by Fischer, New York, 1903, pp. 50–67.

[4] *Journal of Biological Chemistry*, 2, 1906, p. 195.

[5] *Univ. of Calif. Publ., Physiol.*, 3, 1905, p. 1.

[6] *Loc. cit.*, p. 40.

[7] *Biol. Bulletin*, 10, 1906, p. 242.

[8] *Amer. Jour. Phys.*, 17, 1906, p. 350.

[9] *Arch. für Anat. und Physiol., Physiol. Abh.*, 1907, p. 113.

Aberson: *Rec. d. traver. chim. d. Pays-Bas et de la Belg.*, 22, 1903, p. 78.

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Snyder, C. D.: *Univ. of Calif. Publ. Physiol.*, 2, 1905, p. 125; *Am. Jour. Physiol.*, 17, 1906, p. 350; *Arch. f. Physiol.* (Engelmann), 1907, p. 113; 1907, p. 118; *Am. Jour. Physiol.*, 22, 1908, p. 179; 22, 1908, p. 309; *Zentralblatt f. Physiol.*, 22, 1908, p. 236.

Peter, Karl: *Arch. f. Entwicklungsmechanik*, 20, 1905, p. 130.

Abegg: *Zeit. f. Electrochemie*, 11, 1905, pp. 528 and 823.

Euler: *Zeit. f. Physiol. Chem.*, 44, 1905, p. 53.

Senter: *Jour. Physical Chem.*, 9, 1905, p. 311.

Loeb, J.: *Univ. of Calif. Publ., Physiol.*, 3, 1905, p. 1; 3, 1906, p. 39; "Dynamics of Living Matter," New York, 1906, lecture 6; *Pflüger's Arch.*, 124, 1908, p. 411.

Kanitz, A.: *Zeit. f. Electrochemie*, 11, 1905, heft 42; 13, 1907, p. 707; *Pflüger's Arch.*, 118, 1907, p. 604; *Biol. Centralblatt*, 27, 1907, p. 11.

Robertson, T. Brailsford: *Biol. Bull.*, 10, 1906, p. 242; *Arch. Internat. de Physiol.*, 6, 1908, p. 388.

Taylor, A. E.: *Jour. Biol. Chem.*, 2, 1906, p. 87.

Jost: *Biol. Centralblatt*, 26, 1906, p. 225.

Burnett, T. C.: *Jour. Biol. Chem.*, 2, 1906, p. 195.

Madsen and Nyman: *Zeit. f. Hygiene und Infektionskrank.*, 57, 1907, p. 388.

Maxwell, S. S.: *Jour. Biol. Chem.*, 3, 1907, p. 359.

Arrhenius, S.: "Immunochemistry," New York, 1907, chap. 3 and 4.

Bazett, H. C.: *Jour. Physiol.*, 36, 1908, p. 414.

Lucas, Keith: *Jour. Physiol.*, 37, 1908, p. 112.

W. J. Woolley: *Jour. Physiol.*, 37, 1908, p. 122.

Bernstein, J.: *Pflüger's Arch.*, 122, 1908, p. 129.

Jacques Loeb, T. Brailsford Robertson,
S. S. Maxwell, Theo. C. Burnett
Rudolph Spreckels Physiological Laboratory,
University of California

QUOTATIONS

PUBLICATIONS OF THE WISTAR INSTITUTE

The publication of five important biological journals under the direct control of the Wistar Institute of Anatomy of the University of Pennsylvania has attracted widespread attention among anatomists and zoologists of the country. The step is significant, not so much because the institute has acquired five well-established biological journals, but because it marks an important advance in the cooperation, so much talked about recently, among institutions which consider it their duty to devote some of their best energies to the advancement of human knowledge.

The Wistar Institute began its career as a publishing institution by the distribution of Bulletin No. 1, which was a three-page leaflet setting forth some of the plans the institute proposed to follow in promoting anatomical science. This was in 1905. At the close of 1908 the institute is publishing five journals, with a combined yearly output of about 3,000 pages. Several of these journals are self-supporting, while others incur a considerable yearly deficit. The institute has been able to assume the entire financial responsibility of these publications, without encroaching upon its regular income devoted to its museum and research work, through the efforts and enthusiasm of Dr. Horace Jayne. Doctor Jayne, who is in charge of the newly created department of publication, has done much to improve the journals, increase the subscription lists and has been untiring in his efforts to put the department upon a successful working basis. No similar combination of biological journals has ever been attempted in this country, and the Wistar Institute is to be congratulated upon the success attained in this new venture.

The first journal acquired by the Wistar Institute was the *Journal of Morphology*. Founded in 1887 by Professor C. O. Whitman, this journal has completed eighteen volumes, which are esteemed both at home and abroad for their valuable scientific contents and the excellence of book-making. In 1903, for lack of funds, it temporarily suspended publication. . . .

Following the lead of the *Journal of Morphology* came the *Journal of Comparative Neurology and Psychology,* the *American Journal of Anatomy,* the *Anatomical Record* and the *Journal of Experimental Zoology.* These journals were assigned to the Wistar Institute because of its efforts to bring about a mutually beneficial cooperation which would lead to greater scientific results with the same outlay of time and money.

They comprise nearly all the independent technical journals in their respective sciences. Their editors are leading men in the branches they represent, and the articles published are the best results from American laboratories.

They represent no school or exclusive band of workers, nor any group of self-centered laboratories. On the contrary, the chiefest aim is to obtain and retain for them an eminently national character, and encourage through the highest grade of biological research the efforts and cooperation of investigators wherever found. . . .

These journals have been and will always be a source of pride to American scholarship, and they are indispensable to those who desire to keep abreast of the times. The effort to increase their circulation is principally to put the original work done in America before as large a number of students as possible, here and abroad—that all may share in this movement for a more vigorous life in these branches.

The chief idea, which the Wistar Institute is following in publishing these journals, is to maintain the editorial management, so far as possible, outside of its own staff. The reasons are evident. The results thus far are most gratifying, and there is every reason to expect a very great increase in the efficiency and value of the undertaking.

The work of this department of the Wistar Institute alone brings the institute and the University of Pennsylvania into relations with nearly every laboratory in the world where anatomy and zoology are studied.—*Old Penn, Weekly Review of the University of Pennsylvania.*

SCIENTIFIC BOOKS

Modern Electrical Theory. By Norman Robert Campbell, M.A. Pp. xii + 332. Cambridge University Press. 1907.

The past fifteen years have witnessed the erection, upon the foundation of Maxwell's theory, of a great structure of theoretical and experimental knowledge which, for some time to come, will undoubtedly occupy a very large place in the interest and attention of students of physical science. Maxwell's theory was, in the main, the work of a single man of genius; it was general in its point of view, was little concerned with details, and thus possessed a kind of obvious unity which made it easy of comprehension when once the initial difficulties had been overcome. The modern development of electrical theory, on the other hand, has had to deal in great detail with a large number of complex phenomena of apparently diverse character. What is now called the electron theory is the result of the labors of many men, working in different branches of physics and chemistry, with various points of view, and often without recognition of the general, theoretical bearing of their results.

Under these conditions a work like the one before us is of especial value and utility. The author has chosen his material wisely and combined it with skill; he has given a simple and perspicuous account of the theory and of its application to the many and diverse phenomena which have been brought within its scope. The introduction of unnecessary details has been avoided, and although there are inevitably a great many trees, the forest is still distinctly visible. The perspective is thoroughly good and the point of view is not that of the popularizer of second-hand knowledge. Mr. Campbell has worked for many years in the Cavendish Laboratory, which for two generations has been the chief center of progress in electrical science; he has made important contributions to the theory of which he writes, and his book reveals an intimate and professional knowledge of his subject. It is not, however, addressed exclusively to a professional audience; while not exactly food for babes, it does not assume an extensive preliminary knowledge of the subject, and the necessary mathematical developments are presented in an elementary way, so that any one who is not averse to recalling his knowledge of elementary algebra and geometry may read the book with pleasure and profit.

A marked characteristic of modern physics is the free and fearless use of hypotheses—a use which would have been regarded as dangerous, or at least unscrupulous, in the days before we had been taught by the example of great masters like Faraday, Kelvin and Maxwell, that hypotheses were the most useful of all the instruments of research. In those days a hypothesis was considered to be justifiable only when its author could look forward with confidence to the time when it should be raised to the greater dignity of a "theory," and perhaps ultimately be proved to be "true." How far we have advanced from this position is indicated by Professor J. J. Thomson's remark that a physical theory is not a creed, but a policy, and by Mr. Campbell's statement (p. 231) that "a false hypothesis is better than none." This attitude must, of course, be thoroughly understood by the reader. He must recognize that the model structures which are used in this book to explain electrical and optical phenomena are not the only ones possible even at the present time; and that, as investigation proceeds, they will have to be modified and in many cases rejected altogether in favor of others which more perfectly represent the results of experience.

H. A. Bumstead

Einleitung in die Experimentelle Morphologie der Pflanzen. Von Dr. K. Goebel. 8vo, pp. vi + 260, with 135 figures. Leipzig and Berlin, B. G. Teubner. 1908. Price 8 Marks.

This book, which is an amplification of a series of lectures delivered by Professor Goebel in the winter of 1906–7, is one of the most suggestive botanical contributions of recent years. Not only botanists of moderate training, but scientific gardeners should be able to read the work, repeat the experiments and devise new ones. The apparatus is usually very simple, as the author says, "a plant, a pot of dirt and a question." Little attention is paid to the direct effect of light, heat, etc., the reader being directed to Pfeffer's "Pflanzenphysiologie," and Goebel's "Organographie" for a discussion of these factors. For experimental work on lower plants, reference is made to Klebs's "Ueber Probleme der Entwickelung."

There is no attempt at completeness, the book being intentionally an introduction rather than a hand-book.

The titles of the five chapters indicate the scope of the work. (1) The Field of Experimental Morphology, (2) Influencing the Form of the Leaf by Internal and External Conditions, (3) Conditions for the Various Development of Main and Side Axes, (4) Regeneration, (5) Polarity.

In addition to the question, *How* does development proceed, there is another, *why* does it so proceed. The book is most deeply concerned with the second question. Plants diverging from the usual form are called freaks; some plants develop one form under moist conditions and another under dry; some plants have juvenile stages quite different from the adult form; injuries often cause a plant to develop in a direction not followed by the normal plant, etc. Experimental morphology attempts to answer the questions raised by such phenomena. That heredity must be reckoned with is not questioned. The acorn gives rise to an oak, and the beech nut to a beech tree; but normal stages in development may be skipped, after a later stage there may be a return to an earlier, and this because the various stages in development are dependent upon internal conditions which may be influenced by external factors. Development may be checked at a certain stage, when conditions for the succeeding stage are not present.

The experiments and inferences from them are numerous and suggestive. It may be that strict morphologists lay too much stress upon heredity and try to explain too many phenomena as due to recapitulation. It would seem to the reviewer that Professor Goebel has underestimated the importance of heredity as much as most morphologists exaggerate it.

Charles J. Chamberlain

SCIENTIFIC JOURNALS AND ARTICLES

The American Journal of Science contains the following articles: "Some New Measurements with the Gas Thermometer," by A. L. Day and J. K. Clement; "Range of the α-rays," by W. Duane; "Alteration of Augite-ilmenite Groups in the Cumberland, R. I., Gabbro (Hessose)," by C. H. Warren; "Studies in the Cyperaceæ. XXVI. Remarks on the structure and affinities of some of Dewey's *Carices*," by T. Holm; "Applications of the Lorentz-FitzGerald Hypothesis to Dynamical and Gravitational Problems," by H. A. Bumstead.

SPECIAL ARTICLES

ELECTRIC DISTURBANCES AND PERILS ON MOUNTAIN TOPS

In view of the scientific interest that has been aroused by the sudden death of mountaineers on the widely separated peaks of San Gorgonio and Whitney during apparently the same electric storm in June, 1904,[1] the following recent experience of Captain R. M. Brambila, U. S. Infantry, and the writer will be welcomed as furnishing some hint of the power and magnitude of such electric disturbances.

This experience was endured by the party during the regular visit to the automatic weather observatory maintained by the Nevada Agricultural Experiment Station on Mount Rose (altitude 10,800 feet), the dominating peak north of Lake Tahoe (on the California-Nevada state line), and approximately 200 miles north of Mount Whitney.

The storm, which was mainly electric in nature, displayed itself first on the evening of Friday, October 19, 1907, in a heavy cloud mass lying close along the crest of the Carson Range north of Mount Rose, but in no wise involving Mount Rose itself. The flashes of lightning were frequent and heavy. Little thunder, if any, however, was heard. On the morning of the twentieth, when the actual ascent of Mount Rose began, clouds gathered from the direction of Lake Tahoe about the summit, and enveloped it somewhat persistently during the day. The wind did not exceed ten miles per hour, and the temperature remained above freezing.

From the summit itself the cañons below could be seen filled with masses of vapor. As night darkened a moderate storm of hail and snow with rain began to fall. The pack horse, which had been stabled on a terrace just below the observatory, was covered from tail to ears to protect him from the pelting missiles.

[1] The distance between these peaks, which lie on opposite sides of the Mojave Desert, southern California, is approximately 180 miles and the difference in elevation is 5,015 feet, the higher peak, Mount Whitney (altitude 14,515 feet), being the highest mountain in the United States, excluding Alaska.

The death on San Gorgonio, said to be the first case of the kind in San Bernardino County, occurred July 24, 1904, that on Mount Whitney two days later, July 26. Referring to these fatalities, Professor Alexander G. McAdie, quoted in the *Monthly Weather Review*, September, 1904, page 420, says:

The accidents have a scientific interest in that there are but few records of deaths by lightning in this state. But it should be noted that comparatively few people have been exposed to storms at high elevations. Mr. Byrd Surby was killed on the summit of Mount Whitney, within 50 feet of the monument. It was snowing at the time of the accident. It is probably not well known that the variations in the electric potential of the air during a snowstorm are almost as rapid and as great as those prevailing during a thunderstorm. In this present case I am inclined to think that the electrical disturbance was not localized, but simply incidental to a disturbed field which extended well over the high Sierra, Inyo, Panamint and Telescope ranges; also the San Bernardino Range, and probably the mountains of Arizona. This condition lasted perhaps a fortnight.

Then the electric display began. First a dull detonation to the south, and, after an interval, a flash at the observatory window as if there were wires in the observatory and electricity had struck them. To this we paid little heed, for the occurrence was trivial. After a time, however, a crash a hundred feet below us and perhaps 500 feet away and the immediate terror of the horse drew us to the door.

As we emerged, every artificial projection on the summit was giving forth a brush discharge of electricity. The corners of the eaves of the observatory (covered with Malthoid roofing), the arrow of the wind vane, the cups of the anemometer, each sent forth its jet, while the high intake pipe of the precipitation tank on the apex of the summit was outlined with dull electric fire.

Whenever our hands arose in the air, every finger sent forth a vigorous flame, while an apple, partially eaten, in the hand of Captain Brambila sent forth two jets where the bite left crescent points. This latter phenomenon occurred, however, only when the apple was raised above the head and ceased when it was lowered so that the eating of the apple involved no visible eating of flame.

To cap the climax my felt hat above the brim flashed suddenly into flame. I could feel the draft and, it seemed to me I could hear it too. The halo was dazzling, but before the senses could react it was gone. I had earlier but ineffectually rubbed Captain Brambila's hair to elicit a discharge of electricity, but because he was diminutive in size, nature had selected me to serve as the point of electric discharge. So vivid were the flames that continued to play from the corner of the observatory that I reached up to assure myself that the observatory was not actually on fire.

We felt no ill physical effects nor any special alarm, but for prudence's sake we sought the interior of the observatory, where the pranks of the electricity were apparently completely avoided. About 7:30 o'clock, an hour after the electric storm had burst, it had vanished.

The clouds, however, continued to hover around the summit, and the following evening a heavy rainstorm swept from the mountain earthward toward Reno, gaining violence as it descended, until the valley was drenched. We followed the storm closely with but little inconvenience from rain.

Only once before have I met electricity actively present on Mount Rose. This was during daylight of June 25, 1906, in a wet snowstorm accompanied by dense fog. At that time the thunder was pealing in the abyss below me, until I felt like some Jupiter hurling thunderbolts at the earth beneath.

The puzzle is that the tension did not burst on the apex of the summit where the discharge of earth electricity had particularly ionized the air, instead of upon the rocks below. A possible reason may be found in the suggestion of Dr. R. S. Minor that the scud which was sweeping between the heavier clouds above and the mountain mass may have become electrified by passing between the two poles and then have discharged its electricity as it was swept down nearer the mountain where the air currents swirl in its lee.

So far the discharges on Mount Rose have occurred at this lower point, and this habit may prove to be the observatory's security. The large extent of the summit over which the brush discharge was active, and the intensity of the latter, indicate imminent danger to the entire observatory. It was believed, when the observatory was planned, that the bolt would be induced to strike the high intake pipe of the precipitation tank on the crest; but such a conductor, it seems, would prove insignificant on account of the gigantic proportions of the electric activity. Besides, it is impossible to create a satisfactory circuit from tank to mountain, for the summit is apparently one mass of shivered rocks whose interstices are filled only with dry earth.

A wire cage in which to sit during thunderstorms has been suggested as affording possible immunity for the observers. It is possible that the observatory itself, which is sheathed with Malthoid roofing above and nested in the rocks below, may serve the same purpose. The placing of wire netting around the louvered shelter where the meteorograph is installed might give this instrument protection from electric shock, but the projection of the wind vane and anemometer masts from the shelter may attract sufficient electricity to fuse the netting and reach the instrument by way of the mechanical connections. There has been actual danger on Mount Rose, so far as known, only this single time during the past three years.

J. E. Church, Jr.
University of Nevada,
Reno, Nevada

THE BLOWING OF SOILS

When a boy on my father's farm in Iowa I experienced a three days' dust storm, when the air was so full of dust that one could hardly see, and the sun was almost obscured. After the storm I noticed that drifts of loose earth had accumulated in all the protected hollows, in the lee of corn shocks and fences, and on the grass lands adjacent to the cultivated fields. We had no other storm so severe as this one, but I noticed that the drifting soil particles in the air were gradually filling up a small pond that adjoined a plowed field. This little pond was so situated that no wash from the plowed area could enter it, and its filling up was undoubtedly due to the deposition of wind-blow particles. Some years ago I again visited the place and found that this pond was dry and filled up practically level with the surrounding land.

In the spring of 1889 I had occasion to observe the erosion by the wind of a recently plowed field on my father's farm, near Yates Center, Kan. The field sloped gently toward the southwest, and for several days the wind blew violently from that direction, carrying away the soil in some of the most exposed places to the full depth to which it had been loosened by plowing. Most of the soil was, of course, dropped in the lee of the first obstruction; but the finer particles were probably carried for many miles. Other fields in the vicinity suffered the same fate, and after the storm was over our neighbor adjoining us on the north had the bulk of our soil. Most of it was piled in big drifts just back of an osage hedge.

Later, near Albuquerque, N. M., and at Cibicu, Ariz., I was impressed by the strong indications of eolian origin offered by the adobe clay of this region. This material can hardly have been formed by glacial action as no traces of such can be found, and fluvial action is in most cases excluded by the topography. The deposit is found superimposed on many geologic formations and at a wide range of altitudes. It may be partly rain wash from the hills, but were it entirely so it would show a non-uniformity of mechanical composition—becoming finer in grain with distance from the hills. This does not occur—the deposit being very uniform. It is also remarkably level, showing no traces of the descending slopes characteristic of alluvial fans. Becoming convinced that this deposit was largely of eolian origin, I began to look about for evidences that deposits are made and materials moved by the wind. The following observations resulted:

1. On the Jemez coal lands near Albuquerque, N. M., it was noticed that, on windy days, a sheet of dust was continually blown completely over the region from Mesa Blanca and adjacent ridges.

2. At Cibicu, Ariz., fine dust settled on anything spread on the ground after a reddish southwestern sky at sunset, indicative of dust storms in the Gila-Salt River desert many miles away. This happened even when there was apparently no wind at Cibicu during the previous night and the day.

3. During a year of very slight rainfall at Fort Apache, Ariz., the adobe flats received even more increment than in years when the rainfall was normal. In this region the soil particles are continually being blown to the eastward from the region to the south of the long tongue-like ridge of the Mogollon range which extends to within a few miles of Fort Apache, and the dirt is being collected in the grass-covered area to the leeward of this ridge, but so slowly that the growth of vegetation keeps pace with the deposition.

4. The accumulation of wind-blown earth is

so great in the lower Salt River and San Ysidro-Zia regions, New Mexico, that the cactus and yucca plants are half submerged by it. In the vicinity of the Indian village of Santa Anna, lower down in the same valley, the wind-blown sand has in recent years completely covered the farm lands of the tribe, so that the government was finally compelled to give them another reservation across the Rio Grande at Bernalillo.

5. At the Indian village of San Felipe in the valley of the Rio Grande, the settling of dust particles blown from the almost barren mesa adjacent is very noticeable.

6. Around the White Thunder camp of the Rosebud Indian Reservation, in the valley of White Thunder Creek, S. D., the soil is a clay; yet the sands from the Arikaree strata some six miles away are blown by every wind storm completely across the valley and even into the houses, so that after every heavy wind one can write in the sand on the window sills inside the houses.

7. Last year I laid down a board in some grass on the lee side of Pacific street ridge in the village of LaPush, Wash., near the beach of Quillayute Bay. Several months later I looked at the board and found it covered with one eighth of an inch of beach sand which had been blown about half a mile and over the above ridge, which is completely covered with grass.

Various means have been adopted to prevent the movement of soil by winds. The Moqui Indians do not plow their soil at all. They simply dig a hole in the sand for each hill of corn and then tramp down the dirt with their feet to keep it from blowing away. Many people in the southwest do not plow their ground until the windy season is over. And in the irrigated regions the ground is flooded as soon as plowed. To prevent the movement of soil by the wind as well as to level the land, the farmers of the plains region roll their land or crush it with a weighted plank float. So far as the writer knows, these are the only means now used by farmers to keep the soil from being blown away by the winds. But others could be employed. Groves and hedges could be planted on the windward side of fields to break the winds. Also, at least for small farms, wind breaks like those used by railroads as protection against snow and sand drifting in cuts could be used to advantage, especially in regions too dry for the rapid growth of trees and hedges.

Albert B. Reagan

LaPush, Wash.

A FAULT IN AN ESKER

About three quarters of a mile from East Templeton, Mass., on the southeast side of the direct road from that town to Gardner, there is a cutting in one of the large, esker-like ridges typical of this locality. The deposit consists of distinct layers of fine, compact sand, with a few beds of gravel, of which the pebbles vary in diameter from less than an inch to six inches.

Where the stratification is well marked, near the northeastern end of the pit and about half way up the slope, the horizontal beds are found to terminate abruptly against a flat, narrow layer of sand and gravel, striking roughly east and west and dipping 63° northwards. This layer can be clearly discerned for a distance of more than twenty feet on the face of the pit; but above and below, like the beds which it traverses, it is covered by loose slide material.

That this layer may represent a fault zone, analogous to a fault breccia, in which the slipping destroyed original structures, is suggested by two facts: First, the beds are displaced; where they are best shown, the order of coarse gravel (2 ft.), fine, cross-bedded sand (2 ft.), fine gravel (4 in.), and very fine, compact sand (10 in.), on the south, is repeated, on the north side of the fault, about two feet lower. Second, the strata on the south side are plainly bent downwards next the fault.

Whether this dislocation is restricted to the glacial deposit only, or extends down into bed rock, can not be determined, for no bed rock outcrops here. The first supposition (of limitation to the deposit) seems most reasonable, since (1) the plane of the displacement is near the steepest slope of the deposit; (2) it strikes more or less parallel with the length of the deposit; and (3) post-glacial faults are generally of only a few inches displacement. Possibly the slipping was due to the removal of sand by water running below the surface. Certainly all the evidence militates against the assumption that the digging of the pit could have been the cause.

Fred. H. Lahee
Harvard University

BUFO FOWLERI (PUTNAM) IN NORTHERN GEORGIA

In the September issue of Science for 1907, I discussed the range of Fowler's toad to some extent, according to my own observations. An opportunity to spend the spring and summer of 1908 in the counties of Gwinnett and Jackson in northern Georgia has enabled me to make further observations concerning this interesting and apparently little understood toad.

In this region throughout March I heard the occasional, prolonged trills of the so-considered common toad (*Bufo lentiginosus*). By the first of April these notes had become quite silenced, and the distinct chorus of congregations of Fowler's toads had begun. I first noticed these toads singing on the evening of March 26, although I think the first singers had appeared somewhat earlier. It was interesting to note that the voices of Fowler's toads were never heard with the appearance of cool, chilly nights, although the trilling of the common toad continued. Throughout the early spring, this contrast in the occurrence of the two notes, with respect to temperature changes, was very marked.

Fowler's toad in this region of Georgia is an exceedingly abundant species. Throughout the months of April, May and June its droning cries are heard in thousands along certain streams. At this season the females are laying their long, bead-like strings of eggs in the water, attended by hosts of noisy males. Especially during the spawning season, the females seem to be greatly outnumbered by the males.

During the last week of May, the streams and pools where the eggs had been laid, were alive with tadpoles in different stages of development. About the middle of June, many of these had developed into tiny toads which were hopping along the banks, and in a few days every tadpole had disappeared as if by magic. A few evenings later, there was a noticeable increase in the number of males in voice along this stream. On visiting the locality, I was interested to find the females again laying eggs in great quantities, accompanied by many males. It would seem from this that these toads may have several well-defined egg-laying periods in a season.

After the spawning season these toads leave the water and take up quarters in the fields and pastures. During the day they generally remain quiet beneath stones, logs and bunches of grass. I find them very frequently in deep gullies. Here also I have found their eggs in the transient pools following showers. Several times I have found these toads buried to the eyes in sand greatly heated by an intense sun. In gullies and banks by the roadsides, the horizontal holes left by the decay of tree-roots, are favorite hiding places for these toads during the day. Several sometimes occupy the same tunnel, and may be seen peering out with expressions evincing serenity and contentment. Fowler's toads are rather inclined to be social in their habits. Last summer, near Hartford, Conn., I noticed a great stone door-step under which fifteen or twenty of these toads had taken up summer quarters. Every evening throughout the summer they would appear, one by one, and hop in a long line, up the walk leading into the fields.

I find considerable variation in the size, markings and coloration of Fowler's toad. The general coloration varies from a bright reddish brown to a dark grayish brown. Beneath, I have found no markings whatever, in either sex.[1] In truth, in this region of Georgia every toad examined was, for this and other reasons, apparently a Fowler's toad.

The usual note of Fowler's toad is a brief, penetrating, droning scream. Only once have I heard a decided departure from this. I heard this note late in April, in Gwinnett Co.,

[1] A single small, dark spot in the center of the breast of the males is the only marking I have ever observed beneath.

in upper Georgia. A single individual of a noisy congregation of males had the unmistakable trill of the common toad, but short and decisive like the Fowler's song. It was a perfect combination of the notes of both.

Wherever I have found this toad—in central and southern New England, around Washington, D. C., and in northern Georgia—it has been the only common form. Throughout the region of Jackson and Gwinnett counties of northern Georgia this toad is extremely common. Whether or not its range extends into the central or southern portions of the state, I have not determined. It is evident that *Bufo fowleri* occurs abundantly in much of the territory east of the Appalachian Mountains, and is far from being an uncommon or local race or species.

H. A. Allard
Bureau of Plant Industry,
Washington, D. C.

A PRELIMINARY NOTE ON A GROUP OF LACTIC ACID BACTERIA NOT PREVIOUSLY DESCRIBED IN AMERICA

Various bacteria forming acid in milk have been described. The organisms most frequently met and which are of the greatest economic importance are those belonging to the group represented by *Streptococcus lacticus* (Kruse) or the *Bact. lactis acidi* of Leichmann. This group is characterized by the small amount of acid which the organisms are able to produce in milk. The milk acted upon by pure cultures rarely shows an acidity exceeding one per cent. The limiting factor is apparently the formation of free lactic acid, the organisms being unable to grow in the presence of free acid. As numerous investigations have shown, the amount of acid produced varies with the composition of the milk. Milks high in casein and ash constituents develop a greater amount of acid under similar conditions than do milks whose casein and ash content is lower, because these substances combine with the acid formed.

Freudenreich, in Switzerland, has described a class of lactic-acid-forming bacteria which are able to produce much greater amounts of acid in milk than the organisms of the *Streptococcus lacticus* group. This group of high acid-forming organisms has been brought into prominence recently by the work of Metchnikoff and others on the fermented drink yougurt which is prepared from milk. The organisms found in this type of fermented milk are characterized by the production of large amounts of acid, three per cent. and over, by the high optimum temperature for growth, 42–45° C., by growing only under certain narrow conditions on artificial media, and by their morphology, being large bacilli. In all these the organisms from yougurt agree with those described by Freudenreich.

It has not been thought that such organisms are widely distributed. Indeed some writers have asserted that this type was peculiar to the country to which yougurt is native, Bulgaria. Within the last few months it has been found that organisms whose characteristics are similar to those found by Freudenreich in Swiss cheese and to those found in yougurt are of common occurrence in this country.

If a sample of mixed milk is placed in a tightly stoppered bottle and incubated at 37° C. the acidity rapidly reaches one per cent., due to the growth of *Streptococcus lacticus*. The acidity then continues to increase slowly until at the end of two to three weeks it reaches 2.5 to 3 per cent. The flora at first made up almost wholly of the small diplo-bacilli changes, through the appearance of long slender bacilli, which increase in number with increasing acidity.

In cultural characteristics and in biochemical reactions, the organism isolated is apparently of the same group as those of Freudenreich and the bacteria in yougurt.

As far as the writer is aware, this type has not previously been found in this country, although it is of wide distribution, and has been present for years. Milk bottled in 1902 was recently opened, and showed an acidity of over 3 per cent. A detailed study of the distribution and characteristics of the organism is being made.

E. G. Hastings
Wisconsin Experiment Station

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 13, 1908

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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.

A TALK ON TEACHING[1]

IN speaking to you to-day upon the subject of teaching, I shall try to present some considerations, suggested by my own experience, in regard to the application of educational principles to our own problems. Much of what I shall say will doubtless be familiar to a body of teachers like yourselves. Yet it is perhaps desirable that even the commonplaces of education be brought before us from time to time; for, though we recognize the abstract principles that should be followed, yet it is only by constant attention to them that we shall succeed in making them the real foundation of our courses of instruction.

Throughout our considerations we must keep in view the aim of the education for which the institute stands. In regard to this there is, I believe, little difference of opinion. The aim is to produce men who have the power to solve the industrial, engineering and scientific problems of the day—men who shall originate and not merely execute. The fundamental question is, then, How shall we develop this power? It is *power* that counts, and not *knowledge*. The ultimate test is what a man can *do*, not what he *knows;* and this is the test we should apply to our students upon the completion of each subject of in-

[1] Given at a conference of members of the instructing staff of the Massachusetts Institute of Technology on March 20, 1908. To Professor H. G. Pearson I desire to express my great indebtedness for his suggestions and assistance in connection with the preparation of this paper for the printer.

struction, and to our graduates at the close of their period of study at the institute.

It is true that a part of the power of a scientific man depends upon his knowledge; and a part of our task as teachers consists in bringing him into permanent possession of those kinds of knowledge which are most essential. In connection with this work of imparting knowledge I ask you to note three kinds of errors into which we are especially apt to fall.

First, it is a common mistake to ply the student with more than he can possibly assimilate. For covering a certain subject we are allowed a limited number of hours; into that time we feel that we must crowd, at any rate, all the obviously important topics. This we make the consideration of prime importance, whereas we should first determine what principles and essential facts can, in the amount of time given, be treated with sufficient thoroughness to enable the student really to comprehend them and make them his own. We must, therefore, constantly examine the courses that we are giving, to see whether they are not overcrowded; and, if they are overcrowded, we must consider how they may be disencumbered, so that the main points may be properly emphasized. *Obiter dicta* have no place in a course of instruction: principles which there is not time to drive home should not be mentioned at all; for they simply confuse the student, by distributing his attention over a larger number of topics than he can possibly assimilate at one time.

The existing conditions make the commission of this error only too easy. There is a constant demand that we give our students a wide variety of information. Not to teach a phase of a subject which may be regarded as important invites criticism and argues incapacity on the part of the teacher. Moreover, in many subjects we are badly off in the matter of text-books: most of our so-called text-books are really treatises and reference books. Would that some competent person would write for a ninety-hour course in chemistry or physics a text-book containing only those facts and principles that can be properly taught in a ninety-hour course! It is this defect which has led so many of the institute professors to prepare notes of their own, the object of which is primarily to emphasize the more fundamental principles of the subject.

Notwithstanding these difficulties, however, it is our clear duty as teachers constantly to endeavor not so much to teach many things as to teach well—not so much to "cover the ground" ourselves, as to make sure that our students go over the course with us. In trying to include too much, we not only sacrifice the opportunity for training, of which I shall speak later, but we accomplish far less than we might even in the matter of imparting knowledge.

The second error of which I would speak is the failure to keep sufficiently in touch with the mind of the student—to appreciate the knowledge which he actually possesses and the degree of development of his mental powers. The unfortunate results of this error are most clearly and frequently observed in lecture courses. The lecturer is apt to look at his task merely from an objective view-point: if he presents his subject clearly and logically, he complacently feels that he has done his part, and that it is the fault of the student if he has failed to profit by it. Yet the real test of the success of a lecture course, as of any other form of instruction, is the amount of benefit that the student actually derives from it; and the teacher must frequently, by some means or other, apply this test, must consider the causes of his incomplete success, and introduce such modifications as seem likely to lead to better results. He must keep in touch with the student so that he may appreciate his difficulties. This can be done much better in recitations than in lectures, but best of all through personal conferences; and, when conditions make it necessary to give lectures at all, they should be largely supplemented by these means, so that there may be individual contact with the student. It is to be hoped that the plan of regular conferences for which formal provision has already been made in first-year English and mathematics may be soon extended to other subjects; but in the meantime much is being done in this direction in an informal way by many of our best instructors. I wish only to emphasize the idea that such efforts are a well-paying investment of the teacher's time. They not only enable him to assist the individual student in a variety of ways, but they show the teacher the defects of his own methods of presentation and establish a cordial relationship between him and his class.

One important cause of this imperfect adaptation to the mental needs of the student is the lack of correlation between the different subjects of instruction. A teacher ought to know both what the student has already learned in his previous courses and what he will need to know in the later dependent subjects. To this end it is important that instructors should attend exercises in other subjects than their own, examine the text-books used, the notes and problems given out, and the experiments performed. For example, every instructor teaching applied mathematical subjects in the higher years of the various courses should familiarize himself with the new plan of teaching mathematics which has been recently introduced. I believe, in a large school like the institute, the imperfect correlation of the different subjects of instruction is one of the most serious evils, and one which must be met by an increased effort on the part of each instructor to know about the work that is being done in subjects related to his own.

The third difficulty which I would refer to is that which arises from the tendency of the student to learn by memorizing and to do his work in the laboratory mechanically, without thinking. We must not allow ourselves merely to mourn over the fact that the average student won't think if he can help it, or try to justify our failures to get him to do so by reflections on his earlier education. We must face the situation as it actually is, and realize that it is one of the most important parts of our problem to make the student think.

Herbert Spencer is reported to have said, "if he read as much as other people, he would know as little as they." The remark is worth remembering, in spite of its complacency, for the light it throws on the worthlessness of whatever is done without thinking. In science, as in other departments of knowledge, no acquisition is real and permanent which is not won by hard thought. As every teacher knows, a most effective way of making a student think is by constant questioning. He emphasizes a principle by asking questions about its possible applications. He answers one question by asking another, and, if possible, gets the student to put the questions for himself. The good teacher is constantly trying to lead the student on, but he refuses to carry him. In the laboratory and drawing-room, where students tend to work as if their whole purpose were to go through the mechanical operations as rapidly as possible, the successful instructor will be constantly on the alert to check this tendency. He will be with the student at his desk as much as possible, not telling him what to do, but seeing that he understands and plans out his work for himself. Only in matters of manipulation and technique should a distinctly different plan of instruction be adopted. Here, in order to economize time for more important work, the effort should be made to give the student the necessary manual skill as rapidly as possible, by giving him detailed instruction and showing him by example the little artifices that make the expert manipulator. The engineer, architect or chemist must have a good technique, and we can not afford to neglect it; but one of our problems is to reduce the time needed for its acquirement to its lowest limit.

Summing up now this discussion of the question of imparting knowledge, I would advise especially:

1. That we take care not to include in our courses more than the average student can properly assimilate.

2. That we keep in close touch with the actual knowledge and mental development of the student; that to this end we introduce recitations and invite individual conferences as far as possible; and that we inform ourselves more fully in regard to the work which is done in courses related to our own.

3. That we discourage the habit of memorizing and of working in a thoughtless, mechanical way in the laboratories and drawing-rooms by close personal contact with the student and by appropriate modifications of our courses and of the examinations upon them.

I come now to the other more important and more difficult task of giving the student the mental training upon which the power of handling new undertakings and solving new problems depends. In comparison with this the imparting of knowledge is an insignificant matter. One of our professors has given an apt illustration of the true function of the institute. It should be, he says, a gymnasium where the faculties are exercised and developed, and not a boarding-house where the students are crammed with facts. We want our young men to acquire the power of solving problems; and this, like any other faculty, can only be developed by constant exercise of it. Therefore, we must make problems one of the main features of our courses—problems in the broadest sense, not merely numerical applications of principles. Class-room and drawing-room and laboratory work alike must consist largely in the solution of problems.

This matter of problems seems to me of so much importance that I would like to consider it with you in some detail.

First a few words as to the character of our problems. In the lower schools the questions given out for solution are well called "examples": that is, a teacher does a problem in a certain way, as an example; and the students learn by imitation to do others like it. Of course, for our purposes this kind of problem-solving is of scarcely any value. We must avoid problems which are only pattern-work and those which are simply the substitution of numerical values in formulas. One of our professors who makes problems a large part of his course told me of the student who came to him with the complaint that he couldn't do his problems because each one was different from the others, well showing the kind of problem-work to which he had been accustomed.

There are two classes of problems that are essential to our work—the kind that develop logical thinking or reasoning power and the kind that develop imaginative thinking or the power of planning and originating. For each of these two kinds of problems we should try to make better provision; but the latter kind needs, I believe, special development at the institute. For example, we ought to a greater extent require in our laboratories that the students plan out their own experiments. Students should be told what apparatus is available and what results are wanted, and then should be left largely to their own ingenuity to produce those results. In each particular line of study there is, moreover, a particular form of problem-work that is appropriate. In engineering subjects it is the design of new structures and of new machines; in the descriptive sciences it is the identification of materials (provided this be done not by tables nor by a set method of procedure, but by the student himself upon the basis of his own knowledge); in English it is the writing of themes; and so on. Each teacher must consider how his subject can be presented so as to afford the largest opportunity for developing the student's reasoning power and creative ability.

Permit me next to say a few words in regard to the importance of independent work in the solving of problems. I believe that only by insisting upon this can anything like the full benefit be secured. In the first place, what we want to do is not to teach the student how to solve certain particular problems, but to train him in original thinking—to solve any kind of problem; and to this end he must do the work himself. Secondly, the line can not be effectively drawn at any other point than that of absolute independence. If one allows working together at all, some students will copy, and a still greater number will get other students to do all the thinking for them. Then, again, if problems form a large part of the term's work, the marks of the term ought to be based principally upon those problems; and this is not fair unless we are able to assure ourselves that the results represent individual work. When this requirement is made of the student, the instructor must be ready to assist him in his difficulties, and must provide definitely for opportunity for consultation; else the conscientious student will waste an undue amount of time before some obstacle which a few minutes' talk with the teacher would remove. It is, I think, very desirable to introduce more extensively the plan, already followed in some subjects, of requiring problems to be done at assigned hours under the guidance of the instructor rather than in outside hours of preparation. I am well aware that there are some advantages in allowing students of the same proficiency to work out their problems together: difficulties are overcome with less loss of time, the principles involved become clearer by discussion, and the work is made more attractive. In exceptional cases, especially with small classes of rather advanced students, who have acquired the true point of view, these advantages may be secured without incurring the evils to which I have referred; but I believe that this is true only in such exceptional cases, and that the difference in the emphasis laid upon independent work by different instructors is a source of demoralization to our students.

The introduction of more problem work naturally carries with it the laying of greater weight on the term work and less on the final examination in determining the record of the student—a thing which is in itself highly desirable. An instructor is sometimes heard to say, "If a man gets the subject in the end, it is all right." That remark shows, I think, that he does not have the true conception of the main purpose of his course, which is not to give a certain amount of knowledge in the subject, but to give a mental training which can only be acquired gradually by persistent effort through the whole term. Indeed, in my own opinion, one of the most effective means of raising the standard of our instruction is the abandonment of final examinations in more of our courses. Thereby not only are the many serious evils of the examination system removed—such as the postponement of serious study till the end of the term, the cramming during a short period before the examinations (which is, I believe, wrongly regarded by some instructors who do not appreciate the character of cramming methods as valuable in affording a review and perspective of the whole subject), the attendant nervous strain and injury to health, the evils of tutoring and proctoring—but also because it impresses upon both instructor and student a different educational ideal, that of training the mind rather than storing it with knowledge. Some years ago the faculty took the step of abolishing final examinations in many first- and second-year subjects. I think the time has come when provision should be made by individual instructors and by the faculty for the extension of this plan to many other subjects.

These considerations may be summed up by saying that *problem-solving* is by far the most effective means we have of developing mental power. We must make such work as large as possible a part of our courses, making place for it by the omission of much other material, important though it may be. We must insist on independent work in the solution of problems, but in doing it we must be ready to give assistance to the individual student. Our examinations should be made a test of his power to handle problems connected with the subject rather than a test of his knowledge; and the record we give him should depend mainly on his success in this direction.

Let me pause here to make one remark, lest I should seem to underestimate the success which is already being attained by the teachers of the institute. Any one familiar with our work well knows that what I have said in regard to the relative importance of knowledge and training and the methods of developing mental power is only an expression of the general educational policy of the institute, and that the principles I have discussed have already been extensively put into practise here—probably to a greater extent than in any other large educational institution. I have emphasized these principles only in the hope of impressing each individual instructor more fully with their importance and of encouraging him to aim to base his own teaching upon them as largely as possible.

So far I have considered only that side of our work which relates to the professional training of the engineer or the scientist; but, as we all know, the problem of the institute is not confined to this. It is our function to give a general education in combination with a professional training—to educate the man as well as the engineer. We must constantly bear in mind this twofold aspect of our work, and must be contented to sacrifice in some measure professional attainment in the interest of a broader education. We must aim to develop those qualities which are the result of a liberal training—breadth of view, perspective and soundness of judgment; but we must especially aim to develop character and high ideals. The acquirement of *power* is, as I have said, the intellectual goal towards which we are striving; but we must also keep in view the moral end, which is the cultivation of the spirit which will lead that power to be devoted to some high form of *service*.

Some may perhaps contend that these are not our functions—that our obligations are only on the intellectual side, that the development of the moral, social, esthetic and physical qualities of the student are to be left to outside influences. Such a view is, in my judgment, a seriously mistaken one. It might well be held by the authorities of a graduate school of the purely professional type; but it is quite inconsistent with the conception of the institute as an undergraduate school, whose primary function is to furnish an effective form of general education. Our students come to us during four years of the most critical period of life, when their habits of thought and ideals of life are being formed; and we must appreciate the seriousness of the trust which is thereby imposed upon us. It is of comparatively little significance whether the student acquires more or less knowledge of mathematics, chemistry, physics or engineering; but it is vitally important that his mental power, his general culture, his character and his ideals be adequately developed. We must, therefore, take care not to interpret our function as teachers too narrowly; but we must each of us improve every opportunity for contributing to the more general and more important result which the institute has in view. The means for attaining this result certainly deserve especial consideration in a talk on teaching. I have already expressed my ideas at some length on the development of mental power. Owing to the limited time remaining, I shall not attempt to discuss the means of developing those important qualities which are summed up in the word "culture"; but I should like to consider with you briefly the still more vital question of what can be done to develop character and high ideals. The indefiniteness of the methods by which this may be accomplished makes the subject a particularly difficult one; but it must not be passed over on this account.

The methods of the institute are especially adapted to develop those habits which go to the formation of character. To meet the demands of our curriculum, the student must be willing to subordinate pleasure to duty; he must work industriously and persistently; he must, too, work rapidly, whereby he comes to appreciate the value of time. Our scientific courses offer, moreover, special opportunities for inculcating habits of accuracy, reliability, clearness of expression, neatness and orderliness; and we must insist that the work be so carried out that these benefits do in fact result. Careless or slovenly work of any kind must be vigorously condemned. We should see that note-books be kept in a neat and orderly manner; that reports be written clearly in good literary form; that in the class-room accuracy of expression be cultivated; that the numerical work connected with problems be accurately performed (nothing like full credit being given when merely "the principle is correct"); and that every reasonable effort be made to verify an experimental result or confirm a conclusion before it is accepted as final. The teacher of any science who says it is not his business to attend to these things does not, in my opinion, understand his business, which is not so much to teach the subject-matter of the science as it is to teach *scientific method* and to cultivate the *scientific spirit*.

Yet the formation of character, important as it is, is by no means the whole of this side of our task. The qualities that make up a good character in the narrower sense are, after all, only "the half-virtues which the world calls best." That the man may be really effective, these must be supplemented by high ideals of service, a strong purpose in life, and a real devotion to it. With respect to means of imparting such ideals, I have only a few thoughts to present.

In the first place, I believe that, to accomplish much in this direction, we must get into personal relations with the student. Thereby many different opportunities of influencing him are opened to us. To begin with, we set him the example of rendering unselfish service to others by giving him individual aid beyond that which our formal obligations in class-room and laboratory demand. Let us make it clear to him that it is not our primary purpose to "maintain the standard," but that we are personally interested in aiding him to fulfil the established requirements. Up to the end of the course the teacher should consider every student who is doing unsatisfactory work as one of the problems for which he must try to find a solution; and there is, I believe, no better way of securing attention from a student who is neglecting his work or of bringing up to the standard one who is having difficulty with the subject than by showing a personal interest in him. I know that this makes an added demand on the instructor, and that what any one can do in this way is limited; yet it is an aim to be kept in mind and to be striven for. Since at the institute there is one instructor to about seven students, the net result would be very large if each teacher would endeavor to become well acquainted with even this number of his students.

Close contact enables the teacher, too, to influence in a pronounced way the point of view of the student, both with reference to his work at the institute and to his ultimate aims. On occasions when I have talked intimately with students about these matters, I have often felt keenly how much more they need advice about *life* than about chemistry. Such individual conversations furnish also the opportunity of giving the student a broader interest by letting him know of the scientific and professional problems in which ourselves and others are engaged. He thus sees more clearly the future before him, and appreciates better the value of the studies he is pursuing.

Though personal contact is by far the most effective way of exerting these general influences, yet, since it is possible to provide for it only to a limited extent, we must improve the opportunities which our regular courses of instruction afford for securing the desired result.

Some of the ways in which this may be accomplished are to indicate the wide scope of scientific generalizations and the beauty of theoretical explanations, to point out the important technical applications of the principles presented, to describe the considerations and experiments which led to their discovery and the participation of individual scientists in their development, and to indicate some of the numerous problems of the science that still await solution. By thus emphasizing the broad scientific aspects, the practical bearing and the historical and biographical development of our existing knowledge, and by impressing the student with the idea that at present "our science is a drop, our ignorance a sea," we may do much to awaken his interest in knowledge for its own sake and to develop in him broader points of view and higher aims. Especially must the importance of these considerations be borne in mind in subjects that have to be presented by formal lectures. I have already indicated my opinion that as a means of imparting a fundamental knowledge and of giving a mental training the lecture plan is strikingly ineffective, and can be justified from these points of view only on grounds of economy. It does, however, have in non-technical subjects what may be called a cultural function of some importance; for it provides, better than the recitation plan, the opportunity of arousing the broader interests of which I have been speaking.

In conclusion, as a summing up of these considerations, I would urge that we take care not to interpret our work as teachers too literally—that we realize that our task is a much larger one than that of imparting a knowledge of our particular subject, and that it is a broader one even than that of developing the power of dealing with its problems; that, in fact, the most important and most difficult part of our undertaking consists in cultivating sound habits of thought and work, in developing breadth of interest and good judgment, in molding character, and in creating a high moral purpose.

Arthur A. Noyes

SOME PRINCIPLES IN LABORATORY CONSTRUCTION[1]

By common consent, governing boards of colleges recognize that after a main building has been erected, the next should be a chemical laboratory. The artfulness of teachers of chemistry, perhaps aided by their fumes, has caused their colleagues to exhibit little regret and display but minor envy in the placing of the chemistry department under a separate roof. Limited funds and meager equipment caused the erection of the simplest structures at first. The stupendous development of our commercial prosperity and the more general appreciation of the importance of our science, not only in its applications, but as a factor in stimulating the dormant germ of culture in all men, have caused more generous provisions, with consequent elaboration in construction and equipment of chemical laboratories, entailing the most serious responsibility on the part of the professor in charge.

At the outset, I wish to make it plain that all the ideas put forward here have not been incorporated in our new laboratory. Many have. The reasons why the rest have not is of no interest to you. It is generally recognized that architects, however willing they may be, are of little real value in drawing up plans and specifications for laboratories beyond the exterior and artistic effects, as they are very special in their construction and use, of which the designer is naturally more or less ignorant. Our architect, Mr. George B. Post, however, has shown the greatest consideration and willingness to try to accomplish the ends aimed at. Much that I have to say is based upon a close study of laboratories in this country and in Europe. Many ideas we have put into effect have been secured here and there. A few are original.

The plan of a laboratory should be laid down in accordance with the destiny of the institution, as one may judge by its past and by a careful comparative study of the histories of other institutions, keeping in mind not only the immediate demands, but the probable developments within half a century.

LABORATORY PLAN AND ARCHITECTURAL EFFECTS

In the construction of chemical laboratories, different ideas have to prevail, depending entirely upon the immediate object aimed at by the laboratory. A private laboratory may be constructed along any particular lines desired. Undoubtedly a laboratory for the instruction of students in chemical engineering must be different from that used in instructing students of pharmacy or medicine. Most college laboratories, however, should be constructed with the object of giving a general training in chemistry, and not with the idea of training chemists. That should be incidental, which is not the case with technological institutions, where men are trained particularly in that line. Very special rooms, with particularly special apparatus, fixed and movable, must be provided, depending upon the requirements. This paper is concerned with laboratories for colleges in which general and not specific professional training is the aim.

While it is generally considered that a

[1] Read before the New York Section of the American Chemical Society, March 6, 1908.

chemical laboratory is a workshop, nevertheless a bit of decoration without and within can not fail to gratify the artistic. This is particularly true when a laboratory forms one of a group of buildings constructed according to a particular architectural plan. To cause the chemical laboratory of the College of the City of New York to conform to the architectural features of the rest of the buildings, there have been placed four shields of terracotta, about two meters high and one and a half meters wide, on the ends of the building. The two shields in front of the building have two series of alchemistical symbols, indicating the two fields of organic and inorganic chemistry. The other four have the alchemistical symbols indicating the old elements of earth, air, fire and water.

The ground plan of a laboratory should be laid out to secure the greatest amount of light, air and compactness. The plot of land will, of course, influence any decision. Where land is available, it is generally considered by those who have had experience that a building in the shape of the letter E is most satisfactory. The main entrance may well be placed at the front of the central extension, which, being two stories above the basement, may provide space for the main lecture theater. This part of the basement may well be arranged for receiving freight and contain the main or central room for stores.

It is desirable to limit the entrances to the building to two. Near the main entrance should be the director's office and just within this main door should be a small office for the janitor or door-keeper. All communications should enter the laboratory of the building by that means, and the other entrance to the laboratory should be at the rear, or within a court if the building is constructed with a court, and in connection with the main storeroom. This entrance should be used solely for freight purposes.

The width of the building, in my opinion, should at no point be more than sixty feet, except where the lecture theater is located. This will provide an ample corridor of about ten feet and laboratories not too deep for good light throughout, from without. To secure the latter, ceilings should be at least fifteen feet in the clear from the floor. By the use of reinforced concrete for the interior construction, the greatest economy in height of the building may be had.

FLOORING

There has been very much difference of opinion in regard to the kind of material of which to construct flooring for laboratories. Cement is hard; wood gets soggy and is affected by chemicals that are spilled; and asphalt compositions get soft. The heavy desks and hood supports sink and the furniture is thrown out of plumb. A number of different materials have been suggested. In my opinion the best which has been put forward is that which is known as lithoplast, devised by Dr. W. L. Dudley, of Vanderbilt University. It is essentially a paraffined sawdust sand floor, with a magnesia cement. This flooring may be laid in any length and in one piece, and offers many desirable qualities. The baseboard may be made as a part of this floor. There are no cracks. The presence of the sawdust allows of its expansion and contraction with changes of temperature, and the coating of paraffine over it prevents its rotting or napping, which are the objections put forward in opposition to composition floors containing sawdust. It may be tinted, polished, washed or scrubbed. It can be repaired without having cracked joints, and, furthermore, it allows nails and screws to be driven into it in much the same way that wood does.

PLUMBING

It is well recognized now that the plumbing in a laboratory should be exposed. This is accomplished in some cases by having a pipe trough in the floor, covered by a removable trap or grating. This is unsatisfactory, as such a conduit constitutes an open sewer in the floor.

The piping can be best suspended from the ceiling. This need not be in a haphazard manner, presenting an unsightly appearance, but the pipes may be carried in such order as to really constitute a decorative feature of the rooms. In carrying piping from floor to floor, they may be placed in a cupboard in the wall. The face of the cupboards, being held in place by screws, will give ready access in case there be need to inspect or make repairs.

It is advisable to insert a valve in the main which leads to each laboratory. By this means, in case there is need for repair in any one particular laboratory, only that laboratory is thrown out of commission for the time.

As the result of very careful study of the matter of the composition of the waste-pipe, I will say that I regard a high carbon cast iron as being the most satisfactory. This should be dipped in heavy tar which has been heated until it is perfectly fluid. These drains, with a suitable dip and trap, lead to vertical chemical wastes. The latter may well be of glazed earthenware joined with hot tar and surrounded by six inches of concrete. By having several trunk lines, vertical and opening out through the roof, there is little danger of clogging, and corrosion is reduced to a minimum. Obstructions may be removed by dropping a weight, suspended by a cord, through the opening above the roof.

The form of sink connecting with these wastes is not a mere matter of taste. Alberene serves the purpose admirably, but where it is possible, I think the porcelain overflow roll-rim flush sinks should be used. A perforated outlet prevents large solids being washed into the system. A rubber disk, or even a piece of paper, placed over the perforations gives a pneumatic trough of constant level. Should concentrated acid or alkali by chance come into the sink, it may be instantly diluted by turning a valve.

PAINTING

Undoubtedly whitewashed brick walls constitute a very satisfactory finish for a laboratory. White plaster is more attractive, and still more satisfactory is the white plaster which has been given three coats of acid sulphur-proof paint. A combination lithophone and zinc oxide has proved eminently satisfactory. Incidentally it may be stated that a number of paints were tested and found wanting.

All metal ware, which is likely to be exposed to any fumes whatever in the laboratory, should be painted with an acid-proof paint, and that which is underneath the hoods or between the desks may be treated with a black damp-resisting paint. All pipes upon the ceiling, etc., may be covered with the white enamel acid sulphur-proof paint referred to above.

VENTILATION

There are various systems for ventilating buildings in vogue. The one settled upon by our ventilation expert is known as the push and pull system. The air is filtered, drawn over tempering coils by a large motor-driven fan, carried by ducts, and driven in at the upper portion of the room. A fan in the attic pulls the air from the bottom of the rooms through corresponding ducts. Some prefer the pressure system, arguing that the tendency of the air to leak in around the windows is avoided, and, furthermore, that it facilitates the operation of the hood vents. The hood vents should, in my opinion, be joined up in a separate system with a separate fan. This fan located in the attic will draw the air out at a pressure of about three times as strong as that of the ordinary ventilating system. By providing slides for the hood outlets, or so-called chemical vents, economy in the speed of the motor may be brought about.

Undoubtedly glazed tile is the best material of which to construct the chemical vents. These should be set in hot tar. With buildings constructed of steel and stone, it is not easy, where sizes of the vents are variable, to secure a material properly burned, and it is difficult to hold it in place. We therefore devised a lining for our ducts which we think is satisfactory. The ducts may be cut to pass obstructing steel members or to follow any line that is desired. These ducts are essentially a frame of galvanized iron on the inside of which a lattice work of expanded metal is riveted. Upon this is placed from five eighths to three fourths of an inch of a cement containing some plaster and a sodium silicate composition, which sets to a very rigid mass. It is acted upon very slightly by acids. Of course, hydrofluoric acid attacks it as it does glazed tiling. This is subsequently covered, after thoroughly drying out, with three coats of an acid-proof paint. That which we used was devised by Mr. Maximilian Toch. It may not be uninteresting to give an account of some of the tests to which a preliminary sample duct was subjected before the instructions were given to proceed. A joint was made and was placed in contact with concentrated sodium hydroxide, concentrated ammonium hydroxide, and concentrated hydrochloric, sulphuric and nitric acids. It was slightly affected by the concentrated nitric acid. The coating was furthermore subjected to the vapors of boiling sulphuric acid and to a stream of chlorine. We felt that if it would withstand these reagents it could be safely placed in the building. The interior of these flues may be repainted from time to time by closing all the vents on any one line of the system, except the last one. Atomized acid-proof paint may be swept through the system by having the fan going at full speed. The large duct, five feet in diameter, at the end of the system, should be arranged to collect condensed moisture in a trough from which it may flow into the chemical drain. A man-hole placed at this point allows a cleaner to enter and wash down the walls by means of a hose.

HOODS

The hoods, preferably constructed of wood, should have a stone base slightly inclined to the rear, where an outlet is provided to the chemical drain. We have found that a cup cast of lead containing nine per cent. of antimony is most satisfactory for a connection to the cast-iron chemical drain to which reference has been made. Muthmann has constructed the drain pipes in the new Munich laboratory of this alloy. It is somewhat expensive, but exceedingly attractive, to have the rear of the hoods faced with glass tiling, and the vents made of white porcelain. But if they can do it in Childs's restaurants, I thought we could. Each hood is provided with two vents, one about twelve inches from the floor of the hood, and the other about twelve inches from the top. These vents are provided with sliding porcelain doors so that they may be closed when not in use.

HYDROGEN SULPHIDE

Hydrogen sulphide is delivered throughout the laboratory from a central generating plant in the basement. The Parsons generator, installed in duplicate, and constructed upon such unusually large dimensions that each apparatus will supply two hundred and fifty outlets operating simultaneously, has been adopted. In this connection the opinion is advanced that the setting aside of a special room where students congregate from all over the building for the use of hydrogen sulphide is unnecessary, and inviting the degeneration of liberty into license. In other words, the "stink room," for large laboratories at least, is a relic of the past. A shelf placed out of doors, in a court, for example, may be provided for the limited number of students, who from time to time must use large quantities of such gases as chlorine.

Lead-lined iron pipe is used for the transporting of hydrogen sulphide and hard rubber cocks are attached to this on the interior of the hoods. No hydrogen sulphide outlets are had except in the hoods. The front windows of the hoods are suspended upon paraffined window cord, which I think is superior to the bronze tape or chains used in some laboratories.

All outlets, except those mentioned, are brought to the front and underneath the floor of the hood. Just within the line of the base of the window-case are bored holes through which the tubing can be led into the hoods. When the tubing is not in all of these holes, the hood is thoroughly ventilated, when closed, by means of these openings.

DISTILLED WATER

The problem of economically providing ample distilled water for a large laboratory is one requiring most careful consideration. It has long been known that condensed boiler steam, even with oil arrestors, fails to be pure enough even for ordinary laboratory work. After securing much advice, the system here outlined was adopted. It may be constructed of any number of units. The water is preheated to remove free ammonia. We have the evaporators in duplicate and twenty condensers. On the try-out, three hundred gallons were produced in an hour. The apparatus is erected in the attic. The principle upon which it depends is that of boiling water with high-pressure steam passing through coils within the evaporators. The evaporators are thirty-nine inches in height and thirty inches in diameter, outside measurement, and contain one hundred and forty feet of extra heavy drawn copper tubing, properly coiled and coated with the best quality of block tin. The outer shell is of fifty-ounce cold-rolled copper; the heads are of same weight and are securely fastened to the sides with three-eighth-inch steel machine bolts. All spuds, nipples and fittings and all inside surfaces coming in contact in any way with the water, are heavily coated with the best quality of pure block tin; all joints are of invisible silver brazings, and all the fittings were sweated and brazed.

The evaporators are fitted with water gauges and cocks, all necessary steam, water and sewer connections, and suitable hand-holes for cleaning. The condensers are six feet in height, composed of two cylinders, the inner cylinder being seven inches in diameter, and the outer cylinder eight inches in diameter. The inside tubes are constructed of twenty-ounce cold-rolled copper, and the outer tubes of twenty-four-ounce cold-rolled copper, block tin coated inside and out, lap seamed. All joints were sweated and soldered with pure block tin. All fittings for water and steam connections are tacked together at regular intervals to prevent buckling with brass blocks, block tin coated. The bottoms of the condensers rest upon and empty directly into a large tin-lined reservoir. Tin-lined iron pipes with tin-lined valves serve to distribute the water by gravity throughout the building.

OXYGEN AND HYDROGEN

Hoods in which hydrofluoric acid is to be generated, or silica is to be driven off by that acid, should be lined with thin sheet lead. The front windows may be paraffined.

Oxygen and hydrogen can now be conveniently produced electrolytically in suitably placed tanks in which the gases are collected as generated, and stored. Both of these gases can be laid on to the lecture table and in the spectroscopic room. It is also desirable to have the oxygen laid on to the combustion room adjoining the organic laboratory. In this connection it may be stated that a good safety device is necessary to prevent back flash and possible explosions in these pipes. This can be readily accomplished by inserting a device built on the principle of the Davy lamp. About a meter from the final outlet the pipe is increased to double its bore for 250 cm. and then reduced again to its normal size. By inserting a loose roll of copper gauze in this enlarged portion of the pipe the striking back of the flame is avoided.

LECTURE THEATER

The lecture theater should be lighted by skylight and provided with a horizontal black curtain, electrically operated, for darkening the room. On dingy days or in the evenings, this room should be illuminated by diffused light from overhead reflection of electric bulbs hidden along the cornices of the room. If chandelier lighting be used, the Zalinski diffusion reflector made by the Halophane Company should be installed, as the best results are obtained from them.

The esthetic sense has been appealed to in our lecture room and museum by placing in each of these large rooms four plaster cornices. In the lecture room the four give a mythical representation of the realms of solid, liquid, gaseous and unknown forms of matter. In the museum we have the unknown of the past typified, the period of alchemy, the period of chemistry, and the celestial. A magnificent mural painting pleases the eye of one who sits in the grand lecture theater at the Sorbonne in Paris. In our theater, one looks not at the blank walls, but on the left-hand side he sees a framework which carries the names of the accepted chemical elements and the international atomic weights on movable panels. In this manner, as new elements are discovered, the panels may be shifted. As the atomic weights are changed as the result of our increased knowledge and more accurate work, the values can be changed. It may be interesting to call your attention to the fact that provision has not been made for more than one hundred elements, although I am aware that three hundred or more have been suggested.

On the right side of the wall we have the periodic arrangement of the elements in panels. Immediately underneath these panels are chart hangers, ammeters and voltmeters thirty-six inches in diameter (with illuminated scales) for both alternating and direct currents for electric furnace and other demonstrations. Immediately underneath these are glass blackboards with marked squares, the lines of which are not plainly visible at a distance in the room itself, but may be used with ease by the lecturer in plotting curves.

A suitable and separate system of illumination for the blackboards should be provided.

In my opinion, a lecture room should not be constructed to seat more than 250. The size of the room is so great when a larger number is taken care of that those sitting at the rear, however elevated the seats may be, have difficulty in seeing what actually takes place upon the lecture table. Should the lecture room be larger than that referred to, the experiments must be performed on a very large scale. This we have, in a measure, obviated by placing a reflectoscope on the lecture table, with which experiments on a small scale may be performed, and then thrown upon a screen overhead. In order to accomplish this, the instrument projects various objects upon a mirror which reflects it upon the screen. The screen can be operated to change its angle so that distortion is prevented, as is the practise at Cornell.

In addition to the projection lantern operated on the lecture table, to which reference has been made, a double dissolving lantern is placed at the rear of the room. A convenient method for signaling the operator is had by means of white and red lights, duplicates of which are placed within the movable reading desk on the lecture table so that the operator may signal the lecturer in case there is some temporary delay. Some people prefer a transparent screen placed behind the lecturer with the lantern operated in a room to the rear. We have provided one for such experiments that utilizes the sunlight, which may readily be reflected by a heliostat properly supported without a southern window.

LECTURE TABLE

Many lecture rooms have the lecture tables convex, which, in my opinion, is wrong. Those sitting at the extreme right, for example, see the apparatus head on and can not observe what is really going on. If the table be concave, this is obviated. I do not know any lecture theater in which this system has been adopted. As a matter of economy in room, the straight lecture table perhaps gives the best results.

It will be recognized that the experiments for demonstration should be selected, if possible, from those which show color changes or changes in volume, rather than weight. Pneumatic troughs with glass front and back and rear illumination have given satisfaction in many laboratories. In addition to these we have incorporated a pneumatic trough with mercury, so constructed with an extension pipe 5 cm. in diameter and 800 cm. long, that eudiometer tubes, 2 cm. in diameter, may be raised or lowered to secure an increased or diminished pressure of one atmosphere. The convenience of such an arrangement is obvious.

The size of the lecture table is a matter requiring grave consideration. Some of the most distinguished American lecturers in chemistry think that experiments should be selected to show but one thing at a time. This can not always be done, but necessary apparatus for the experiment, as gas scrubbers, for example, may just as well be placed out of sight and that part of the installation to which the attention of the student is to be particularly directed placed on the table. Despite the clarity of explanation, students often give attention to a fluid flowing into an aspirator bottle, for example, instead of observing the change of color in copper oxide which may be heated in an atmosphere of hydrogen. This principle is so emphasized by some of our most experienced and expert teachers that they allow the apparatus for but one experiment to be placed on the table at a time. That must be removed before the second is begun. An elaborate array of apparatus upon a long table is undoubtedly theatrical in effect and may serve to catch the student's attention at once and hold it throughout the discourse, as he will be afraid of missing a trick. This is not to be depended upon, however, for the next lecture, perhaps upon a more important topic of even greater interest, requiring but little apparatus, may serve to place the student in the opposite frame of mind.

The earnestness of a lecturer frequently urges him to come close to his hearers. It is remarkable what a difference is produced in that intimate mental association between teacher and student when the broad barrier of the lecture table no longer separates them. If the table be long, the psychological moment often passes in the extended march to get around the end of the table, or the time consumed in retracing one's steps wastes the opportunity to briskly emphasize by a quick reference to a sharp experiment. The desirable features of the various methods referred to may be attained by having a long table, say ten meters in length, so constructed that the two meters of the center are movable, being placed upon ball-bearing rubber-tired wheels. Certain experiments involving distillations, etc., may be in place upon either of the fixed partitions. The center may be removed, giving free movement in and out for the lecturer. By having several of these sections, experiments requiring apparatus which must be built up each time, as for example, some forms of electric furnace, may be performed and temporarily removed without disturbance. One of the movable tables may well be provided with a slab of soapstone or slate.

On the lecture table waste outlets for condenser water may be provided, as well as electric outlets for storage battery (low pressure), direct and alternating currents, switches for the several lighting systems, lantern operators, motors controlling the darkening shades, and numerous cocks for gas, water (cold and hot), steam, compressed air, vacuum, oxygen, hydrogen and hydrogen sulphide. Down-draft vents should be provided in each of the fixed portions of the table. An explosion shield of plate glass is easily lowered into the front of one or both of these tables. By a system of sliding doors, all cocks, drawers, etc., may be closed and locked by one key, thus making a complete cabinet.

Underneath and within sight of the lecturer there should be a clock attached to the electric system of the building. In this connection I should like to say that I think a wall clock visible to the students has no place in the lecture room, or, if it be there, it should be in operation only upon public occasions. In the lecture room the student should give undivided attention to the lecturer and the speaker should be the one to keep an eye upon the time. In the laboratory, there should be a clock within clear sight of every student, as he frequently must regulate the speed of his work by the time at his disposal.

PREPARATION ROOM

The preparation room should be placed preferably at the rear of the lecture desk, although in many laboratories it occupies the space underneath the elevated seats at the rear of the lecture room. A convenient arrangement is to have the preparation room and museum adjoining. In the preparation room it is desirable to have a thoroughly equipped chemical table. A hood should be placed in this room for the convenience of the lecture assistant that he may pursue a research. As he usually gives almost all his time to the preparation of lectures, he should be located right at his work. It is desirable to have in the preparation room, lathes for both metal and wood, an anvil, a large vise, and a carpenter's bench, in addition to the glazed cupboards for storing apparatus used for lecture purposes. There should be a drawing table, also.

In the stock room adjoining the preparation room there should be an annunciator in connection with each laboratory throughout the building and the director's office.

ARRANGEMENT OF ROOMS

It is desirable to arrange the laboratory so that the instruction of a particular kind is done on one floor, as far as possible, or in suites of rooms suitably arranged. We have found it convenient to place the laboratories for general chemistry upon two floors, two of them on the floor adjoining the lecture theater, and four on the floor immediately above. In this manner the presence of a large number of students in the corridors of the remaining portions of the building is avoided. In a college, of necessity, the main instruction is with the first-year students.

Where much demonstration is to be done in the laboratory, it is desirable to have all of the desks in the laboratory facing in one direction, the instructor having a desk upon an elevated stand. This is expensive in room consumption, however. Each desk at least should have a sliding shelf for the student's note-book.

Between each pair of laboratories at the end of the corridor is placed a quiz, or recitation, room. This recitation room will seat the largest number of students which can work in any one laboratory at a time. The principle involved is that essentially outlined in the first paper of this series. The lecture room is for the presentation of general principles, and illustration and elaboration of those principles. This can be done with a large body as well as with a small body of students. When, however, a student must apply some of these principles himself, we regard it wiser to have only a limited number of students working in a laboratory at a time. They are, therefore, divided up into sections, never having a larger number than twenty-eight, and preferably less.

On the third floor from the top, the second-year students may work in analytical chemistry. In addition to four analytical laboratories on this floor, we have an organic laboratory. The organic laboratory has connecting with it a room in which extra precautions have been taken to make it fireproof. This room is used as the bomb room. Opening into the organic laboratory is the combustion room, provided with two tables, fitted with two furnaces each. Suspended above each table is a metallic hood, painted with acid-proof paint, for ventilation purposes. These hoods are connected, however, with the chemical vents, as we get a stronger pull from that fan. On passing through the combustion room, we enter the small balance room, thence back into the organic laboratory.

BALANCE ROOMS

The balance rooms, numbering ten in our building, are arranged without regard to illumination by means of sunlight. We depend entirely upon artificial illumination. In this manner we save much lighting space which is frequently sacrificed for the balance rooms. Furthermore, it has distinctive advantages, because the shadow cast by artificial light is a constant and fixed one, whereas it varies with sunlight, depending upon the time of the day.

Our curriculum requirements lay down as prerequisites for physical, organic, industrial, advanced analytical chemistry, or metallurgy, courses not only in general, but qualitative and quantitative analysis. It will thus be seen that the second-year students all work on one floor. A few third-year students work on the same floor in the organic laboratory. The other third-year students and the senior class work on the ground floor, where we have a suite of rooms for physical chemistry, consisting of a laboratory for physical chemistry, an electrolytic and electric furnace room, and a spectroscopic analysis room. The students who may have elected applied chemistry work in the laboratory bearing that name, and just across the hall there are three laboratories adjoining one another for water, bacteriological and gas analysis. In the gas analysis room we have found it satisfactory to build the floor of asbestolith composition, which does not crack, so arranged that the baseboard and floor are all one piece and slope slightly to a central cup for the collection of mercury which may fall upon the floor. In the gas analysis room we have also a tin-lined tank holding 100 liters of distilled water, so that gas measurements are made with distilled water of the same temperature as the room.

The advanced analytical laboratory is provided with drying ovens, like those in the Massachusetts Institute of Technology, steam baths, such as one sees in the Harvard laboratory, closed and open hoods. These are constructed of glazed brick, set in cement and pointed up with plaster of Paris. The steam baths are constructed of alberene covered with a series of porcelain rings and are placed opposite plugged vents. Constant water-level contrivances are connected. The water is heated by means of high-pressure steam. In the basement we have a small room adjoining the assay room, which contains grinding machinery, pulverizing and bullion mills, and also types of furnaces, such as wind, down-draft gas, muffle and annealing furnaces.

Except in the case of the laboratories for general chemistry, there is a private laboratory for an instructor adjoining each laboratory in which the students are supposed to pursue a particular course.

In the basement we have a machinery room, containing two filtering plants, a drum for heating water, compressed-air engines, and water and vacuum pumps. In the line of the vacuum piping there is inserted, just before it reaches the pump, a scrubbing apparatus built of cast iron, lined with porcelain. Three of these drums are arranged so that the gases which pass into the vacuum pump are passed through a tower of pumice saturated with concentrated sulphuric acid; another tower containing solid caustic and the third one is placed in front as a safety reservoir. These towers are so arranged that they may be cut out of the system for a short time so they may be cleaned and refilled. This is done from the top. The accumulated liquors may be drawn from the bottom by means of hard rubber cocks.

One small room having a floor drain and connection with the chemical vent is set aside in the basement for the hydrogen sulphide generators. The floors, walls and ceilings are of one piece of asbestolith. This practise is followed in the storage battery room on the same floor.

A constant temperature room is conveniently had by selecting a small inside room in the center of the building and next the ground. It may be lighted by electricity, and, in this way, comparatively slight changes of temperature will be observed during the year.

STORAGE BATTERY

The principle advocated for storage-battery control may best be explained by outlining our system. Forty-eight cells are provided, with a discharge rate of 60 amperes in one hour, and with 120 ampere hours capacity on an 8-hour discharge. The cells are permanently connected as follows: One battery of 8 cells, connected two in series and four in parallel, giving four volts and capable of discharging at the rate of 60 amperes for 8 hours; two batteries of 12 cells each, connected three in series and four in parallel, giving 6 volts and having the same discharging capacity as the 4-volt battery; one battery of 16 cells connected four in series and four in parallel, giving 8 volts and yielding 60 amperes for 8 hours. All the batteries can be discharged so as to give 240 amperes in one hour.

The four battery systems are connected by cables to five bus bars on the distributing board in the electrolytic room, each bar being provided with 24 distributing sockets. The ends of the batteries are connected in series so that the differences of potential between the bars are, respectively, 4, 6, 6 and 8 volts, and 24 volts between the end bars. By this arrangement any desired voltage from 4 to 24 volts may be obtained. Connections are made from the distributing sockets to any current outlet in any part of the laboratory by means of plugs connected by a flexible cable provided with a fuse. Current is supplied to the user at the voltage and maximum current strength asked for. It is possible to supply about 60 outlets at a time with any voltage up to 24 volts. On disconnecting any allotted cells, the user has to state the approximate number of ampere hours taken from them. A record is kept of this for each battery, and it is thus easy to tell when a battery requires charging. The cells in each battery being used up at the same rate, any single cell is protected from being run down by a careless user, and all cells in a battery are in a comparable state.

The charging leads from the dynamo are led direct to the electrolytic room and connected to two sockets, and the charging connection to any set of cells is made on the distributing board, the battery room only having to be entered to inspect the cells. Current can also be taken direct from the dynamo from these sockets. Two plugs on the distributing board are connected to traveling cables in the battery room, so that any desired number of cells can be permanently assigned for specific purposes, and the condition of each cell investigated. The switchboard is of the simplest construction, yet it offers the most flexible arrangement known to the writer. It is essentially a marble slab supported vertically with brass-lined equidistant holes. A pair of holes leads to each outlet in the laboratory and is numbered. At the bottom are five rows of similar holes leading to the sets of cells in the battery room referred to. The connections are made by two flexible cables.

ELECTRO-ANALYSIS

Knowing of no better arrangement, the room for electro-analysis was copied after that of Professor Edgar F. Smith, of the University of Pennsylvania. There are 14 places containing voltmeters of 50 volts in half-volt divisions, and four voltmeters of 150 volts in half-volt divisions. On each side of these are two ammeters, one reading from 0 to 1 ampere in 100 ampere divisions and the other from 0 to 25 amperes in one fifth ampere divisions. The rheostats for these instruments are of the enamel type, having a total resistance of 172 ohms and divided into 51 steps arranged in geometrical progression.

STOREROOMS

The arrangement of the stock rooms presents interesting problems which are met, as a rule, in many small stores where compactness affords limited opportunity for roominess. As many drawers of various sizes, for different purposes as can be, should be built as part of the cabinet work up to about forty inches from the floor. Upon this can be constructed two kinds of shelves. First, ordinary wooden bottom shelves, preferably movable, for holding chemicals in bottles; second, wire-bottom shelves for holding glassware. Glass tubing and rods, placed on end, are well taken care of by upright partitions about 15 cm. apart and 25 cm. deep. It is desirable to have suspended over the outside of the last mentioned, for at least half the distance down, a cloth which prevents the accumulation of dust within the glass tubing. The value of glass for blowing purposes is frequently destroyed by minute particles of dust which accumulate inside the tubes.

In each stock room there should be a large chemical sink, either of alberene or porcelain, preferably the latter, provided with a flush rim. This sink is equipped with cold, hot, and distilled water. Above the sink, peg boards should be placed for the draining of glassware. It is desirable to provide non-spattering nozzles for the cocks over these large sinks.

As alcohol is bought in quantity and without the internal revenue tax, it is necessary to keep careful control over it. We have accomplished this in a most satisfactory manner by securing one of the copper tanks made by the Bramhall, Deane Company. The tank is so constructed, that alcohol is readily pumped into it from the regular containers in which it is shipped. It is provided with a safety valve to prevent excessive pressure being created in case of its being accidentally heated. It is also provided with a glass gauge the entire height, so that the contents may be judged. The cock by which the alcohol is drawn off is made with a lock.

It will be observed from the above that the teaching of one kind of chemistry is localized, and, as one progressively descends, the work of the student becomes more and more specialized along lines of preparatory study which he is to pursue subsequently at a professional school.

Charles Baskerville
College of the City of New York

THE AMERICAN BISON SOCIETY

The president of the society, Dr. William T. Hornaday, has written a letter asking cooperation with the society, in the effort it is now making to complete a fund of $10,000 with which to purchase and establish the Montana National Bison Herd, on the range that has been provided by congress. The ultimate object of this movement is to perpetuate the Bison species and leave it for future generations of Americans. It is hoped that there may be at Ravalli, Montana, in the not far-distant future, a herd of a thousand pure-bred bison, owned by the national government, and self-sustaining, on a fenced range.

At its last session, congress appropriated $40,000 with which to buy from the Flathead Indians twenty square miles of choice grazing grounds, erect a fence around it and dedicate it to use as a national bison range. The society pledged itself to provide the nucleus herd, and present it to the government, as soon as the range is ready. Ten thousand dollars must be obtained with which to discharge this obligation. Up to date subscriptions amounting to $3,102 have been received, and subscriptions to complete the amount required should be sent without delay to Dr. Hornaday, at the Zoological Park, New York City.

THE COMMITTEE OF ONE HUNDRED OF THE AMERICAN ASSOCIATION ON NATIONAL HEALTH

The president of the committee, Professor Irving Fisher, states that President Roosevelt has definitely taken up the program of the committee as part of his administration policy. He intends to incorporate the recommendation in his next message to congress—that the health bureaus of the government be concentrated into a common department, from which the bureaus not consistent with health and education will be removed elsewhere. This will be the first and most important step toward a powerful department whose special interest will be health and education.

The president authorized the announcement of this decision at the recent conference in Washington between the Committee of One Hundred, the American Medical Association, the American Public Health Association, the Conference of State and Provincial Boards of Health, the National Child Labor Committee, the Government Commission on the Organization of Scientific Work, the Public Health and

Marine Hospital Service, the Department of Health of the District of Columbia, the Division of Vital Statistics of the Bureau of the Census and the Surgeon General of the Army, representatives of all of which were present, the only absentees being the Surgeon General of the Navy, the Bureau of Animal Industry and the Bureau of Pure Foods, the representative of which, Dr. Wiley, was detained by a railroad accident. There were eighteen persons present. The conference passed a resolution heartily endorsing the president's action.

Similar resolutions endorsing the work of the Committee of One Hundred were passed on the day previous by the State and Provincial Boards of Health. Later, in Section 6 of the International Tuberculosis Congress, Surgeon General Walter Wyman, of the Public Health and Marine Hospital Service, who was chairman of that section, announced that he was in favor of the president's policy and would cordially cooperate in the endeavor to bring the transfers about.

There is at present no known opposition which should interfere with the passage this fall of legislation to make the necessary transfers. A large number of congressmen have signified their favorable attitude. It is believed that the legislation can be secured provided congressmen are convinced that the leaders in education and in hygiene are earnestly in favor of it.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold its autumn session at the Johns Hopkins University, beginning on Tuesday, November 17. On the evening of November 18 there will be a meeting of the committee on policy of the American Association for the Advancement of Science.

THE Right Hon. A. J. Balfour, F.R.S., has been nominated to deliver the Romanes lecture at Oxford University next year. The lecture will, it is reported in the press, be given by President Roosevelt in 1910.

THE Paris Academy of Sciences has elected M. Philippe van Tieghem, the distinguished botanist, as permanent secretary, to succeed the late M. Becquerel.

SIR WILLIAM TURNER, K.C.B., F.R.S., has been elected president of the Royal Society of Edinburgh.

THE following are the officers recommended by the president and council of the Royal Society for election for the year 1908–9: *President*—Sir Archibald Geikie, K.C.B., D.C.L., Sc.D., LL.D. *Treasurer*—Alfred Bray Kempe, M.A., D.C.L. *Secretaries*—Professor Joseph Larmor, D.Sc., D.C.L., LL.D., and Professor John Rose Bradford, M.D., D.Sc. *Foreign Secretary*—Sir William Crookes, D.Sc. *Other Members of Council*—Sir George Howard Darwin, K.C.B.; Professor James Cossar Ewart, M.D.; Sir David Gill, K.C.B.; John Scott Haldane, M.D.; Charles Thomas Heycock, M.A.; Professor Horace Lamb, D.Sc.; Professor Hector Munro Macdonald, M.A.; Frederick Walker Mott, M.D.; the Hon. Charles Algernon Parsons, C.B.; Professor William Henry Perkin, Ph.D.; Professor Edward Bagnall Poulton, D.Sc.; Lieutenant-Colonel David Prain, C.I.E.; Sir Arthur William Rücker, D.Sc.; the Right Hon. Sir James Stirling, LL.D.; Professor Frederick Thomas Trouton, Sc.D., and William Whitaker, B.A.

DR. FELIX ADLER, professor of political ethics at Columbia University, and Dr. W. M. Davis, professor of geology at Harvard University, made their inaugural addresses in the grand hall of the University of Berlin, on November 3.

PROFESSOR WILLIAM Z. RIPLEY, of the department of economics of Harvard University, has left Cambridge for London, where he will deliver on November 13 the annual Huxley lecture before the Royal Anthropological Institute. His subject is "The European Inhabitants of the United States."

THE Anthropological Society of Stockholm has elected Dr. Sven Hedin to honorary membership in the society, and has conferred on him a Wahlberg gold medal.

THE Royal Scottish Geographical Society will confer its gold medal upon Lord Avebury.

Dr. B. R. Rickards, director of the bacteriological laboratory of the health department of the city of Boston, has resigned to take charge of the laboratory of the State Board of Health at Columbus, O.

Mr. J. C. Temple has resigned the position of assistant in soil bacteriology in the North Carolina Agricultural Experiment Station and College to accept a position as soil bacteriologist in the Georgia Experiment Station.

Dr. A. J. Evans, F.R.S., will resign the keepership of the Ashmolean Museum, Oxford, at the end of this year.

The American Philosophical Society has appointed Dr. Henry F. Osborn, of New York, as its representative at the commemoration of the hundredth anniversary of Charles Darwin's birth, and the fiftieth anniversary of the publication of the "Origin of Species," to be held at Cambridge, under the auspices of the university, on June 22–24, 1909. It has appointed Dr. William Trelease, of St. Louis, to represent it at the inauguration of Albert Ross Hill, LL.D., as president of the University of Missouri, on December 10 and 11, 1908.

Dr. Adolph Hempel, '95, Illinois, plant pathologist and entomologist and professor in the Agricultural College at Sao Paulo, Brazil, will represent the University of Illinois at the first Pan-American scientific congress to be held at Santiago, Chili, commencing December 25.

Professor Charles D. Marx, of the department of civil engineering of Leland Stanford Junior University, has been engaged by the supervisors of San Francisco to report on the Hetch-Hetchy water project, now under consideration by the city.

Professor R. J. H. DeLoach, professor of cotton industry in the State College of Agriculture at Athens, Ga., has been made a member of the committee on Cotton Breeding of the American Breeders' Association.

Professor Bessey, of the University of Nebraska, delivered the annual "college day" address on the twenty-first of October at the Iowa State College, Ames, Iowa, this being the fortieth anniversary of the opening of the college. The subject of the address, which is soon to be published in *The Alumnus*, was "Laying the Foundations."

The second lecture of the Harvey Society course, delivered by Dr. William G. MacCallum, of Johns Hopkins University, at the New York Academy of Medicine, on November 7, was on the subject of "Fever."

W. Falta, M.D., docent of internal medicine in the University of Vienna, gave a lecture on "The Relations between Diseases that are caused by Disturbances of Internal Secretions," at the Harvard Medical School, on November 3.

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, New York, read a paper on "Recent Studies in Transplantation of Organs in Animals," at the meeting of the American Philosophical Society, Philadelphia, on November 6.

Raemer Rex Renshaw, instructor in chemistry in Wesleyan University, gave an illustrated lecture on "Industrial Alcohol," before the Middletown Scientific Association on November 10.

A memorial service at the University of Kansas in honor of the late Dr. Francis Huntington Snow, chancellor of the university from 1889 to 1901, and professor in the department of natural science since 1866, was held on November 10. Mr. James Willis Gleed delivered an address on behalf of the alumni, and Dean Green for the faculty. Dr. S. W. Williston, of the University of Chicago, who for many years was a colaborer with Dr. Snow in the work of building up the entomological and paleontological departments of the university to their present high standards, gave an account of Dr. Snow's work for the advancement of science. Col. H. L. Moore, of Lawrence, spoke for the citizens of the town on "Dr. Snow as a Private Citizen."

At the meeting commemorative of Dr. Daniel C. Gilman, late president of Johns Hopkins University, held last Sunday afternoon in McCoy Hall, addresses were delivered by President Remsen, Professors Gildersleeve and Welch, and the Hon. Charles J. Bonaparte, United States attorney-general.

DR. ALTHOFF, who a year ago retired from the directorship of the ministry in charge of the Prussian universities, and eminent for his services to higher education, has died at the age of sixty-nine years.

THE deaths are also announced of Professor Paul Henning, curator of the Royal Botanical Museum, at Berlin; of Dr. Cuthbert Collingwood, at the age of eighty-two, the author of "Rambles of a Naturalist in the China Seas," and of various scientific papers; of M. Gustave Canet, past president of the Institution of Civil Engineers, of France, and one of the founders of the French Association for the Advancement of Science; and of Mr. Henry Chapman, known for his work on the development of the application of machine tools actuated by hydraulic power, the perfecting of torpedo machinery, and with air compressors.

THE Swedish Medical Society of Stockholm celebrated the hundredth anniversary of its foundation on October 25.

AT the Baltimore meeting of the American Nature Study Society, December 29–31, there will be a session devoted to the relation of nature study and agriculture in elementary and ungraded rural schools, and another on relation of nature study to high-school science. Teachers and others who have suggestions to contribute are invited to send statements of their views and experience to the secretary of the society, Professor M. A. Bigelow, Teachers College, New York City.

PROFESSOR WILLIAM JAMES is now giving at Harvard University the course of eight lectures that he gave last spring at Oxford University on the Hibbert lectureship. The title of the lectures is "The General Situation in Philosophy," and the subjects of the several lectures are as follows:

November 6—The Types of Philosophic Thinking.

November 9—Monistic Idealism.

November 13—On Hegel.

November 16—On Fechner.

November 20—The Compounding of Consciousness.

November 23—Bergson's Critique of Intellectualism.

November 27—The Continuity of Experiences.

November 30—A Pluralistic Universe.

JESUP lectures will be delivered, under the auspices of Columbia University, at the American Museum of Natural History, on Wednesday evenings at eight o'clock, by Professor Richard C. Maclaurin, professor of mathematical physics. Professor Maclaurin's general subject will be "Light." The lectures, ten in number, will begin November 18.

HEWITT lectures, which are similarly conducted by the university at Cooper Union, will be given by Dr. William J. Gies on Monday evenings, beginning February 8. Dr. Gies, who is professor of biological chemistry at the College of Physicians and Surgeons, is arranging a series of experimental demonstrations to accompany his eight lectures, the subject of which will be "The Chemistry of Nutrition."

THE Shaler memorial expedition to Brazil, by whose provisions Professor Woodworth and several other members of the Harvard department of geology are now working in South America, has been the subject of a conference in the lecture room of the mineralogical museum. Professor R. DeCourtney Ward, who spent part of his summer in the country with Professor Woodworth, spoke of the weather and climate of Brazil, and Mr. Winthrop P. Haynes described the geology of eastern Brazil.

ACCORDING to foreign exchanges Professor Ehlers, of Copenhagen, well known as an authority on leprosy, is now in Paris with the view of organizing a scientific expedition to the Danish West Indies, which comprise the islands of St. Thomas, St. John and Santa Cruz. The object of the expedition is said to be to endeavor to determine the part played by blood-sucking insects, especially fleas and bugs, in the dissemination of leprosy. If the negotiations for the purpose come to a practical issue the expedition will consist of an equal number of Danish and French workers.

THE German Meteorological Society offers a prize of 3,000 Marks for the best treatment of meteorological observations obtained in the international ascents. The paper must be presented anonymously in German, English or French, not later than the end of 1911, to the secretary of the society, Professor G. Hellmann, Berlin W., 56. Shinkelplaz 6.

The exhibit on the ground floor of the American Museum of Natural History illustrating the solar system has been altered so as to be more comprehensive and instructive. The sun is now represented by an illuminated globe three inches in diameter, which brings the orbit of the earth just within the foyer. The foyer, therefore, now contains the whole of the orbits of Mercury, Venus and the earth and part of that of Mars, while the adjoining exhibition halls contain the remainder of the orbits of Mars and parts of those of Jupiter and Saturn. The orbits are represented by circles of wire on which the days and months are indicated and along which the planets, shown as lights of proper size, are moved from day to day in correct position.

The production of quicksilver in the United States in 1907, as shown by confidential returns to the United States Geological Survey from every producing mine in the country, amounted to 21,567 flasks of 75 pounds each, and was valued at $828,931, the figures showing a decrease, when compared with those for 1906, of 4,671 flasks in quantity and of $129,703 in value. A detailed report on the industry, prepared by H. D. McCaskey, geologist of the survey, has been published in an advance chapter from "Mineral Resources of the United States, Calendar Year 1907." An output of quicksilver was reported from but three states in 1907—California, Texas and Utah—and the single producer in Utah reported no production for the last seven months of the year. A small amount was reported from Oregon in 1906, but none at all in 1907. In California, which furnishes about 80 per cent. of the domestic production, the industry was not in a very flourishing condition during the year. The returns from the state show a decrease of 2,879 flasks in quantity and of $68,264 in value from the production of 1906—an output of 17,431 flasks, valued at $662,544, having been reported in the later year as compared with 20,310 flasks, valued at $730,808, in the earlier. The decrease in the hydraulic mining of gold, formerly so important an industry in California, the decreased amount of gold and silver recovered by amalgamation process alone, and the increased tendency to ship ores of the precious metals to smelters have all tended to reduce the local demand for quicksilver. Statistics of world production of quicksilver for 1907 are not yet available, but a comparison of the figures for quantities produced in foreign countries in 1906 with those for the United States in that year shows that this country ranked second among the quicksilver producers in that year, Spain having first place. Austria held third place, Italy fourth and Russia fifth. Practically all of the quicksilver product of Spain comes from the famous old mines of Almaden, where about 4,000 men are employed. It is probable that these mines alone contain sufficient reserve ore to enable them to dominate the world's market.

In May, 1906, Dr. Sheffield Neave was asked by the Tanganyika Concessions, Limited, on behalf of that company, of the Union Minière, and of the Benguella Railway Company, to ascertain, in respect of the mining area of Katanga, the distribution of the various species of tsetse and other biting flies, to study the distribution of sleeping sickness should it be found to exist, and to investigate the blood of the population in any infected area, to make research generally in respect of the disease in the concession and its neighborhood, and to report and advise as to what measures should be taken in respect thereto. The author has now narrated his experiences in a paper entitled Portions of Report on Work of Katanga Medical Commission, 1906, 1907, 1908. An abstract in *The British Medical Journal* states that a considerable portion of the time was spent ascertaining the distribution of *Glossina palpalis,* but other research work, when time permitted, was carried out. Dr. Neave found that the most typical form of enlarged glands containing trypanosomes was that which included the following qualities: (1) A symmetrical enlargement on both sides; (2) chain formation as opposed to single glands; (3) a resilient sensation given on palpation somewhat resembling an elastic distended airball; (4) size, about that of a hazel nut, a gland giving the idea of being something a little less than half an inch when taken up in the ordinary way between thumb and finger under the skin. In 1,327 palpations the percentage of enlarged glands from endemically-infected districts was found to be 62.4 per cent., as compared with 3,972 palpations, with a percentage of 39.2, where the disease did not exist. This latter figure clearly shows that enlarged glands must not always be considered proof of sleeping sickness. The letter from Mr. Williams to Dr. Neave indicates that the disease is not so severe and widespread in Katanga as was at first thought.

THE RESIGNATION OF PRESIDENT ELIOT

At a meeting of the president and fellows of Harvard College, on October 26, President Eliot presented the following letter:

To the President and Fellows of Harvard College:

Gentlemen: I hereby resign the office of president of Harvard University, the resignation to take effect at your convenience, but not later than May 19th, 1909.

The president's intimate association with the other members of the corporation in common service to the university is one of the most precious privileges of his highly privileged office. For this association with the fifteen friends who are dead, and the seven who are living, I shall always be profoundly grateful.

Congratulating you on your labors and satisfactions in the past, and on the sure prospect of greater labors and satisfactions to come, I am, with high respect,

Your friend and servant,

Charles W. Eliot

10 October, 1908

Whereupon it was

Voted, That the president's resignation be regretfully accepted, to take effect May 19, 1909.

UNIVERSITY AND EDUCATIONAL NEWS

The Iowa State College is just completing a new hall of agriculture of white stone construction, over two hundred feet in length, at a cost of approximately three hundred thousand dollars.

The cornerstone of the new agricultural hall of the University of Missouri was laid recently. The building will cost $100,000. Among the speakers were B. H. Bonfoeyn, of Unionville, Mo., a curator of the university; Norman J. Colman, commissioner of agriculture under President Cleveland; Dr. B. T. Galloway, an alumnus, now chief of the division of vegetable pathology of the Department of Agriculture; Dr. A. Ross Hill, president of the university; Dr. R. H. Jesse, late president, and Henry J. Waters, dean of the college of agriculture.

The University of Kansas has completed the equipment of a special laboratory for water analysis in connection with the state water survey. Special problems of public water supply, sewage and industrial waste will be taken up this winter. The work for the U. S. Geological Survey in analyzing the waters of rivers and streams in the state has been completed.

With the organization of the department of mining engineering in charge of Professor E. C. Holden, a graduate of the Columbia School of Mines and a practical mining engineer, the college of engineering of the University of Wisconsin is giving this fall for the first time a complete course in the practical details of mining. During the first semester the students are given work in excavation, explosives, blasting and tunneling, which will be followed by other courses in boring and shaft sinking. In the second semester the subjects of prospecting, the development and the exploitation of mines will be studied, and the students from the senior class will be given additional courses in the design of haulage, hoisting, pumping and ventilating systems for mining plants. Plans are now being made for the further equipment of the department with machines and apparatus for demonstration and laboratory work. The main portion of the equipment will be centered in an ore dressing laboratory, which will probably occupy the building formerly occupied by the university heating plant. Some small additions of machinery have already been secured, and it is expected that within a year a well-equipped ore dressing laboratory will be at the service of the students of mining engineering.

The widow of the Bavarian Surgeon-General Lotzbeck has given the sum of 20,000 Marks to endow a scholarship for medical students.

Professor John T. Hayford has accepted the directorship of the new school of engineering which Northwestern University will inaugurate in 1909. He will terminate his connection with the U. S. Coast and Geodetic Survey, and take up his duties at Evanston in the summer of 1909.

Mr. R. E. Stone has resigned an instructorship in botany at the Alabama Polytechnic Institute to accept a professorship of agricultural botany in the University of Nebraska.

Dr. Cyrus W. Field has resigned his position as assistant director of the research laboratory of the Department of Health, New York City, to accept the position of professor of pathology and bacteriology in the medical department of the University of Louisville.

Dr. Arnold Jacobi, director of the Natural History Museum in Dresden, has been appointed professor of zoology in the technical high school of that city.

Dr. Max Reithoffer has been appointed professor of electrical engineering at Vienna.

Dr. Alexander Supan, head of the Perthes Geographical Institute and editor of *Petermann's Mitteilungen*, has been made professor of geography at Breslau.

DISCUSSION AND CORRESPONDENCE

THE GARTER SNAKES OF NORTH AMERICA

To the Editor of Science: The U. S. National Museum has recently published (Bulletin 61, June 24, 1908) an important and very interesting account of the garter snakes of North America, by Mr. Alexander G. Ruthven. On reading the discussion of the variability in color and scutellation, I was struck by the absence of any reference to Sperry's earlier work along the same line. Again on reading the account of *butleri*, I was surprised to find no reference to Whittaker's very detailed study of the connection between *butleri* and *brachystoma*. These omissions led me to examine Mr. Ruthven's bibliography, with the rather surprising result of finding the three following papers lacking:

F. N. Notestein, 1906. The Ophidia of Michigan with an Analytical Key. Seventh Rep. Mich. Acad. Sci., pp. 111–125.

W. L. Sperry, 1905. Variation in the Common Garter-Snake (Thamnophis sirtalis). Fifth Rep. Mich. Acad. Sci., pp. 175–179.

C. C. Whittaker, 1906. The Status of Eutænia brachystoma. Seventh Rep. Mich. Acad. Sci., pp. 88–92.

Now, of course, it is very possible that I have entirely misunderstood the scope of Mr. Ruthven's bibliography, and that he only intends to include papers to which he refers in his text. He certainly knew of these three papers, as he has been a member of the Michigan Academy of Science since the spring of 1904.

But if his bibliography is complete so far as his own text-references go, I still do not understand why no reference is made to Sperry's and Whittaker's papers. So far as I know, Sperry's paper was the first discussion of variability in a garter snake, based on a large amount of material from a single locality. Some of the conclusions are of such importance that they ought to have been discussed by Mr. Ruthven. Concerning *butleri*, Mr. Ruthven says he has "already expressed the opinion" that Cope's specimen of "*brachystoma*" is identical with *butleri*. As Mr. Ruthven's opinion was not published until March, 1906, and Whittaker's elaborate discussion of the point was presented to the Michigan Academy, at Ann Arbor, in March, 1905, it would seem as though some mention of Whittaker's conclusions ought to have been made by Mr. Ruthven.

Very possibly it may be said that neither Sperry's nor Whittaker's paper was of sufficient importance to warrant notice, but to this I can not agree, and the purpose of this communication is to call attention to what seems to me an unfair neglect of earlier workers.

Hubert Lyman Clark

A NEW LOCALITY FOR MIOCENE MAMMALS

Some time ago Mr. William Stein, one of my students, brought me a fragment of the lower jaw of some equine, containing two teeth, excellently preserved. The specimen was found at his father's ranch at Troublesome, in Middle Park Colorado, in the course of making a well. It was about thirty feet from the surface, in red soil. As no Miocene beds have ever been reported from this region, the discovery is a remarkable one. Photographs of the specimen (three aspects) were made and sent to Dr. J. W. Gidley, of the National Museum. He very kindly replied that it was difficult to determine the species, but the characters shown seemed to place it rather definitely in the genus *Parahippus*. The horizon was Middle or Upper Miocene. Dr. W. D. Matthew also kindly examined the photographs, and thought the animal was correctly referred to *Parahippus*, and of Miocene age.

Mr. S. A. Rohwer made a trip to Troublesome, in order to search for further materials, but although he carefully examined all the surrounding region, he could not find any fossils. It seems probable that the deposit is quite local, and it may be that only extensive excavations at the Stein ranch will uncover the fossiliferous beds.

T. D. A. Cockerell
University of Colorado

EDUCATION AND THE TRADES

I read with much interest "The High School Course," by President David Starr Jordan in *The Popular Science Monthly* for July. While the tenor and purpose of the article as a whole are commendable, as progressive and liberal, one sentence contained therein shows that President Jordan is not unlike the orthodox ministers and church members, who pride themselves upon their broad-mindedness in having renounced the fire and brimstone hell, although they still hold fast to the devil—or who would look after the bad people, pray?

The sentence to which I refer is the following:

> But the purpose of this training must be intellectual, not to teach a trade, and only secondarily to fit for engineering courses of the universities.

Not to teach a trade! Why not lift the trades out of the gutter? and acknowledge them to be suitable, yea, fertile fields for intellectual activity?

President Jordan says:

> The development of manual training of some sort for all boys and girls will represent the greatest immediate forward step in secondary education.

Why? Simply because it is an approach toward the proper recognition and appreciation of that which is practical and useful.

In noting the great hue and cry which has gone over the country against child labor, I have often thought that these children who labor are not much more sinned against than the school children who are shut up in school rooms day after day and forced to study things which seem wholly foreign to their lives. They are obliged to sacrifice their most receptive years to the old traditional idea of education which consisted in the acquisition of so-called *intellectual knowledge;* of knowledge which was out of the reach of the working people, held aloft and kept free from contamination with the vulgar trades; knowledge which could never be degraded by use, in earning a living. Is it not high time that we break away from these shackles of tradition, and no longer wrong the trades by ostracizing them and considering the mastery of a trade something separate and apart from an intellectual pursuit?

A trade is defined as:

> An occupation, especially mechanical employment, as distinguished from the "*liberal arts*"—the learned professions, and agriculture. As, we speak of the trade of a smith, of a carpenter, or a mason, but, not now of the trade of a farmer, or a lawyer, or a physician.

This *now,* in the definition, shows that the farmer, lawyer and physician used to belong among the "tradespeople."

The intellectual boundaries will not suffer if the trades enter in. The old "no-trespassing" signs must come down, and the *trade-idea* must be elevated and placed upon a par with the so-called liberal arts.

It harks back to the old-world ideas of nobility and caste to insist upon a separation of the cultivation of the intellect, and the use that may be made of such cultivation.

Why should it be unworthy or undignified, and devoid of intellectual profit, to teach carpentering and plumbing, cooking and dressmaking, etc., instead of *manual training*, and *domestic science?* Is it not a foolish remnant of old-world pride, a relict of false aristocracy to which we feel we must cling, for fear the old world may sneer at our democracy?

A president of a university once said to me:

> If any one in speaking of our department of domestic science should call it a cooking school, just take a club to him, in my name.

In discussing some elaborately concocted dish, with a graduate of this department of domestic science, I remarked that too much time and labor were consumed in its preparation to justify its place in a menu, and she replied:

> O, I just learned how to make it in order to be able to teach in a domestic science department in some college, you know!

So it seems that our manual training is more or less entangled with the prevailing ideas about intellectuality and—the trades.

It is considered actually dangerous to open our curricula doors to the great arena of practicability, for fear of the over-cultivation of the material nature at the expense of the *inner life*. Let me quote from a recent university commencement address:

> Educational science regards the development of the inner life as the true course, and yet it is almost entirely neglected in both common school and college. A material education is the one sought, and though this is against all philosophy, it is kept up by the clamor and clatter of the world's perverted ideals. The true doctrine is preached in the halls of education and finds eloquent advocacy in school literature, but when it comes to real experience it recoils before the money-making, pleasure-getting and fame-achieving anxieties of the schools.
>
> The energy of the school purpose is diverted almost wholly to how to make a living, while how to live, which is the greater quest, is quite neglected.

In this age of the world it seems utter folly to philosophize about the outer and the inner life, as if they were two separate and distinct entities.

Imagine the world intent upon the cultivation of the inner life—having renounced its worldly zeal in making a material living! Commerce would go to sleep and civilization would drop back into barbarism. The consensus of opinion of the thinking world today is that the status of commercialism in any country is an index to the condition of civilization in that country. Every kind of labor may be the means of the cultivation of the outer and the inner life, but the inner life will never be lifted to a higher, spiritual plane by decrying what is popularly called the money-getting-sin. The inner life can only develop as the outer life prepares the way; the two are bound together and no philosophy can rend them asunder.

Only by teaching honestly what the world needs, and can use, may the schools accomplish their lofty aims.

It is a slow and wasteful method to try to help on the progress of general education by forcing an overflow of the *liberal arts* down into the trades, by way of the public schools. The better way would be to help the trades themselves to climb to more and more increased proficiency by the aid of the public schools and higher institutions of learning.

Stella V. Kellerman

PROVINCIAL MUSEUMS

Professor C. C. Nutting has recently written a very suggestive paper entitled "The Function of the Provincial Museum,"[1] which the writer has read with great interest. On page 169 the following statement occurs, which requires emendation:

> One has to look in vain for such a museum in our central states, the nearest approach to it being our own museum at Davenport. But the time is coming when such institutions will rank in importance with either of the other classes enumerated above.[2]

[1] *Proc. Daven. Acad. Sci.*, X., p. 167.

[2] Referring to the University and Metropolitan museums.

It is possible that Professor Nutting excluded from his consideration all museums which were wholly or partly supported by public funds, but the inference drawn from the paragraph quoted above is that there are no museums in the central states which are following along the lines indicated in his paper. There are at least two museums which should be classed as provincial museums which are now doing (and have been for some time past) the work outlined in Professor Nutting's paper, viz., the Public Museum of Milwaukee and the Chicago Academy of Sciences.

Both of the institutions mentioned are making extensive local collections, the exhibits are arranged and labeled with special reference to the education of the public, loans of material are made to the schools and large study collections are being acquired for research work. Free public lectures are maintained in the latter institution.

This statement is made with no desire to criticize Professor Nutting's very excellent paper, but simply to rectify a manifestly misleading statement, the inaccuracy of which doubtless escaped the notice of the author.

FRANK C. BAKER

MILK PROTEINS

TO THE EDITOR OF SCIENCE: The October number of the *Journal of Biological Chemistry* contained an article entitled "Milk Proteins," by Geo. A. Olson, and written as a "Contribution from the Agricultural Chemical Laboratory of the University of Wisconsin." It is generally assumed that when articles appear under the above caption they have received the sanction of those in charge of the laboratory from which they emanate. I desire to state that in this case Mr. Olson is entirely responsible for the material of his article and that those in charge of the laboratory assume no responsibility whatever for the deductions therein stated. I trust you will find a place in an early issue of SCIENCE for this note.

E. B. HART

UNIVERSITY OF WISCONSIN,
November 2, 1908

QUOTATIONS

THE RETIREMENT OF PRESIDENT ELIOT

THE announcement that President Eliot is to retire next March will come as a shock to thousands of persons who have never even seen University Hall. The country has come to look upon him as a great natural force, like the Gulf Stream, unwearied by the flight of time, unworn by incessant activity. Yet at the age of seventy-five even the strongest man is entitled to throw off some of his burdens. This is not the occasion, however, to review President Eliot's career as a whole; for he has, we trust, years of beneficent toil still ahead of him; our purpose is merely to touch on a few of the aspects of his administration at Harvard, and the causes which have made his the most notable career in the history of American education.

President Eliot would be the first to point out that he was fortunate in both the place and time of his labors. Harvard was the oldest college in the United States; it had the longest tradition of culture; it was at the center of the most highly educated and thoroughly civilized part of the union. Then, too, he assumed the presidency in 1869, just at the beginning of that period of enormous agricultural and industrial expansion which followed the civil war. America was growing rich rapidly, and Harvard has shared this prosperity. Other colleges have also had their part in this general advancement: why has Harvard taken the lead? Why is it the foremost university in America to-day? There can be but one answer: Because President Eliot has displayed in extraordinary measure the qualities of a great leader. When the graduates of Harvard addressed him in a formal letter on his seventieth birthday, they said: "With prophetic insight you anticipated the movements of thought and life; your face was toward the coming day." This is perhaps the best definition of a leader—that he is a man who sees in the long march of events the coming of the inevitable, and sets himself to hasten it.

President Eliot foresaw the coming of the elective system. It had, indeed, already come, here and there, in a limited way. Many educators, however, were not aware of the fact; others caught half-glimpses of the movement and stubbornly—shall we say blindly?—resisted it. He perceived the impending revolution and unhesitatingly cast his influence on the side of the new régime. It was evident that, with the development of scientific research in many branches, with the quickening interest in historical studies and economics, in the fine arts, and in modern languages—that under these circumstances the old hard and fast curriculum was bound to break down; that it had broken down. No college could pretend to minister to the intellectual needs of mankind which confined its students to the narrow round of the classics, mathematics, cut-and-dried philosophy, and a smattering of physics and chemistry. The new wine was bursting the old bottles. President Eliot dared greatly. Under a storm of criticism he boldly converted Harvard into an experimental laboratory for the application of the elective system. That experiment has not yet ended. We may not have mastered all the principles involved; we are still overwhelmed by the mass of details to be coordinated and subordinated. But whatever final results the centuries may bring, we can say now that President Eliot achieved a success which astonished his supporters and confounded his opponents.

The elective system is based on the theory that the best educational product is to be obtained only when student and teacher enjoy the widest intellectual freedom; and to this theory President Eliot has adhered with unswerving consistency. Indeed, he is often accused of pushing it to extremes. The student is allowed unrestricted range in the choice of courses; the professor's academic freedom has, as President Eliot himself once expressed it, been subject to only two limitations, "those of courtesy and honor." The president, too, has followed a liberal principle in picking his faculty. He has never shown that suspicion or dread of unusual intelligence, that predilection for mediocrity, which marks some of our heads of universities. He has selected the ablest men he could find, whether graduates of Harvard or not, and Harvard has thus escaped the blight of inbreeding which two or three decades ago afflicted Yale so severely. And all these policies have been carried out with wonderful executive skill—with unexampled grasp of detail, with foresight, patience, steadiness and tolerance.

To find a man who can fill his place is, of course, impossible. His attention to public questions and his utterances on such subjects as labor and its rights have made him the foremost private citizen of the United States. But it will take a long time for the next president of Harvard to establish such a reputation. Even the administrative work will have to be rearranged; for the giants who can lift the load to which his shoulders have grown accustomed are few. Nor are Harvard's problems all solved. The practical application of the elective system is full of difficulties. The system has been abused at Harvard and elsewhere. Small institutions of limited resources, ambitious to present an imposing list of courses in the catalogue, have sacrificed the instruction in the old studies with well developed disciplines, in order to spread the teaching thin over a broad field. If Harvard has been able to avoid this form of enfeeblement and demoralization, it has had other forms to contend with. Committees of the faculty are still trying to devise means by which students shall not divide and dissipate their energies in too many directions, or shall not slip through college on "soft" courses and practically avoid all study. These, however, are minor matters; for if Harvard can maintain a distinguished faculty, can make the conditions of life and teaching at Cambridge so attractive as to draw to its service the finest minds and characters in America, the rest will be comparatively easy. Thus President Eliot's successor can, as the letter of resignation puts it, face "the sure prospect of greater labors and satisfactions to come."—New York *Evening Post.*

SCIENTIFIC BOOKS

Marine Engineering. By Engineer-Commander A. E. Tompkins, Royal Navy, Late Instructor in Steam and Marine Engineering, Machine Construction, etc., at the Royal Naval College, Greenwich, and Lecturer at the Royal Naval War College, etc. New York, The Macmillan Company. $4.50.

This work the author terms a complete textbook on the construction and working of marine engines and boilers, from which it is to be assumed it does not apply to the designing, as the information on the latter subject is quite limited, whereas that on construction—or what follows the design—together with care and management are very complete. He gives a very full history of the development of the steam engine from Savery in 1698 to the turbine and gas producer of to-day. Much information is given to the one wishing to practise the art of designing the different structures, but the most to those desiring to become skilled in the construction, operation and care of the marine engine, as the designing of such machinery demands a line of study outside of what can be given in a treatise of this kind.

The articles on Care and Management are particularly valuable, as they are from the author's experience of many years in charge of machinery in warships of many types in the British Navy. It is, therefore, as he states: "A summary of the best practise of the present day." In support of this let me quote from chapter 32:

> The main propelling machinery is always erected in the workshops before its final erection in the ship. By this system the alignment and proper fitting of all parts are ascertained and any discrepancy remedied while still in the building stage, and usually a water-pressure test is made of cylinder jackets and other fittings in the shop. Although this preliminary building-up of the engines, only to be taken down and rebuilt, seems somewhat of a useless undertaking, experience shows that large saving in the cost of labor and better fitting and adjustment are obtained. . . . The successful working of the machinery is largely dependent upon this accuracy.

The correctness of this view is confirmed by my experience in the same line of work. The double care taken, although seemingly useless and unnecessarily expensive, has been found to be the most economical, also the one from which not only the best results are obtained, but is sure to avoid trouble and disappointment. The amount of care taken is often overdone, but what the author recognizes as necessary can not be avoided if superior results are desired. This part of the book has been dwelt upon as it is one so little recognized in works treating on the steam engine, whereas the neglect to properly inspect and install this engine in the vessel has defeated success from a faultless design. The great trouble in the production of the marine engine has been the absence of the same degree of intelligence in this part of the work, builders and their workmen having too great a tendency to rush the erection in the vessel, notwithstanding the fact that the time and care taken, as well as the first expense incurred are returned a hundred-fold before the vessel leaves the builders' hands, not to say anything in reference to a better performance from the beginning of its life.

Notwithstanding the general excellence of the book, there is one view to which exception must be taken and that is about the combustion chamber in the cylindrical boiler. Here the author states it should not be common to all furnaces, but should be as numerous as the latter in order to produce better circulation so as to save the tube-sheets. This is not only a fallacy as the trouble is due to unnecessarily heavy tube-sheets, but also an evil, as it prevents proper combustion of the gases and tends to produce smoke to obstruct observation and make the presence of the ship known.

This single criticism, however, should not take from the value of the work as it abounds in so much that is good and valuable to one seeking information on the subject and desiring to be correctly informed as to the marine engine practise of to-day and the lines on which it may be extended in the future.

The field of observation and subject covered show how great has been the growth in marine engineering in the past fifty years. In this the author has not been content to treat only on what to-day is found in general service, but invades the realm of the experimenter, taking up the combination of the reciprocating engine with the turbine, as well as the introduction of the gas producer in combination with the gas engine. The result in the first case will shortly be known as the White Star Line has taken this matter up and is building a large vessel equipped with such engines. The latter subject, however, although one of great interest in view of what has been done with the internal combustion engine, seems to warrant going deeper into the subject and has led up to its consideration on shipboard in connection with supplying gas for the use of the engine. In treating of the gas producer he not only speaks of the good features, but tells of the difficulties, which are of considerable importance, one being the cleaning of the fires and the other the replenishing of the water to produce steam admitted to the fuel when the vessel is in salt water. These are subjects which the enthusiasts on the gas producer have overlooked and will have to be taken care of in its development.

The questions from examination papers at the end of the volume, although some of them are unnecessary, for the proper care and management of the marine engine, such as "Define the term 'the Latent Heat of Steam,'" there are others which will be found valuable such as "Explain how a boiler is liable to suffer from undue haste in raising steam, and describe the precautions that are necessary when steam is being raised." The man who has the care of a steam engine should know all about the management of the boiler and no doubt will attend to his duties much better if his head is not filled with latent ideas.

Horace See

New York,
October 21, 1908

Gray's New Manual of Botany. A Handbook of the Flowering Plants and Ferns of the Central and Northeastern United States and Adjacent Canada, rearranged and extensively revised by Benjamin Lincoln Robinson, Asa Gray Professor of Systematic Botany in Harvard University, and Merritt Lyndon Fernald, Assistant Professor of Botany in Harvard University. New York, Cincinnati, Chicago, American Book Company. Seventh edition, illustrated. Copyright, 1908, by the president and fellows of Harvard College.

Sixty years ago Dr. Asa Gray issued the first edition of his "Manual of the Botany of the Northern United States," which covered the region "from New England to Wisconsin, and south to Ohio and Pennsylvania inclusive." In the second edition (1856) this rather limited region was extended southward so as to include Virginia and Kentucky, and westward to the Mississippi River, and here the boundaries remained for the third, fourth and fifth editions. The sixth edition was nominally "revised and extended westward to the 100th meridian," but in fact did not include all of the plants in the large addition to its area. The westward range of the present edition terminates at the 96th meridian, and it thus includes the trans-Mississippi states of Minnesota, Iowa and Missouri, and small fractions of eastern Nebraska and Kansas.

To one who was "brought up" on Gray's "Manual," this new edition has peculiar interest, and while many changes have been made in the old book the revisers have succeeded in preserving enough of the style of treatment, and the general appearance to make one soon feel at home in the new volume. The first thing that one who knew the old manual notices is the almost complete inversion in the sequence of the families, the book now following Engler and Prantl's "Pflanzenfamilien," instead of De Candolle's "Prodromus." This brings it into harmony with most modern systematic publications in this country and Europe, and makes it much more usable than it would have been had the old sequence been continued.

Another innovation is the introduction of many illustrations (numbering more than a thousand) which help to make the specific descriptions more distinctive. These are usually selected with much care, being used only when they can certainly help the text. Thus in the grasses (*Gramineae*) and sedges (*Cyperaceae*) they are very freely used, as they are also in *Umbelliferae*.

In regard to nomenclature we are told that the editors have scrupulously endeavored to bring it "into accord with the Vienna agreement." Accordingly the law of priority is observed, and also that requiring the double citation of authorities in certain cases. These, with the acceptance of the year 1753 as the date of the beginning of the binomial nomenclature, and the partial decapitalization of specific names, bring about many changes in the form and appearance of the names of familiar plants, so that sometimes one is not quite sure of the identity of particular species. To help such a situation the authors have judiciously introduced synonyms for certain genera and species.

Although the work is supposed to be rather conservative one notices a surprising number of significant changes in the names of plants. Thus we find *Amaranthus*, instead of *Amarantus; Nymphaea*, instead of *Nuphar; Castalia*, instead of *Nymphaea; Radicula*, instead of *Nasturtium; Gleditsia*, instead of *Gleditschia; Acer saccharam*, instead of *A. saccharinum; Acer saccharinum*, instead of *A. dasycarpum; Acer negundo*, instead of *Negundo aceroides; Psedera*, instead of *Ampelopsis* or *Parthenocissus; Lomatium*, instead of *Peucedanum; Brauneria*, instead of *Echinacea; Agoseris*, instead of *Troximon*, etc. Many minor changes in specific names due to observance of the law of priority may be noticed in glancing through the book; thus we find *Populus deltoides*, instead of *P. monilifera; Carya ovata*, instead of *C. alba; C. illinoensis*, instead of *C. olivaeformis; Fagus grandifolia*, instead of *F. ferruginea; Maclura pomifera*, instead of *M. aurantiaca; Gymnocladus dioica*, instead of *G. canadensis*, etc. That the authors have not been carried away by the flood of new "species" is shown by the fact that they enumerate only sixty-five species of *Crataegus*. They have not been as successful in the genus *Viola* where they admit forty-five species. *Sisyrinchium* is allowed thirteen species, in place of the single species in the first to the fifth edition. Yet we are thankful that the authors have held down the species makers to the extent they have, and we take it as an omen of better things in this regard.

In closing this very general notice of this important addition to the literature of systematic botany we wish to record our opinion that this is the right kind of a revision of such a standard work. It honors the great botanist much more to bring out such a modernized edition than to insist upon retaining the original treatment in all particulars as was done in the ill-starred sixth edition of this manual. The spirit of Dr. Gray was always progressive, and it is right that the successive editions of his books after his death should retain this characteristic, as has been done so well in the volume before us.

Charles E. Bessey
The University of Nebraska

SCIENTIFIC JOURNALS AND ARTICLES

The concluding (October) number of volume 9 of the *Transactions of the American Mathematical Society* contains the following papers:

G. D. Birkhoff: "Boundary values and expansion problems of ordinary linear differential equations."

A. B. Coble: "An application of the form problems associated with certain Cremona groups to the solution of equations of higher degree."

E. B. Wilson: "On the differential equations of the equilibrium of an inextensible string."

Max Mason and G. A. Bliss: "The properties of curves in space which minimize a definite integral."

Arnold Dresden: "The second derivatives of the extremal integral."

R. L. Moore: "Sets of metrical hypotheses for geometry."

"Notes and errata, volume 9."

The opening (October) number of volume 15 of the *Bulletin of the American Mathematical Society* contains: "Construction of Plane Curves of given Order and Genus, having Distinct Double Points," by Virgil Snyder; "On Periodic Linear Substitutions whose Coefficients are Integers," by Arthur Ranum; "Even Multiply Perfect Numbers of Five Different Prime Factors," by R. D. Carmichael; "The Fourth International Congress of Mathematicians: Sectional Meetings," by

C. L. E. Moore; "Notes"; "New Publications."

The November number of the *Bulletin* contains: "The Fifteenth Summer Meeting of the American Mathematical Society," by H. E. Slaught; "Answer to a Question raised by Cayley as regards a Property of Abstract Groups," by G. A. Miller; "Note on the Theorem of Generalized Fourier's Constants," by W. D. A. Westfall; "On the Logical Basis of Grassmann's Extensive Algebra," by A. R. Schweitzer; "General Algebraic Solutions in the Logic of Classes," by L. M. Hoskins; "A General Diagrammatic Method of Representing Propositions and Inference in the Logic of Classes," by L. M. Hoskins; "Heinrich Maschke; his Life and Work," by Oskar Bolza; "Notes"; "New Publications."

The American Naturalist for October opens with a paper by F. F. Blackman, on "The Manifestations of the Principles of Chemical Mechanics in the Living Plant." D. D. Whitney describes a number of experiments on "The Desiccation of Rotifers," the conclusions drawn from them being that rotifers do *not* revive after being dried for any length of time, the supposed resuscitation being due to the appearance of those hatched from the winter eggs. O. P. Hay has an article "On the Habits and the Pose of the Sauropodous Dinosaurs, especially of Diplodocus"; he considers that the attitude of these animals was probably like that of a crocodile with the body prone and legs more or less sprawled out, and doubts that they walked erect with legs in an elephantine position. Dr. Hay may not know that crocodiles—some at least—occasionally stand on their hind legs and rush at an assailant. W. A. Setchell gives some "pointers" on "Juvenile Substitutes for Tobacco."

The *Report of the Commissioners on Fisheries and Game* [for Massachusetts] for 1907 contains much general information and is very interesting reading. We commend it to that writer in *Nature* who recently stated that there was no evidence that the lobster was decreasing! As in the report for 1906 there is much information as to the history and status of the heath hen which there is a possibility of saving from extermination. The cut of the new knockabout type of Gloucester fishing vessel shows how far common sense has overcome the prejudice of sailors against any innovation; while the value of the innovations is shown in the statement that "again we are able to record that not a single Massachusetts fishing vessel has foundered." To appreciate this it is necessary to recall that in the ten years ending in 1883, 82 vessels and 895 men were lost.

Part II. of "The National Collection of Heads and Horns," issued by the New York Zoological Society is mainly devoted to a description of the splendid series gathered by A. S. Reed and presented by Emerson McMillin, another bit of testimony of the liberal manner in which New Yorkers support their scientific institutions. The specimens are from Alaska and British Columbia and comprise some striking examples of the mountain sheep, caribou and giant moose of that region.

Incidental to the recent meeting of the International Fishery Congress the Bureau of Fisheries has issued an account of its establishment, functions, organization, resources, operations and achievements. This is well illustrated and contains not only information in regard to the work of the Bureau of Fisheries but as to the fisheries of the United States.

MOOREHOUSE'S COMET

Professor E. B. Frost, director of the Yerkes Observatory, calls attention to the recent increase of brightness of Moorehouse's comet and writes on October 29:

It was visible to the naked eye, and three or four degrees of tail could readily be seen in a small field glass. Three spectrum plates were obtained with the Zeiss ultra-violet doublet and objective prism by Mr. Parkhurst with some assistance from me. Two of these had exposures of one hour. No continuous spectrum was perceptible, whence we may reach the important inference that last night the comet's light was very largely intrinsic. Seven bands were very conspicuous as knots on the plate. I am measuring the spectra this morning, but have no doubt that they will prove to show the ordinary hydrocarbon spectrum.

The photographs taken last night at the Harvard Observatory show a tail at least nine degrees in length, and much longer than on previous nights.

EDWARD C. PICKERING
HARVARD COLLEGE OBSERVATORY,
October 31, 1908

SPECIAL ARTICLES

NOTE ON THE OCCURRENCE OF RHODOCHYTRIUM SPILANTHIDIS LAGERHEIM IN NORTH AMERICA

IN the *Botanical Gazette* for October, 1908,[1] there is published a note on the occurrence of this interesting parasite upon the leaves of the ragweed (*Ambrosia artemisiæfolia*) in North Carolina. This short note is published in the hope that some readers who do not have access to the *Gazette* may have their attention called to this organism and that they may be on the lookout for it in other sections.

The plant is an alga devoid of chlorophyll. It is parasitic on the leaves, stems, pedicels, flower bracts, etc. It begins its development in early summer on the small seedlings and by developing succeeding crops of zoospores continues infection of these same plants throughout the season, until finally the flower racemes are affected. The main body of the parasite forms sporangia which vary from 50 to 300 μ in diameter, the smaller ones being on the leaves. The plant has a reddish-yellow oil deposited in the protoplasm which is so massed in the larger sporangia that it causes a bright red color visible through the thin layer of cortical tissue, so that the plant has the appearance of being studded with minute red dots, suggesting a *Synchytrium*. The plant is always located in or adjacent to the vascular bundles. There is an extensive system of mycelial rhizoids which are profusely branched. These rhizoids extend both up and down. The terminal mycelium is provided with numerous haustoria, many of which are often applied very closely to the spiral ducts, but never entering them, so far as I have observed. The plant body remains connected with the outside wall by the entrance tube. The outer end of these tubes is broadened into a trumpet-like expansion which is the remains of the zoospore wall. The plant thus resembles a giant *Entophlyctis*. The outer end develops into a broad exit tube through which the zoospores escape. The zoospores are biciliated, containing a reddish-yellow oil which is accumulated in the forward end of the elliptical zoospore where the two cilia are attached. Many of the zoospores conjugate in pairs, this taking place during the process of swimming. When the zoospores come to rest, they become rounded and are 8–10 μ in diameter. The zygozoospores are considerably larger.

The resting spores are provided with a very thick wall which is divided into three layers. At maturity there is an abundance of the reddish-yellow oil in the resting spores which is withdrawn along with the protoplasm and starch from the rhizoid system. The rhizoids then become plugged where they join the main body of the sporangium. The inner wall of the resting spores is laid down entirely distinct from the other walls and forms a complete envelop around the content which can be separated distinctly as the endospore from the other walls. The sporangia as well as the rhizoids are provided with starch. Great masses of starch are present in the sporangia. This starch is not, however, manufactured through the photosynthetic process by the organism, but is obtained from the host.

This organism, *Rhodochytrium spilanthidis* Lagerheim[2] was described by Lagerheim[2] fifteen years ago, from material collected on a species of *Spilanthes* in Ecuador. Though Lagerheim searched diligently on other genera he found it occurred only on *Spilanthes*. Here is then an interesting problem of distribution. Collectors in the southern part of

[1] Atkinson, G. F., "A Parasitic Alga, *Rhodochytrium spilanthidis* Lagerheim, in North America," *Bot. Gaz.*, 46, 299–301, 1908.

[2] Lagerheim, G. de, "*Rhodochytrium*, nov. gen., eine Uebergangsform von den Protococcaceen zu den Chytridiaceen," *Bot. Zeit.*, 51, 43–53, pl. 2, 1893.

the United States, Mexico and other tropical and subtropical countries could do an important service by the discovery of this plant. It will be interesting to know whether it is distributed through the intervening region between North Carolina and Ecuador, or whether it is more probable that it has been introduced through the agency of commerce from one country to another. My attention has recently been called to the fact that a form of this plant was distributed in Ellis & Everhart's "Fungi Columbiani" No. 2166 collected on *Asclepias pumila* at Stockton, Kansas, July 18, 1904, by E. Bartholomew and determined by Dr. Farlow as forma *asclepiadis* Farl. The rhizoid system does not seem to be nearly so well developed in this form as in that on the ragweed. This not only shows a greater geographic range, but also an extension to genera outside of the Compositæ. It ought to be found on other hosts. The writer will be pleased to receive specimens from other sections if they are found.

The plant was discovered in North Carolina by Dr. F. L. Stevens. Since the note was written for the *Gazette,* Dr. Stevens has given additional notes on the occurrence of the plant. The first collection was made in August, 1903, at West Raleigh. It occurs there every year in great abundance. In many cases the ragweed is so affected that the distortion can be recognized from the car windows. The stems and leaves affected are more or less stunted, twisted and curled. Rarely the affected areas on the stems may be slightly greater in diameter.

Other locations in North Carolina, with dates on which it has been collected by Professor Stevens, are given herewith.

1. Polkton	August	1, 1908.
2. Clayton	"	2, 1908.
3. Carey	"	5, 1908.
4. McLeansburg	"	7, 1908.
5. Davidson	"	13, 1908.
6. Mt. Ulla	"	15, 1908.
7. Hiddenite	"	17, 1908.
8. Taylorsville	"	18, 1908.
9. Connelly Springs	"	20, 1908.
10. Connelly Springs	"	21, 1908.
11. Marion	"	21, 1908.
12. Rutherfordton	August	22, 1908.
13. Hendersonville	"	25, 1908.
14. Auburn	"	27, 1908.

Geo. F. Atkinson

THE PRESENT STATE OF OUR KNOWLEDGE OF THE ODONATA OF MEXICO AND CENTRAL AMERICA

The completion of the account[1] of the Odonata in the *Biologia Centrali-Americana* and the rather restricted circulation which the book must enjoy, owing to the necessarily expensive character of this series,[2] will perhaps justify the publication in Science of a summary of the main results obtained, and of a comparison with previous work done in this field.

The preparation of this volume successively undertaken by McLachlan, of London; Hagen, of Cambridge, Mass., and Karsch, of Berlin, and successively relinquished by each of them under the pressure of ill-health or of other work, was entrusted to the present writer in the beginning of 1899.

The material on which it is based was primarily that acquired for the purpose by Dr. Godman, editor of the *Biologia,* and his associate, the late Osbert Salvin, F.R.S., but thanks to the directors, curators and owners of public and private museums, a still larger series of specimens has been available. It is, therefore, a great pleasure to acknowledge the aid thus rendered by the Academy of Natural Sciences of Philadelphia, the United States National Museum, the Museum of Comparative Zoology, the American Museum of Natural History, the Carnegie Museum of Pittsburg, the California Academy of Sciences, the Field Columbian Museum, the late Robert McLachlan, F.R.S., and Messrs. E. B. Williamson, C. C. Adams, C. C. Deam, J. G. Needham, H. Kahl, O. S. Westcott and E. A. Smyth, Jr.

[1] "Odonata," by Philip P. Calvert, forming pages 17–420, v–xxx, plates II.–X., 1 map, of volume Neuroptera, *Biologia Centrali-Americana.* Edited by F. Ducane Godman, F.R.S., etc., London, 1901–8, 4to.

[2] A sketch of the *Biologia* was published in *Entomological News,* XVI., pp. 317–322, December, 1905.

These collections contain the fruits of the field labors in Mexico, Central America and adjacent territory, both north and south, of Messrs. A. Agassiz, A. Alfaro, C. F. Baker, H. S. Barber, O. W. Barrett, J. H. Batty, Dr. Berlandier, P. Biolley, F. Blancaneaux, A. Boucard, L. Bruner, Burgdorf, H. K. Burrison, P. P. Calvert, Merritt Cary, G. C. Champion, Chaves, L. J. Cole, O. F. Cook, Collins, Lieutenant Couch, J. C. Crawford, Jr., G. R. Crotch, C. C. Deam, F. Deppe, C. H. Dolby-Tyler, Dubosc, A. Dugès, G. Eisen, H. J. Elwes, Festa, A. Forrer, H. Frühstorfer, G. F. Gaumer, F. D. Godman, P. H. Goldsmith, R. F. Griggs, the Hassler Expedition, R. H. Hay, B. Hepburn, Professor A. Heilprin (Expedition of the Academy of Natural Sciences, Philadelphia), Heyde, J. S. Hine, M. E. Hoag, C. F. Hoege, L. O. Howard, H. N. Howland, E. Janson, M. Kerr, C. H. Lankester, F. L. Lewton, F. E. Lutz, G. F. Mathew, W. M. Maxon, J. F. McClendon, R. E. B. McKenney, McNeill, N. Miller, A. B. Nichols, Palmer, H. Pittier, Ribbe, W. Richardson, C. W. Richmond, S. N. Rhoads, G. O. Rogers, H. Rogers, O. Salvin, H. de Saussure, W. Schaus, Schild, Schumann, S. C. Schumo, Shakspear, H. H. Smith, F. E. Sumichrast, O. Thieme, W. L. Tower, C. H. Townsend, J. F. Tristan, M. Trujillo, C. A. Uhde, C. F. Underwood, F. H. Vaslit, W. H. Vogel, C. Werckele, O. S. Westcott, C. H. White, E. B. and L. A. Williamson, H. Wilson and Mrs. E. B. Williamson.

In consonance with the general plan of the *Biologia* the work deals chiefly with the geographical distribution and taxonomy of these insects in Mexico and Central America, but includes their extra-limital occurrence also. The advance in knowledge which is here recorded can be seen from a comparison with the three older works which attempted completeness at their respective periods. (1) The "Synopsis of the Neuroptera of North America," by Hermann Hagen, published by the Smithsonian Institution in 1861; (2) the same author's "Synopsis of the Odonata of America" in the *Proceedings of the Boston Society of Natural History*, volume XVIII., 1875, which, as it omits the Lestinæ and Agrioninæ, must be supplemented for these subfamilies by the synopses of Baron Edmond de Selys Longchamps in the *Bulletins de l'Academie Royale des Sciences de Belgique*, 1865–77; and (3) the "Catalogue of Neuroptera Odonata" [of the world], by Mr. W. F. Kirby, London, 1890. This comparison is set forth in the following tables:

TABLE I.

Showing the Increase in the Number of Species and of Localities

Author	Number of Species		No. of Localities quoted from						
	Mexico	Cen. Amer.	Mexico	B. Hon. & Yucatan	Guatemala	Honduras	Nicaragua	Costa Rica	Panama
Hagen, 1861	69	4	10	(1)	(1)	(1)	0	0	0
Hagen, 1875, and Selys, 1861–77	88	26	15	(1)	(1)	(1)	1	0	1
Kirby, 1890	89	38							
Calvert, 1901–8	219	208	144	10	55	5	7	31	13

TABLE II.

Showing the Increase in the Number of Records

Author	Number of Records[3]						
	Mexico	B. Hon. & Yucatan	Guatemala	Honduras	Nicaragua	Costa Rica	Panama
Hagen, 1861	77	1	2	4	0	0	0
Hagen, 1875, and Selys, 1862–77	120	1	10	4	1	0	15
Calvert, 1901–8	1215	27	508	66	25	237	125

After deducting the duplications, the total number of species now known for Mexico and Central America as a whole is 293, of genera 71.

Only five of the species recorded by previous authors have not been seen by the writer—*Paraphlebia hyalina, Argia orichalcea, Herpetogomphus boa, Herpet. menetriesii* and *Macromia* sp., the last known only in the

[3] A "record" for any species is the noting of its occurrence in any one locality, and for each species there are as many records as there are separate localities at which it has been found.

nymphal stage. Two species, *Argia calida* Hagen and *A. funebris* Hagen, are known only from the type specimens.

Synoptic keys are given to the genera of the six sub-families comprising more than one genus each and to the species of forty-five of the genera. Two genera (*Hesperagrion* and *Metaleptobasis*—both Agrioninæ) and eighty-one species have been described as new.

Except in these eighty-one species and in the genus *Argia,* the specific descriptions and the figures on the plates are limited to features unnoticed, or insufficiently or incorrectly described or figured in the previous literature, which it is believed has been cited very fully. The distribution of each species is given in detail; the number and sex of the specimens examined and the collector's name are stated after each locality. To give the fullest information on such topics, the first of the two tables in the introduction comprises an alphabetically-arranged list, by countries, of all the localities from which Odonata are represented, the state, altitude and temperature-zone of each locality, the date of collection, the collector's name, and often remarks on the physical character of the environment or the precise spot where the insects were gathered.

The greater part of the nine years occupied in the preparation of this work has been consumed by the gathering and tabulating of various characters—especially those of the veining of the wings—which have been employed by previous writers to separate the genera, or which seemed to lend themselves to that purpose. These data (collected without the aid of clerks or assistants), numbering above one hundred and fifty thousand, were reduced to percentages for each of the species studied. Features which showed a variation of ten per cent. or less were thereby assumed to be of sufficient constancy to serve as generic characters, and among these importance was naturally assigned to those showing the least degree of variability. Many of the specific, as well as the generic, characters employed in the work rest on a similar basis. At the same time it must be remarked that the data are not sufficiently numerous for any one species to furnish bases for mathematical formulæ. The limitations of time and strength and in many cases also the available material forbade the examination of more than twenty-five or thirty individuals of a species, but not infrequently these were tabulated for twenty-five different characters, which in the case of the wind-details were noted for both sides of the body in each specimen. Further statement of this part of the work is not made here nor is it more than hinted at in a large part of the *Biologia* volume itself, since it is hoped to publish in another place tables of the percentages obtained.

Under each species, where possible, special attention has been given to noting: (1) the color changes through which the imago passes from the time of transformation to the final tints of old age—which has been done for fifty-two species, the most extensive changes being perhaps those of *Hesperagrion heterodoxum* (pp. 103, 377 and Plate VI., Figs. 1–6); (2) the geographical variations; (3) the individual variations found in the same locality. Owing to the conservative attitude adopted towards species, many of these variations (2) and (3) will doubtless afford—indeed have already afforded in one case—additional "species" to later workers in this field, but in these days one may perhaps reply to criticism with *de speciebus dividendis non disputandum.* In the matter of nomenclature some use has been made of trinomials, in the sense of the American Ornithologists' Union.

The areas which have been most carefully examined are portions of the Mexican states or territories of Tepic, Jalisco, Guerrero, Morelos, Distrito Federal, Tamaulipas, Vera Cruz and Tabasco, the central belt of Guatemala from the Caribbean to the Pacific and a few localities in Costa Rica. The odonatologically unknown area in Mexico and Central America is, therefore much greater than that which has been investigated.

Of the physical data which have yet been brought together, only those on temperature are sufficiently complete to enable one to make a natural division of Mexico and Central America as a whole, with which the distribution of the Odonata can be compared. A new map showing the mean annual temperatures of these countries has been compiled on the basis of previous maps and more recent records of meteorological observatories, and is included in the volume. Classifying these temperatures into groups of 5° C. each, there are obtained five (or six?) zones whose mean annual temperatures range from 30° (or more?) C. to less than 10° C. The second table in the introduction, a systematic list of the species, gives their distribution, *inter alia,* by temperature-zones. Incidentally it may be mentioned that the zone of 25°–20° C. has yielded the greatest number of species of dragonflies and the greatest number of endemic species.

As may be gathered from the foregoing, the ecological relations of these insects have not been fully treated in the *Biologia,* but many data have been brought together in a separate paper[4] dealing with the composition of this Odonate fauna and its relations to temperature, rainfall, forest areas and other environmental factors. Two ecological topics, however, are incidentally referred to in the *Biologia* volume but not in the ecological paper: Mimicry and the Proportions of the Sexes.

The examples of mimicry indicated are: *Paraphlebia* and *Palæmnema* (page 133, footnote ‡); *Libellula saturata croceipennis, Orthemis ferruginea, Libellula foliata* and *Paltothemis lineatipes* (pp. 212, 292); *Dythemis cannacrioides* and *Cannacria* species (p. 277); *Rhodopygia hollandi* and *Erythemis hæmatogastra* (pp. 319, 338); *Platyplax sanguiniventris* and *Erythemis peruviana* (pp. 328, 334). In none of these cases, however, is there as yet any evidence for or against the protective value of these resemblances.

Proportions of the Sexes.—10,838 specimens have been cited in this work from Mexico and Central America and 2,746 of the same species from other countries. Of the 10,838, 7,165 are males, 3,673 are females. That these numbers can not be regarded as having any special significance may be seen from the following comparisons:

A. Forms with dissimilarly colored wings in the two sexes, males the more conspicuous: *Hetærina cruentata* 265 ♂, 91 ♀; *H. vulnerata* 43 ♂, 44 ♀; *H. macropus* 239 ♂, 81 ♀; *H. infecta* 27 ♂, 27 ♀.

B. Forms with uncolored wings, bodies dissimilarly colored in the two sexes: *Argia extranea* 236 ♂, 160 ♀; *A. pulla* 414 ♂, 53 ♀; *A. lacrymans* 7 ♂, 7 ♀; *Ischnura ramburi* 18 ♂, 27 ♀; *I. denticollis* 140 ♂, 143 ♀; *I. demorsa* 44 ♂, 57 ♀; *Orthemis ferruginea* 196 ♂, 76 ♀; *O. levis* 28 ♂, 28 ♀.

C. Forms with similarly colored wings and bodies: *Megaloprepus cœrulatus* 42 ♂, 32 ♀; *Mecistogaster ornatus* 49 ♂, 73 ♀.

It is more likely that these numbers are due to the accidents of collecting than that they represent the proportions of nature.

Philip P. Calvert
University of Pennsylvania

[4] "The Composition and Ecological Relations of the Odonate Fauna of Mexico and Central America," by Philip P. Calvert. To appear in the *Proc. Acad. Nat. Sci. Philadelphia* for 1908.

SOME INVERSIONS OF TEMPERATURES IN COLORADO

As a part of some botanical work being done on the hills south of Boulder, Colo., two thermographs were kept running during the spring of 1908. One of these was located on the campus of the University of Colorado, at an altitude of 5,420 feet, the other on a mesa (flat-topped hill) about three quarters of a mile to the south, and at an altitude of 5,835 feet. The station on the mesa is about one mile east of the face of Green Mountain, which rises abruptly 3,000 feet.

As is well known, a mean difference of three degrees Fahrenheit usually occurs for each 1,000 feet in mountain districts, the higher points being the colder. Unless "inversion" occurs the records of the mesa would be expected to show about one or two degrees colder than the university campus. The observations show that inversion does occur and that the night temperatures on the mesa are distinctly higher than on the university campus. For the present note it will be sufficient to give certain data for the month of May.

TEMPERATURES OF CAMPUS AND MESA, MAY, 1908

	Campus, 5,420 ft.	Messa, 5,835 ft.
Monthly mean	51.5	54.1
Mean maximum	60.5	61.0
Mean daily range	23.2	19.5
Greatest daily range	39.0	36.0
Least daily range	0.0	2.0
Number of days having minimum 32 degrees or lower	5.0	2.0
Date of latest frost	May 21	May 5

For the table above the monthly mean was calculated by averaging the daily means obtained by the formula

(7 A.M. + 2 P.M. + 9 P.M. + 9 P.M.) ÷ 4 = *mean*.[1]

The mean temperature of the mesa station was 2.6 degrees higher than that of the campus; the mean maximum 0.5 degrees and the mean minimum 3.4 degrees higher. It will be noted that the greatest difference is in the mean minimum. The mean daily range is conspicuously less for the mesa than for the campus. To state the case briefly the mesa station has a milder climate than that of the campus; the daily range is less, the mean temperature greater; also for the present year, at least, killing frosts did not continue so late in the season.

The month of April was warmer than May, but in spite of this anomaly there were about the same differences between campus and mesa. An important point to notice, however, is that the mean maximum was higher at the campus station, 63.8 as against 61.6 on the mesa, but the mean minima show about the same differences as recorded for May. In April, therefore, the campus showed a much more severe climate than the mesa. Days were hotter, nights were cooler.

Hann states (p. 252) that "in calm weather the valleys are colder than the enclosing mountains, up to a certain height." In the observations made by the writer there was this difference, not only in calm weather but also in windy weather, indeed, nearly every night the mesa station showed the higher temperature.

Since the university campus is on the plains, while the mesa is part of the lower foothills, it may be said that the plains have a more severe climate than the lower foothills. The writer believes that this difference in climate is an important one in determining the limits of distribution of plants at the tension line between foothills and plains. This question will be discussed at length in an article soon to be published in the University of Colorado Studies by the present writer and Messrs. G. S. Dodds and W. W. Robbins.

FRANCIS RAMALEY

UNIVERSITY OF COLORADO,
BOULDER, COLO.

[1] Hann, "Handbook of Climatology," Ward's translation, 1903, p. 7.

SOCIETIES AND ACADEMIES

THE AMERICAN PHYSICAL SOCIETY

THE fall meeting of the Physical Society was held at Columbia University, New York City, on Saturday, October 24, 1908, with President Edw. L. Nichols in the chair.

The following papers were presented:

"Note on Spherical Aberration," W. S. Franklin.

"New Photometric Methods of Studying the Radiating Properties of Various Substances," Edward P. Hyde.

"Sparking Potentials in a Very High Vacuum," R. A. Millikan.

"Non-Newtonian Mechanics," Gilbert N. Lewis.

"The Definition of a Perfect Gas," A. G. Webster and M. A. Rosanoff.

"The Specific Heats of Gases and the Partition of Energy," W. P. Boynton. (By title.)

"The Distribution of Sound from the Megaphone," A. G. Webster.

"The Reflection of Sound by the Ground," A. G. Webster.

"Thermometric Lag in Calorimetry," Walter P. White. (By title.)

"The Electromagnetic Mass of a General Electric System," D. F. Comstock.

"A Study of Electric Wave Vibrators and Receivers," H. W. Webb.

"Note on a Method of Determining the Concentration of the Free Electrons in a Metal," O. W. Richardson.

"The Kinetic Energy of the Positive Ions emitted by Hot Bodies," F. C. Brown.

The next meeting of the society will be at Chicago on the Friday and Saturday following Thanksgiving.

ERNEST MERRITT,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 20, 1908

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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.

URANIUM AND GEOLOGY[1]

INTRODUCTION

IN our day but little time elapses between the discovery and its application. Our starting-point is as recent as the year 1903, when Paul Curie and Labord showed experimentally that radium steadily maintains its temperature above its surroundings. As in the case of many other momentous discoveries, prediction and even calculation had preceded it. Rutherford and McClung, two years before the date of the experiment, had calculated the heat equivalent of the ionization effected by uranium, radium and theorium. Even at this date (1903) there was much to go upon, and ideas as to the cosmic influence of radio-activity were not slow in spreading.[2]

I am sure that but few among those whom I am addressing have seen a thermometer rising under the influence of a few centigrams of a radium salt; but for those who pay due respect to the principles of thermodynamics, the mere fact that at any moment the gold leaves of the electroscope may be set in motion by a trace of radium, or, better still, the perpetual motion of Strutt's "radium clock," is all that is required as demonstration of the cease-

[1] Address of the president of the Geological Section of the British Association for the Advancement of Science, Dublin, 1908.

[2] See letters appearing in *Nature* of July 9 and September 24, 1903, from the late Mr. W. E. Wilson and Sir George Darwin referring to radium as a solar constituent and one from the writer (October 1, 1903) on its influence as a terrestrial constituent.

less outflow of energy attending the events proceeding within the atomic systems.

Although the term "ceaseless" is justified in comparison with our own span of existence, the radium clock will in point of fact run down, and the heat outflow gradually diminish. Next year there will be less energy forthcoming to drive the clock, and less heat given off by the radium by about the one three-thousandth part of what now are evolved. As geologists accustomed to deal with millions of years, we must conclude that these actions, so far from being ceaseless, are ephemeral indeed, and that if importance is to be ascribed to radium as a geological agent, we must seek to find if the radium now perishing off the earth is not made good by some more enduringly active substance.

That uranium is the primary source of supply can not be regarded as a matter of inference only. The recent discovery of ionium by Boltwood serves to link uranium and radium, and explains why it was that those who sought for radium as the immediate offspring of uranium found the latter apparently unproductive, the actual relation of uranium to radium being that of grandparent. But even were we without this connected knowledge, the fact of the invariable occurrence in nature of these elements, not only in association but in a quantitative relationship, can only be explained on a genetic connection between the two. This evidence, mainly due to the work of Boltwood, when examined in detail, becomes overwhelmingly convincing.

Thus it is to uranium that we look for the continuance of the supplies of radium. In it we find an all but eternal source. The fraction of this substance which decays each year, or, rather, is transformed to a lower atomic weight, is measured in tens of thousands of millionths; so that the uranium of the earth one hundred million years ago was hardly more than one per cent. greater in mass than it is to-day.

As radio-active investigations became more refined and extended, it was discovered that radium was widely diffused over the earth. The emanation of it was obtained from the atmosphere, from the soil, from caves. It was extracted from well waters. Radium was found in brick-earths, and everywhere in rocks containing the least trace of demonstrable uranium, and Rutherford calculated that a quantity of radium so minute as 4.6×10^{-14} grams per gram of the earth's mass would compensate for all the heat now passing out through its surface as determined by the average temperature gradient. In 1906 the Hon. R. J. Strutt, to whom geology owes so much, not only here but in other lines of advance, was able to announce, from a systematic examination of rocks and minerals from various parts of the world, that the average quantity of radium per gram was many times in excess of what Rutherford estimated as adequate to account for terrestrial heat-loss. The only inference possible was that the surface radium was not an indication of what was distributed throughout the mass of the earth, and, as you all know, Strutt suggested a world deriving its internal temperature from a radium jacket some 45 miles in thickness, the interior being free from radium.[3]

My own experimental work, begun in 1904, was laid aside till after Mr. Strutt's paper had appeared, and valued correspondence with its distinguished author was permitted to me. This address will be concerned with the application of my results to questions of geological dynamics.

Did time permit I would, indeed, like to dwell for a little on the practical aspect of measurements as yet so little used or under-

[3] *Proc. R. S.*, LXXVII., p. 472, and LXXVIII., p. 150.

stood; for the difficulties to be overcome are considerable, and the precautions to be taken many. The quantities dealt with are astoundingly minute, and to extract with completeness a total of a few billionths of a cubic millimeter of the radio-active gas—the emanation—from perhaps half a liter or more of a solution rich in dissolved substances can not be regarded as an operation exempt from possibility of error; and errors of deficiency are accordingly frequently met with.

Special difficulties, too, arise when dealing with certain classes of rocks. For in some rocks the radium is not uniformly diffused, but is concentrated in radio-active substances. We are in these cases assailed with all the troubles which beset the assayer of gold who is at a loss to determine the average yield of a rock wherein the ore is sporadically distributed. In the case of radium determinations this difficulty may be so much the more intensified as the isolated quantities involved are the more minute and yet the more potent to affect the result of any one experiment. There is here a source of discrepancy in successive experiments upon those rocks in which, from metamorphic or other actions, a segregation of the uranium has taken place. With such rocks the divergences between successive results are often considerable, and only by multiplying the number of experiments can we hope to obtain fair indications of the average radio-activity. It is noteworthy that these variations do not, so far as my observations extend, present themselves when we deal with a recent marine sediment or with certain unaltered deposits wherein there has been no readjustment of the original fine state of subdivision, and even distribution, which attended the precipitation of the uranium in the process of sedimentation.

But the difficulties attending the estimation of radium in rocks and other materials leave still a large balance of certainty—so far as the word is allowable when applied to the ever-widening views of science—upon which to base our deductions. The emanation of radium is most charactertistic in behavior; knowledge of its peculiarities enables us to distinguish its presence in the electroscope not only from the emanation of other radio-active elements, but from any accidental leakage or inductive disturbance of the instrument. The method of measurement is purely comparative. The cardinal facts upon the strength of which we associate radium with geological dynamics, its development of heat and its association with uranium, are founded in the first case directly on observation, and, in the second, on evidence so strong as to be equally convincing. Recent work on the question of the influence of conditions of extreme pressures and temperatures on the radio-active properties of radium appear to show that, as would be anticipated, the effect is small, if indeed existent. As observed by Makower and Rutherford, the small diminution noticed under very extreme conditions in the γ radiation possibly admits of explanation on indirect effects. These observations appear to leave us a free hand as regards radio-thermal effects unless when we pursue speculations into the remoter depths of the earth, and even there while they remain as a reservation, they by no means forbid us to go on.

The precise quantity of heat to which radium gives rise, or, rather, which its presence entails, can not be said to be known to within a small percentage, for the thermal equivalent of the radio-active energy of uranium, actinium and ionium, and of those members of the radium family which are slow in changing, has not been measured directly. Professor Rutherford has supplied me, however, with the calculated amount of the aggregate heat energy liberated per second by all these bodies. In the applications to which I will presently have to refer I take his estimate of 5.6×10^{-2} calories per second as the constant of heat-production attending the presence of one gram of elemental radium.

To these words of introduction I have to add the remark, perhaps obvious, that the full and ultimate analysis of the many geological questions arising out of the presence of radium in the earth's surface materials will require to be founded upon a broader basis than is afforded by even a few hundred experiments. The whole sequence of sediments has to be systematically examined; the various classes of igneous materials, more especially the successive ejecta of volcanoes, fully investigated. The conditions of entry of uranium into the oceanic deposits has to be studied, and observations on sea-water and deep-sea sediments multiplied. All this work is for the future; as yet but little has been accomplished.

THE RADIUM IN THE ROCKS AND IN THE OCEAN

The fact first established by Strutt that the radium distributed through the rock materials of the earth's surface greatly exceeds any permissible estimate of its internal radio-activity has not as yet received any explanation. It might indeed be truly said that the concentration of the heaviest element known to us (uranium), at the surface of the earth is just what we would not have expected. Yet a simple enough explanation may be at hand in the heat-producing capacity of that substance. If it was originally scattered through the earth-stuff, not in a uniform distribution but to some extent concentrated fortuitously in a manner depending on the origin of terrestrial ingredients, then these radioactive nuclei heating and expanding beyond the capacity of surrounding materials would rise to the surface of a world in which convective actions were still possible and, very conceivably, even after such conditions had ceased to be general; and in this way the surface materials would become richer than the interior. For instance, the extruded mass of the Deccan basalt would fill a sphere 36 miles in radius. Imagine such a sphere located originally somewhere deep beneath the surface of the earth surrounded by materials of like density. The ultimate excess of temperature, due to its uranium, attained at the central parts would amount to about 1,000° C., or such lesser temperature as convective effects within the mass would permit. This might take some thirty million years to come about, but before so great an excess of temperature was reached the force of buoyancy developed in virtue of its thermal expansion must inevitably bring the entire mass to the surface. This reasoning would, at any rate, apply to material situated at a considerable distance inwards, and may possibly be connected with vulcanicity and other crustal disturbances observed at the surface. The other view, that the addition of uranium to the earth was mainly an event subsequent to its formation in bulk, so that radio-active substances were added from without and, possibly, from a solar or cosmic source, has not the same *a priori* probability in its favor.[4]

I have in this part of my address briefly to place before you an account of my experiments on the amounts of radium distributed in surface materials. Here, indeed, direct knowledge is attainable; but this knowledge takes us but a very few miles inwards towards the center of the earth.

The Igneous Rocks.—The basalt of the Deccan, to which I have referred, known to cover some 200,000 square miles to a depth of from 4,000 to 6,000 feet or more, appears to be radio-active throughout. A

[4] *Nature*, LXXV., p. 294.

fine series of tunnel and surface specimens sent to me by the Director of the Indian Geological Survey has enabled me to examine the radio-activity at various points. It is remarkable that the mean result does not depart much from that afforded by a long series of experiments on north of Ireland basalt and on the basalt of Greenland.

Again, the granites and syenites—and those of Mourne, Aberdeen, Leinster, Plauen, Finsteraarhorn have been examined—while variable, yet approximate to the same mean result.

In the Simplon and St. Gothard tunnels igneous rocks have been penetrated at considerable depth beneath the surface. The greatest true depth is attained, I think, in the central St. Gothard massif. It is remarkable, and may be significant, that in these rocks I have reached the lowest radio-activities I have met—down to almost one billionth of a gram of radium per gram; although the general mean of the St. Gothard igneous rocks, owing to the high radio-activity of the Finsteraar granite at the north end of the tunnel, is not exceptionally low. Radio-active minerals seem common in the Simplon rocks, involving considerable variations in successive experiments. Some of the highest results are omitted on the mean given below, but as it is difficult to know what to allow for purely sporadic radium the mean is not very certain. In the case of a specially high result I asked Professor Emil Werner to determine the uranium: my result was confirmed. My list of mean results on igneous rocks up to the present is the following:

Basalts (14)	5.0[5]
Granites (6)	4.1
Syenites (1)	6.8
Lewisian gneiss (3)	5.7
Simplon (32)	7.6
St. Gothard (32)	5.1

The general mean is 6.1.

From the igneous rocks have originated the sediments after a toll of dissolved substances has been paid to the ocean. It does not of course follow necessarily that the percentage of radium, or more correctly of uranium, in the sedimentary rocks should be less than in the igneous. The residual materials might keep the original percentage of the parent rock, or even improve upon it. There are reasons for believing, however, that there would be a diminution.

Those sedimentary rocks which have been derived from materials formerly in solution offer a different problem. In their case there is little or none of the original materials carried into the secondary rock, and the radio-activity will depend mainly upon how far uranium is precipitated or abstracted with the rock-making substances. In other words, upon how far the waters of the ocean will restore to the rocks what it has borrowed from them.

This brings me to consider the condition of the ocean as preparatory to quoting experiments on the sediments.

The Ocean and its Sediments.—The waters of the ocean, covering five sevenths of the earth's surface to a mean depth of 3.8 kilometers, represent the most abundant surface material open to our investigation. As the mean of a very large number of experiments upon twenty-two different samples of sea-water from various widely separated parts of the ocean, I obtain a mean of 0.016×10^{-12} gram per cubic centimeter. There is considerable variability. Taking the mass of the ocean as 1.458×10^{-18} tonnes, there must be about 20×10^{-9}

[5] This number is to be multiplied by 10^{-12}, and represents billionths of a gram of radium per gram of material investigated. Throughout the rest of my address this understanding holds, unless where a different meaning is specified. The numbers in parentheses signify the number of different specimens investigated.

grams (20,000 tons) of radium in its waters.

The experiments which I have been able to make on deep-sea deposits, thanks mainly to the kind cooperation of Sir John Murray, apply to ten different materials of typical character.

The results are so consistent as to lead me to believe that although so few in number they can not be far wrong in their general teaching.

The means are:

	Radium	Extension: Millions of Square Miles
Globigerina ooze	7.2	49.5
Radiolarian ooze	36.7	2.5
Red clay	33.3	51.5

Diatom oozes have not yet been examined.

It is apparent from these results that the more slowly collecting sediments are those of highest radio-activity, as if the organic materials raining downwards from the surface of the ocean carried everywhere to the depths uranium and radium abstracted from the waters; but in those regions where the conditions were inimical to the preservation of the associated calcareous tests, there was the less dilution of the radioactive substances accumulating beneath. The next table shows that radio-activity and the percentage of calcareous matter in these deposits stand in an inverse relation:

			Calcium Carbonate, Per Cent.	Radium
Globigerina ooze,	*Chall.*,	338	92.24	6.7
Globigerina ooze,	"	296	64.34	7.4
Red clay,	"	5	12.00	15.4
Red clay,	"	276	28.28	52.6
Radiolarian ooze,	"	272	10.19	22.8
Radiolarian ooze,	"	274	3.89	50.3

The percentages of calcium carbonate are from the report of the *Challenger* Expedition. The red clay in the table, which reads as an apparent exception, is probably a case of recent change in the character of the deposit, for the evidence of manganese nodules and sharks' teeth brought up with this clay is conclusive as to the slow rate of its collection. Readers of Sir John Murray's and Professor Renard's report will remember many cases where recent change in the character of a deposit is to be inferred.

A point of much importance in connection with our views on oceanic radioactivity is that of the presence in the waters and in the deposits of the parent radio-active substance, uranium. The evidence that the full equivalent amount of uranium is present is, I believe, conclusive.

In the first place, to so vast a reservoir as the ocean the rivers can not be supposed to supply the radium sufficiently fast to make good the decay. In a very few thousand years, in the absence of uranium, the rivers must necessarily renew almost the entire amount of radium present. I have made examination of the water of one great river only—the Nile. The quantity of radium detected was 0.0042×10^{-12} per cubic centimeter. That is less than the oceanic amount. In short, it is evident that the uranium must accumulate year by year in the oceanic reservoir, like other substances brought in by the rivers, and that the present state of the waters is the result of such actions prolonged over geological time.

While this reasoning is conclusive as regards the waters of the ocean, it does not assure us that the sediments accumulating in their depths are throughout as radioactive as their surface parts would indicate. There might be a precipitation of radium unattended by uranium, in which case their deeper parts would not be radioactive.

Against this possibility there is the evidence of such true deep-sea deposits as were formed in past times and to-day still preserve their radio-activity. For instance, the chalk, which, considering that it was undoubtedly a very rapidly formed deposit, exhibits a radio-activity quite comparable with that of the *Globigerina* oozes, deposits which it most nearly resembles. In this deposit, clearly, the uranium must have collected along with the calcareous materials. We can with security argue that the similar oozes collected to-day must likewise contain uranium. In the case of the red clays we have the direct determination of the uranium which Professor Emil Werner was so good as to make at my request. Considering the difficulties attending its separation, the result must be taken as supporting the view that here, too, the radium is removed from the uranium. Regarding the efforts of other observers to detect uranium in such deposits, it is noteworthy that without the guidance of the radium, enabling specially rich materials to be selected for analysis, the success of the investigation must have been doubtful. The material used was a red clay with the relatively large quantity of 54.4 billionths of a gram per gram. In a few grams of this Werner obtained up to seven twelfths of the total theoretic amount, and of course the separation of the uranium is not likely to have been complete.

It might be thought a hopeless task to offer any estimate of the total bulk of the sub-oceanic deposits, and from this to arrive at some idea of the quantity of radium therein contained. Nevertheless, such an estimate is not only possible but is based on deductions which possess considerable security. As a major limit I believe the estimate of the total mass of deposit is unassailable, and such deductions as might be applied will still leave it an approximation to the truth.

The elements of the problem are simple enough; we know that the sedimentary rocks have been derived from the igneous, some 30 per cent. of the latter entering into solution in the process of conversion. Some of the soluble constituents, owing to their great solubility, have remained in solution since they entered the ocean.[6] These are the salts of sodium. An estimate of the amount of these salts in the ocean gives us a clue to the total amount of rock substance which has contributed to oceanic salts and oceanic deposits since the inception of the oceans. Some years ago I deduced on this basis that the igneous rocks which are parent to the sodium in the sea must have amounted to about 91×10^{16} tons.[7] This figure in no way involves the rate of supply by the rivers, or our estimate of geological time. It only involves the quantity of sodium now in the ocean—a fairly well-known factor—and the loss of this element, which occurs when average igneous rocks are degraded into sedimentary rocks—a factor also fairly well known. Mr. F. W. Clark, to whom geological science is indebted for so much exact investigation, has recently repeated this calculation, using data deduced anew by himself, and arrives at the result that the bulk of the parent igneous rock was 84.3×10^6 cubic miles.[8] On a specific gravity of 2.6 my estimate in tons gives nearly the same result: 84×10^6 cubic miles.

Now about one third part of this parent rock goes into solution when breaking up into a detrital sediment. The limestones upon the land are part of what was once so brought into solution. Having made deduction of these former marine deposits (and I here avail myself of Van Hise's and Clark's estimates of the total amount of the sedimentaries and the fraction of these which are calcareous),[9] and, allowing for

[6] *Trans. Royal Dublin Soc.*, Vol. VII., Ser. II., pp. 23 ff.

[7] *Ibid.*, p. 46.

[8] "The Data of Geochemistry," by F. W. Clark, p. 29.

[9] *Ibid.*, p. 31.

the quantity remaining in solution in the ocean, the result leaves us with the approximation of twenty million cubic miles of matter once in solution, and now for the greater part existing as precipitated or abstracted deposits at the bottom of the ocean. We are to distribute this quantity over its floor. If the rate of collection had been uniform in every part of the ocean throughout geological time, a depth of about one seventh of a mile (240 meters) of deposit would cover the ocean bed.

While, I believe, we can place considerable reliance on this approximation, we are less sure when we attempt an estimate of its mean radio-activity. If we assume for it an average radio-activity similar to that of *Globigerina* ooze, we find that the quantity of radium involved must be considerably over a million tons. Apart from the value which such estimates possess as presenting us with a perspective view of the great phenomena we are dealing with, it will now be seen that it supports the finding of the experiments on sedimentary rocks, and leads us to anticipate a real difference in the radio-activity of the two classes of material.

The Sedimentary Rocks.—The radium content of those of detrital character is indicated in the following sandstones, slates and shales:

Shales, sandstones, grits (10)	4.4
Slates (Cambrian, Devonian)	4.7
Mud from Amazon	3.2

Some of the above are from deep borings in Carboniferous rocks (the Balfour and Burnlip bores),[10] and from their nature, where not actually of fresh-water origin, can owe little to oceanic radio-activity. Many of the following belong to the class of precipitates, and therefore owe their uranium wholly or in part to oceanic source:

Marsupites chalk	4.2
Green sandstone	4.9
Green sand (dredged)	4.5
Limestones and dolomites [Trenton, Carboniferous, Zechstein, Lias, Solenhofen (7)]	4.1
Keuper gypsum	6.9
Coral rock, Funafuti bore (4)[11]	1.7
Trias-Jura sediments, Simplon: 17 rocks of various characters	6.9
Mesozoic sediments, St. Gothard: 19 rocks of various characters	4.2

The general mean of sixty-two rocks is 4.7.

Making some allowance for uncertainties in dealing with the Simplon rocks, I think the experiments may be taken as pointing to the result:

Igneous rocks from 5 to 6.

Sedimentary rocks from 4 to 5.

If our estimate of oceanic radium be applied to the account of the sedimentary rocks in a manner which will be understood from what I have already endeavored to convey, there will be found to exist a fair degree of harmony between the great quantities which we have found to be in the sediments of the ocean and the impoverishment of the sediments which the experiments appear to indicate.

In all these results fresh and unweathered material has been used. The sand of the Arabian desert gave me but 0.4. Similarly low results have been found by others for soils and such materials. These are not to be included when we seek the radio-activity of the rocks.

As regards generally my experiments on the radium-content of the rocks, I can not say with confidence that there is anything to indicate a definite falling off in radio-activity in the more deeply seated materials I have dealt with. The central St. Gothard

[10] For these rocks, and for much other valuable material, I have to thank Mr. D. Tate, of the Scottish Geological Survey.

[11] For these I have to thank the trustees of the British Museum and Mr. A. S. Woodward, F.R.S.

and certain parts of the Deccan have given results in favor of such a decrease. On the other hand, as will be seen later, the granite at the north end of the St. Gothard and the primitive gneiss of the Simplon show no diminution. According to the view I have put forward above as to the origin of the surface richness in radium it is I think to be expected that, while the richest materials would probably rise most nearly to the surface, there might be considerable variability in the radio-activity of the deeper parts of the upper crust.

URANIUM AND THE INTERNAL HEAT OF THE EARTH

While forced to deny of the earth's interior any such richness in radium as prevails near the surface, the inference that uranium exists yet in small quantities far down in the materials of the globe is highly probable. This view is supported by the presence of radium in meteoric substances and by its very probable presence in the sun—that greatest of meteorites. True, the radio-thermal theory can not be supposed to account for any great part of solar heat unless we are prepared to believe that a very large percentage of uranium can be present in the sun, and yet yield but feeble spectroscopic evidence of its existence. Taken all together, the case stands thus as regards the earth. We are assured of radium as a widely distributed surface material, and to such depths as we can penetrate. By inference from the presence of radium in meteoric substances and its very probable presence in the sun, from which the whole of terrestrial stuff probably originated, as well as by the inherent likelihood that every element at the surface is in some measure distributed throughout the entire mass, we arrive at the conclusion that radium is indeed a universal terrestrial constituent.

The dependent question then confronts us—Are we living on a world heated throughout by radio-thermal actions? This question—one of the most interesting which has originated in the discovery that internal atomic changes may prove a source of heat—can only be answered (if it can be answered) by the facts of geological science.

I will not stop to discuss the evidence for and against a highly heated interior of the earth. I assume this heated interior the obvious and natural interpretation of a large class of geological phenomena, and pass on to consider certain limitations to our knowledge which have to be recognized before we are in a position to enter on the somewhat treacherous ground of hypotheses.

In the first place, we appear debarred from assuming that the surface and central interior of the earth are in thermal connection, for it seems certain that, since the remote period when (probable) convective effects became arrested by reason of increasing viscosity, the thermal relations of the surface and interior have become dependent solely on conductivity. From this it follows if the state of matter in the interior is such as Lord Kelvin assumed—that is, that the conductivity and specific heat may be inferred from the qualities of the surface materials—we have remained in thermal isolation from the great bulk of the interior for hundreds of millions of years, and perhaps even for more than a thousand million of years. Assuming a diffusivity similar to that of surface rocks, and starting with a temperature of 7,000° Fahr., Kelvin found that after 1,000 million years of cooling there would be no sensible change at a depth from the surface greater than 568 miles. In short, even if this great period—far beyond our estimates of geological time—has elapsed since the *consistentior status,* the cooling surface has as yet borrowed heat from only half the bulk of the earth.

It is possible, on the other hand, that the conductivity increases inwards, as Professor Perry has contended; and if the central parts are more largely metallic, this increase may be considerable. But we find ourselves here in the regions of the unknown.

With this limitation to our knowledge, the province of geothermal speculation is a somewhat disheartening one. Thus if with Rutherford, who first gave us a quantitative estimate of the kind, we say that such and such a quantity of radium per gram of the earth's mass would serve to account for the 2.6×10^{20} calories which, according to the surface gradients, the earth is losing per annum, we can not be taken as advancing a theory of radio-active heating, but only a significant quantitative estimate. For, in fact, the heat emitted by radium in the interior may never have reached the surface since the convective conditions came to an end.

And here, depending upon the physical limitations to our knowledge of the earth's interior, a possibility has to be faced. That uranium is entirely absent from the interior is, as I have said, in the highest degree unlikely. If it is present, then the central parts of the earth are rising in temperature. This view, that the central interior is rising in temperature, is difficult to dispose of, although we can adduce the evidence of certain surface-phenomena to show that the rise in temperature during geological time must be small or its effects in some manner kept under control. In a word, whether we assume that the whole heat-loss of the earth is now being made good by radio-active heating or not, we find, on any probable value of the conductivity, a central core almost protected from loss by the immense mass of heated material interposed between it and the surface, and within this core very probably a continuous source of heat. It is hard to set aside any of the premises of this argument.[12]

We naturally ask, Whither does the conclusion lead us? We can take comfort in a possible innocuous outcome. The uranium itself, however slowly its energy is given up, is not everlasting. The decay of the parent substance is continually reducing the amount of heat which each year may be added to the earth's central materials. And the result may be that the accumulated heat will ultimately pass out at the surface by conductivity, during remote future times, and no physical disturbance result.

The second limitation to our hypotheses arises from this transformation and gradual disappearance of the uranium. And this limitation seems as destructive of definite geothermal theories as the first. To understand its significance requires a little consideration. The fraction of uranium decaying each year is vanishingly small, about the ten thousand-millionth part; but if the temperature of the earth is maintained by uranium and consequently its decay involves the fall in temperature of the whole earth, the quantity of heat escaping at the surface attendant on the minute decrement would be enormous. An analogy may help to make this clear. Consider the case of a boiler maintained at a particular temperature by a furnace within. Let the combustion diminish and the furnace temperature fall a little. The whole mass of the boiler and its contents follow the downward movement of temperature, heat of capacity escaping at the surface. An observer, only noting the outflow of radiated heat and unable to observe

[12] Professor H. A. Wilson has made a suggestive estimate of the thermal effects of radium enclosed in the central parts of the earth (*Nature*, February 20, 1908).

the minute drop of temperature, would probably ascribe to the continued action of the furnace, heat which, although derived from it in the past, should no longer be regarded as indicating the heating value of the combustion. Magnify the boiler to terrestrial dimensions: the minutest fall in temperature of the entire mass involves immense quantities of heat passing out at the surface, which no longer indicate the sustaining radio-thermal actions within.

It is easy to see the nature of the difficulties in which we thus become involved. In fact, the heat escaping from the earth is not a measure of the radium in the earth, but necessarily includes, and for a great part may possibly be referred to, the falling temperature, which the decay of the uranium involves. If we take λ (the fraction of uranium transforming each year) as approximately 10^{-10} and assume for the general mass of the earth a temperature of 1,500°, a specific heat of 0.2, and, taking 6×10^{27} as its mass in grams, we have, on multiplying these values together, a loss in calories per annum of 1.8×10^{20}. This by hypothesis escapes at the surface. But the surface loss, as based on earth-gradients of temperature, is but 2.6×10^{20} calories. We are left with 0.8×10^{20} calories as a measure of the radium present. On this allowance our theories, in whatever form, must be shaped. Nor does it appear as if relief from this restriction can be obtained in any other way than by denying to the interior parts of the earth the requisite high thermal conductivity. Taking refuge in this, we are however at once confronted with the possibility of internal stores of radium of which we know nothing, save that they can not, probably, be very great in amount. In short, I believe it will be admitted on full examination of this question that, while we very probably are isolated thermally from a considerable part of the earth's interior, the decay of the uranium must introduce a large subtractive correction upon our estimates of the limiting amounts of radium which might be present in the earth.

But, finally, is there in all these difficulties sufficient to lead us to reject the view that the present loss of earth-heat may be nearly or quite supplied by radium, and the future cooling of the earth controlled mainly by decay of the uranium? I do not think there are any good grounds for rejecting this view. Observe, it is the condition towards which every planetary body and every solar body containing stores of uranium must tend; and apparently must attain when the rate of loss of initial stores of heat, diminishing as the body grows colder, finally arrives at equilibrium with the radio-thermal supplies. This final state appears inevitable in every case unless the radio-active materials are so subordinate that they entirely perish before the original store of heat is exhausted.

Now, judging from the surface richness in radium of the earth and the present loss of terrestrial heat, it does not seem reasonable to assign a subordinate influence to radio-thermal actions; and it appears not improbable that the earth has attained, or nearly attained, this final stage of cooling.

How, then, may we suppose the existing thermal state maintained? A uniformly radio-active surface layer possessing a basal temperature in accordance with the requirements of geology is, I believe, not realizable on any probable estimate of the allowable radium, or on any concentration of it which my own experiments on igneous rocks would justify.

But we may take refuge in a less definite statement, and assume a distribution by means of which the existing thermal state of the crust may be maintained. A specially rich surface layer we must recognize, but this need be no more than a very few miles deep; after which the balance of the radium may be supposed distributed to any depth with which we are thermally connected. Below that our knowledge is indefinite. The heat outflow at the surface is in part from the surface radium, in part due to the cooling arising from the diminishing amount of uranium, in part from the deep-seated radium. In this manner the isogeotherms are kept in their places, and a state is maintained which is in equilibrium with the thermal factors involved, but which can not be considered steady, using the word in a strictly accurate sense, in view of the decay of the uranium.

While the existing thermal state may, I think, thus be maintained by radio-active heating and radio-active decay, we find ourselves in considerable difficulties if we extend this view into the past and assume that the same could be said of any previous stage of the earth's history. If the heat emitted by the earth, when the surface was at melting temperature, was in a state of equilibrium with the radio-active supplies, then, at that date, there must have been many thousands of times the present amount of uranium on the earth, and the period of the *consistentior status* must be put back by thousands of millions of years. Apart from hopeless contradiction with every geological indication as to the age of the earth, difficulties in solar physics arise. For the sun must be supposed of equal duration, and we are required to assume impossible amounts of uranium to maintain his heat all that great lapse of time; and again this uranium would perish at just the same rate as that upon the earth, so that at the present time the solar mass must be, for by far the greater part, composed of inert materials of high atomic weight: the products of the transformations of the uranium family. The difficulty is best appreciated when we consider that even to maintain his present rate of heat-loss by radium supplies, some 60 per cent. of his mass must be composed of uranium. But there are other troubles to face if we adopt this view. The earth, or rather those parts of it which are sufficiently near the surface to lose heat at the requisite rate, would have cooled but one per cent. in 10^8 years. Shrinkage of the outer parts and crustal thickness will be proportionately small, and we must put back our epochs of mountain building to suit so slow a rate of cooling and skrinkage and refer the earlier events of the kind into a past of inconceivable remoteness. Otherwise we must abandon the only tenable theory of mountain formation with which we are acquainted. On such a time-scale the ocean would be supersaturated under the influence of the prolonged denudation like the waters of certain salt lakes, and the sediments would have accumulated a hundredfold in thickness.

Nor do the facts as we know them require from us such sacrifices. We are not asked to raise these difficulties on suppositious quantities of uranium for the existence of which there is no evidence. Radium has occasioned no questioning of the older view that the cooling of the earth from a *consistentior status* has been mainly controlled by radiation. But, on the contrary, this new revelation of science has come to smooth over what difficulties attended the reconciliation of physical and geological evidence on the Kelvin hypothesis. It shows us how the advent of the present thermal state might be delayed and geological time lengthened, so that Kelvin's forty or fifty million years might be reconciled with the hundred million years which some of us hold to be the reading of the records of denudation.

On this more pacific view of the mission of radium to geology, what has been the history of the earth? In the earlier days of the earth's cooling the radiation loss was far in excess of the radio-thermal heating. From this state by a continual convergence, the rate of radiation loss diminishing while the radio-thermal output remained comparatively constant, the existing distribution of temperature near the surface has been attained when the radio-thermal supply may nearly or quite balance the loss by radiation. The question of the possibility of final and perfect equilibrium between the two seems to involve the interior conductivity and in this way to evade analysis.

It will be asked if the facts of mountain building and earth-shrinkage are rendered less reconcilable by this interference of uranium in the earth's physical history. I believe the answer will be in the negative. True, the greatest development of crustal wrinkling must have occurred in earlier times. This must be so, in some degree, on any hypothesis. The total shrinkage is, however, not the less because delayed by radio-thermal actions, and it is not hard to point to factors which will attend the more recent upraising of mountain chains tending to make them excel in magnitude those arising from the stresses in an earlier and thinner crust.

UNDERGROUND TEMPERATURE

It would be a matter of the highest interest if we could definitely connect the rise of temperature which is observed in deep borings and tunnels with the radio-activity of the rocks. We are confronted, however, by the difficulty that our deepest borings and tunnels are still too near the surface to enable us to pronounce with certainty on the influence of the radium met with in the rocks. This will be understood when it is remembered that a merely local increase of radio-activity must have but little effect upon the temperature unless the increase was of a very high order indeed. A clear understanding of this point shows us at once how improbable it is that volcanic temperatures can be brought within a very few miles of the surface by local radio-activity of the rocks. To account on such principles for an elevation of temperature of, say 1,200° at a depth of three or four miles from the surface, a richness in radium must be assumed far transcending anything yet met with in considerable rock masses; and as volcanic materials appear to show nothing of such exceptional richness in radium we can hardly suppose local radio-activity of the upper crust responsible for volcanic phenomena.

When we come to apply calculation to results on the radio-activity of the materials penetrated by tunnels and borings, we at once find that we require to know the extension downwards of the rocks we are dealing with before we can be sure that radium will account for the thermal phenomena observed. At any level between the surface and the base of a layer of radio-active materials—suppose the level considered is that of a tunnel—the temperature depends, so far as it is due to local radium, on the total depth of the rock-mass having the observed radio-activity. This is evident. It will be found that for ordinary values of the radium content it is requisite to suppose the rocks extending downwards some few kilometers in order to account for a few degrees in temperature at the level under observation. There is, of course, every probability of such a downward extension. Thus in the case of the Simplon massif the downward continuance of the gneissic rocks to some few kilometers evokes no difficulties. The same may be said of the granite of the Finsteraarhorn massif and the gneisses of the St. Gothard massif, materials both of which are penetrated by the St. Gothard tunnel, and which appear to possess a considerable difference in radio-activity. In dealing with this subject, comparison of the results obtained at one locality with those obtained at another is the safest procedure. We must accordingly wait for an increased number of results before much can be inferred. I will now lay the cases of the two great tunnels as briefly as possible before you.

And first as to the temperature effects observed in the two cases.

The Simplon tunnel for a length of some seven or eight kilometers lies at a mean distance of about 1,700 meters from the surface. At the northerly end of this stretch the rock temperature attains 55°, and at the southern extremity has fallen to about 35°. The temperature of 55° is the highest encountered. The maximum predicted by Stapff, basing his estimates on his experience of the St. Gothard tunnel, was 47°. Other authorities in every case predicted considerably lower temperatures. Stockalper, who also had experience of the St. Gothard, predicted 36° at a depth of 2,050 meters from the surface, and Heim 38° to 39°.[13]

When the unexpectedly high temperatures were met with, various reasons were assigned. Mr. Fox has suggested volcanic heat. Others point to the arrangement of the schistosity and the dryness of the rocks, where the highest temperatures were read. The latter is evidently to be regarded more as explanation of the lower temperatures at the south end of the tunnel, where the water circulation was considerable, than of the high temperatures of the northern end. The schistosity may have some influence in bringing the isogeotherms nearer to the surface; however, not only are the rocks intensely compact in every direction, but what schistosity there is by no means inclines in the best directions for retention of heat. From the sections the schistosity appears generally to point upwards at a steep angle with the tunnel axis.[14]

Where there is such variability in the temperatures, irrespective of the depth of overlying rock, there is difficulty in assigning any significant mean gradient. The highest readings are obviously those least affected by the remarkable water-circulation of the Italian side. The higher temperatures afford such gradients as would be met in borings made on the level—about 31 meters per degree.

The temperatures read in the St. Gothard rocks were of a most remarkable character. For the central parts of the tunnel the gradients come out as 46.6 meters per degree. Stapff, who made these observations and conducted the geological investigations, took particular pains to ascertain the true surface temperatures of the rock above the tunnel; and from these ascertained temperatures, the temperatures in the tunnel rock and the overlying height of mountain, he calculated the gradients.

But this low gradient is by no means the mean gradient. At the north end, where the tunnel passes through the granite of the Finsteraarhorn massif, there is a rise in the temperature of the rock sufficient to steepen the gradient to 20.9 meters per degree. Stapff regarded this local rise of temperature as unaccountable save on the view that the granite retained part of the original heat. This matter I will presently return to.

Now, it is a fact that the radium-content of the Simplon rocks, after some allowance for what I have referred to as sporadic radium, stands higher than is afforded by the rocks in the central section of the St. Gothard, where the gradient is low. For the Simplon the general mean is (on my experiments) 7.1 billionths of a gram per gram. This mean is well distributed as follows:

[13] See the account given by Schardt, *Verhandl. Schweizerischen Naturf. Gesellsch.*, 1904, 87, "Jahresversammlung," pp. 204 ff.

[14] Schardt, *loc. cit.*

Jurassic and Triassic altered sediments	6.4
Crystalline schists, partly Jurassic and Triassic, partly Archean	7.3
Monte Leone gneiss and primitive gneiss	6.3
Schistose gneiss (a fold from beneath)	6.5
Antigorio gneiss	6.8

The divisional arrangement is Professor Schardt's. Forty-nine typical rocks are used in obtaining these results, and the experiments have been in many cases repeated on duplicate specimens. Including some very exceptional results, the mean would rise to 9.1×10^{-12} grams per gram.

Of the St. Gothard rocks I have examined fifty-one specimens selected to be, as far as attainable, representative.[15]

Of these, twenty-one are from the central region, and their mean radium content is just 3.3. The portion of the tunnel from which these rocks come is closely coincident with Stapff's thermal subdivision of regions of low temperature.[16] This portion of the mountain offers the most definite conditions for comparison with the Simplon results. The region south of this is affected by water circulation; the regions to the north are affected by the high temperature of the granite.

We see, then, that the most definite data at our disposal in comparing the conditions as regards temperature and radio-thermal actions in the two tunnels appear to show that the steeper gradient is associated with the greater radium-content.

It is possible to arrive at an estimate of the downward extension of the two rock masses (assumed to maintain to the same depth their observed radio-activity), which would account for the difference in gradient. In making this estimate, we do not assume that the entire heat-flow indicated by the gradients is due to radium, but that the difference in radium-content is responsible for the difference of heat-flow. If some of the heat is conducted from an interior source (of whatever origin), we assume that this is alike in both cases. We also assume the conductivities alike.

Calculating on this basis, the depth required to establish on the radium measurements the observed difference in gradients of the Central St. Gothard and of the Simplon, we find the depth to be about 7 kilometers on the low mean of the Simplon rocks, and 5 kilometers on the high mean. There is, as I have already said, nothing improbable in such a downward extension of primitive rocks having the radio-activities observed; but as a different distribution of radium may, of course, obtain below our point of observation, the result can only claim to be suggestive.

Turning specially to the St. Gothard, we find that a temperature problem of much interest arises from the facts recorded. The north end of the tunnel for a distance of 2 kilometers traverses the granite of the Finsteraarhorn massif. It then enters the infolded syncline of the Usernmulde and traverses altered sediments of Trias-Jura age for a distance of about 2 kilometers. After this it enters the crushed and metamorphosed rocks of the St. Gothard massif, and remains in these rocks for 7½ kilometers. The last section is run through the Tessinmulde for 3 kilometers. These rocks are highly altered Mesozoic sediments.

I have already quoted Stapff's observations as to the variations of gradient in the northern, central and southern parts of the tunnel. He writes:

> They (the isotherms) show irregularities on the south side, which clearly depend on cold springs, they bend down rapidly, and then run smoothly

[15] I would like to express here my acknowledgments to the trustees of the British Museum for granting me permission to use chips of the rocks in their possession; and especially to Mr. Prior for his valuable assistance in selecting the specimens.

[16] *Trans. North of England Mining and Mech. Engineers*, XXXIII., p. 25.

inclined beneath the water-filled section of the mountain. Other local irregularities can be explained by the decomposition of the rock; but there is no obvious explanation of the rapid increase in the granite rocks at the northern end of the tunnel (2,000 meters), and it is probably to be attributed to the influence of different thermal qualities of the rock on the coefficient of increase. For the rest these 2,000 meters of granite belong to the massif of the Finsteraarhorn, and, geologically speaking, they do not share in the composition of the St. Gothard. Perhaps these two massifs belong to different geological periods (as supposed for geological reasons long ago). What wonder, then, if one of them be cooler than the other.[17]

Commenting on the explanation here offered by Stapff, Prestwich[18] states his preference for the view that the excess of temperature in the granite is due to mechanical actions to which the granite was exposed during the upheaval of this region of the Alps.

The accompanying diagram shows the distribution of temperature as given by Stapff, and the distribution of radium as found from typical specimens of the rocks. There is a correspondence between the two which is obvious, and when it is remembered that the increase in radio-activity shown at the south end would have been, according to Stapff, masked by water circulation, the correspondence becomes the more striking. The small radium values in the central parts of the tunnel are remarkable. The rocks of the Central St. Gothard massif are apparently exceptionally poor in radium.

At the north end the excess of radium is almost confined to the granite, the rock to which Stapff ascribed the exceptional temperatures. The radium of the Usernmulde is probably not very important, seeing that these sediments can not extend far downwards. The principal local source of heat appears located more especially beneath the synclinal fold, for Stapff's table (*loc. cit.*, p. 31) of the gradients beneath the plain of Andermatt shows a rising gradient to a point about 2,500 meters from the north entrance of the tunnel. It is observable that the radio-activity of the granite increases as it approaches the Usernmulde and attains its maximum (14.1) where it dips beneath the syncline.

The means of radium-content in the several geological sections into which the course of the tunnel is divisible are as follows:

Granite of Finsteraarhorn	7.7
Usernmulde	4.9
St. Gothard massif	3.9
Tessinmulde	3.4

The central section, however, if considered without reference to geological demarcations, would, as already observed, come out as barely 3.3. And this is the value of the radio-activity most nearly applicable to Stapff's thermal subdivision of the region of low temperature.

If we accept the higher readings obtained in the granite as indicative of the radio-active state of this rock beneath the Usernmulde, a satisfactory explanation of the difference of heat-flow from the central and northern parts of the tunnel is obtained. Using the difference of gradient as basis of calculation, as before, we find that a downward extension of about six thousand meters would, if the outflow took place in an approximately vertical direction, account for the facts observed by Stapff. This depth is in agreement with the result as to the downward extension of the St. Gothard rocks as derived from the comparison with the Simplon rocks.

We are by no means in a position to found dogmatic conclusions on such results; they can only be regarded as encouragement to pursue the matter further. The coincidence must be remarkable which thus similarly localizes radium and tem-

[17] *Loc. cit.*, p. 30.

[18] *Proc. R. S.*, XLI., p. 44.

perature in roughly proportional amounts, and permits us, without undue assumptions, to explain such remarkable differences of gradient. There is much work to be done in this direction, for well-known cases exist where exceptional gradients in deep borings have been encountered—exceptional both as regards excess and deficiency.

John Joly

(*To be continued*)

ABSTRACTS FROM THE ANNUAL REPORT OF THE PRESIDENT OF CORNELL UNIVERSITY

The number of students enrolled in the university for the year ending September, 1908, was 4,465, of whom 3,734 were regularly enrolled students during the academic year from September to June, and the rest attendants at the summer session and the winter school in agriculture. This is an increase of 240 over the enrollment for the preceding year and an increase of more than 1,000 over the enrollment of four years ago, when the figures were 3,423.

A little more than half (2,025) of these 3,734 regular students came from New York State. From Pennsylvania came 322; New Jersey, 190; Ohio, 155; Illinois, 108, and Massachusetts, 101, while 690 came from forty-five other states and territories of the United States (including Porto Rico, Hawaii and the Philippine Islands), and 143 from twenty-eight different foreign countries (including China, 28; Cuba, 14; Argentine Republic, 14; Canada, 12; India, 11; Japan, 11; Mexico, 7; Brazil, 7; Peru, 6; England, 4; Australia, 3; Switzerland, 3, etc.).

The total number of students who have been enrolled in the university since it opened in 1868 is approximately 26,000 and the number of degrees conferred during these forty years is 10,475, more than three fourths of which have been conferred by President Schurman in the last sixteen years. The number of degrees granted in June, 1908, was 715, of which 649 were first degrees and 66 advanced degrees.

The number of members of the instructing staff is given as 548, and, excluding the members of the staff of the Medical College in New York City, the faculty at Ithaca is found to be made up as follows: 75 professors, 64 assistant professors, 6 lecturers, 122 instructors and 144 assistants. Twenty years ago there were 33 professors, 4 associate professors, 13 assistant professors, 41 instructors and 4 assistants.

President Schurman dwells on the necessity of higher professorial salaries for the purpose of maintaining the dignity, importance and attractiveness of the teaching profession in America. If intellect is to be well-trained in America there must be tangible evidence that the public set a fair value on highly educated men. Otherwise the best brains of the country will be lost to the teaching profession. As Burke has well said, "The degree of estimation in which any profession is held becomes the standard of the estimation in which the professors hold themselves." Hence it is scarcely an exaggeration to assert that the provision in Colonel Vilas's magnificent bequest to the University of Wisconsin for the establishment of certain professorships with salary of not less than $8,000 each will, if it becomes at once effective, mark an epoch in the development of a proper standard for the estimation of professors in the United States.

The problem of securing men of the highest character, ability and training to fill professorial vacancies is at best a difficult one. Cornell has never limited herself to the graduates of the university, to the state in which it is located, or even to America. Two years ago a gentleman in

France was appointed to a professorship; this year Leeds University, England, and Edinburgh University, Scotland, have furnished two professors.

One of the most important pieces of educational legislation, as President Schurman points out, was the establishment by the College of Arts and Sciences of an administrative board with direct supervision over the work of freshmen and sophomores in that college, and President Schurman states the underlying motive for this action in the following words:

> Among the best of our colleges and universities the great break in the course of a collegiate or liberal education comes at the end of the second year, both as regards the curriculum and the methods of instruction. This differentiation of the work, methods of instruction and educational aims of the first two years of the course in the college of arts and sciences in contrast with those of the later years of that course calls for a corresponding differentiation in the staff of instruction, which could not fail to insure greater thoroughness of instruction, greater simplicity and effectiveness of administration and closer personal and social intercourse between teachers and students.

It has been recognized at Cornell University that a scheme of education which permits students to elect their own studies, whatever its advantages, is at any rate attended with great risks, especially for the younger and inexperienced undergraduates; and for some time past a considerable portion of the work of freshmen and sophomores has been prescribed. But the care and supervision of these underclassmen has hitherto remained in the hands of the entire faculty of arts and sciences, a very large body, many of whom give no instruction whatever to freshmen and sophomores in arts. Now, however, these underclassmen will be under the direct charge of a distinct administrative board, composed of 17 members (of whom 14 are of professorial rank) selected from the teachers of freshmen and sophomore courses and this board is given full power to supervise their work and to provide means for making it effective.

In effect this board will be a separate faculty, which will have special charge of freshmen and sophomores, thus giving these underclassmen all the advantages of the small college faculty.

One of the most important problems which press for settlement upon the administrative board for freshmen and sophomores is the proper method of instructing underclassmen, and President Schurman brings forward the question in the following terms: The colleges and universities have in the past given less attention to improving the methods of teaching than the schools; and universities certainly have made the mistake of applying to freshmen the methods suitable to the graduate school or to the popular rostrum. But the freshman should not be treated either as an investigator or as a passive listener. Recitation, question and answer, and constant drill are the methods of instruction proper to the freshman class room. The object is assimilation by the ignorant pupil of knowledge with mental reaction upon it.

If the modern undergraduate is unresponsive in the class room, that is a natural result of the exclusive use of the lecture system. As one of the professors puts it in his report: "Intellectual overfeeding without intellectual exercise is bound to bring about mental torpor."

President Schurman also discusses fully the functions of graduate study. In the graduate department as in the university as a whole there is constant danger that the national tendency to worship mere magnitude may distort the vision of the faculty and especially of the trustees and friends of the university. It is important, therefore, to keep clearly in view the essential objects of a graduate school. These are the enlargement of existing knowledge and the training of young men and women of superior ability and education in methods of independent investigation so that they too may, in time, make some contribution to the stock of human knowledge. A love of knowledge, an ardent desire to wrest something from the unknown, a conviction that science and scholarship are along with virtue the chief good of human life, would seem to be the animating motives of a life of research. Given this subjective equipment in combination with superior powers of observation, reasoning and imagination, and productive scholarship and science are assured. But these gifts are not possessed by all professors, and still less by all graduate students. And it is a grave question whether graduates of mediocre ability—minds lacking in energy, ambition and imagination—should, after they have demonstrated their quality in a probationary year, be encouraged or even permitted to continue work intended to fit men to become scholars and investigators.

The recommendations contained in President Schurman's report of last year in regard to the requirement of arts work for admission to the professional schools, have been under careful consideration by the faculties of the various colleges of the university and by the trustees, but final action has been deferred. The faculties of engineering and architecture have drawn up five-year courses as alternatives to the present four-year courses, in which they include over 70 hours in arts and sciences and at least 30 hours in literary and historical subjects. The faculty of law favor the requirement of a year and in the near future of two years of arts work for admission to the course in law. All these proposals are now under consideration. The medical college, on the other hand, has so advanced its requirements that a bachelor's degree or its equivalent is required for admission to the course in medicine. Finally, courses suitable for students in preparation for the vocations of teaching, organized philanthropy, the civil service and business management were arranged by the faculty of arts and sciences for the benefit of juniors and seniors in that college, and these groups of studies will hereafter be included in the list of electives.

President Schurman next devotes considerable space to the work and needs of the New York State Veterinary College which is by law dedicated to both instruction and research. Dr. Veranus A. Moore, the distinguished pathologist of the university, who has for years held the position of professor of pathology and bacteriology in the veterinary college, has been appointed director of that college to succeed Dr. Law, who retires on a pension provided by the Carnegie Foundation for the Advancement of Teaching. The minimum requirements which Dr. Moore sets down for next year are an increase of the annual legislative appropriation for maintenance from $30,000 to $40,000; a new annual appropriation to begin with $10,000 for research, experimental investigations and extension work; and a special appropriation of $125,000 for buildings and equipment for the clinical work of the college.

> The total expense of adequately maintaining this college together with the interest on the first cost of the buildings when completed would equal but a fraction of one per cent. of the loss to our state by the death of animals from diseases that are largely preventable.

The great event of the year for the New York State College of Agriculture was the purchase by the university of additional farm lands which in combination with present holdings now gives the college of agriculture 579 acres for farming purposes, in addition to the 100 acres provided for the veterinary college for an experimental station. Now that the university has greatly enlarged its farm, it will be possible, if state funds are available, to add to the live stock of the college, which is needed as material both for demonstration to students and research by professors. New York state produces about one ninth of the hay and forage of the United States, and the animal industries of the state are of enormous value. This is a field, therefore, to which the instruction and investigation of the college should be peculiarly directed, and the state appropriation of $25,000 for barns has solved the problem of housing facilities as the purchase by the university of land has solved the problems of pastures and fodder.

New courses have been added to the curriculum in the college of civil engineering, notably in the field of sanitary engineering, but President Schurman points out that there is still necessity for improvement in the field of hydraulics, and he adds that strong as the department of hydraulics now is it is greatly in need of development to meet the demands of the age and the prospects of the future. Water is destined from now on to play a great part in the economic development of the United States, for apart from its uses for domestic and sanitary purposes, it is hereafter to be used on a vast scale for power and for irrigation as well as for navigation. The maximum benefit to be got will be sought in the east from navigation and power and in the west from irrigation and power. For the new work to come in these vast fields there will be needed a type of engineer highly specialized in hydraulics.

In addition to the farm lands purchased for the State College of Agriculture and the State Veterinary College, President Schurman announces the acquisition of nearly 50 acres of land as an extension of the campus proper on the southeast, thus making the entire area now included in the campus 350 acres, the distance north and south being about five eighths of a mile, and the distance east and west about a mile. The university campus and farms now aggregate nearly 1,100 acres.

Coming to the finances of the university, President Schurman reports that excluding the medical college in New York City, which is maintained by separate funds, the productive funds of the university amounted on August 1, 1908, to $8,628,370.31 as compared with $8,550,916.84 on August 1, 1907, while the inventoried value of the university grounds and buildings at the present time is given as $4,263,405.07. The most marked changes in the investments during the year were an increase in steam railroad bonds from $1,019,500 to $1,414,100 and a decrease in real estate mortgages from $1,515,538.48 to $1,324,217.66. The income statement shows a total income from all sources of $1,356,498.59. The income of the university at Ithaca, excluding the state colleges, ran short of the expense budget by $12,242, as a result of the purchase of campus lands.

President Schurman closes his report with a brief but cogent statement of the most pressing needs of the university, first among which he places endowments for the augmentation of the present low salaries of professors and instructors, who, as the president points out, are the vital and energizing soul of any university. Next comes the need of a system of residential halls and commons for the young men of the university, thousands of whom are now obliged to seek accommodations in private boarding and lodging houses throughout the city. After these in order of importance, though equally urgent for the conduct of the work of the university, are mentioned the need of a general assembly hall capable of accommodating the entire student body, a new and greatly enlarged armory, a new laboratory for veterinary clinics, a new testing and experimenting laboratory in civil engineering, new machine shops in mechanical engineering, and an entirely new establishment for the department of chemistry, where the great increase in the number of students taking the work has created serious embarrassment even necessitating the exclusion from the already overcrowded laboratory of undergraduates in whose courses chemistry is a prescribed or elective subject. A new chemical laboratory entirely adequate for the purpose would, as President Schurman estimates, cost from $300,000 to $400,000.

THE DELOS ARNOLD COLLECTIONS OF NATURAL HISTORY SPECIMENS

Hon. Delos Arnold, of Pasadena, has presented to the department of geology of Stanford University his great collection of fossils, shells, corals, minerals, ethnologic materials, etc. This collection is a gift to the university on the condition that it be kept intact, and that it be properly cared for, labeled and exhibited. It represents the work of a lifetime by an enthusiastic student and collector, and is one of the finest private collections of fossils in the country. It is especially valuable on account of the large amount of recent and Tertiary material collected on the west coast of North America. For the use of students of the geology of California and the west coast generally, it is without an equal.

The collection was begun by Mr. Arnold in 1860 when he lived in the state of Iowa, and besides the constant work done upon it by him, it has received many acquisitions up to 1908, and it is stipulated by the donor that still further additions may be made to it in the future. Most of the minerals were collected in Colorado in the seventies and in Arizona in the eighties.

The collection of recent marine shells so necessary in the study of Tertiary geology is one of the finest in this part of the country, and it embraces a large amount of material collected on the Atlantic coast from Maine to the West Indies. It includes most of the common forms both of shells and corals and a large number of the rarer ones collected by Mr. Arnold at Jacksonville, Key West, St. Augustine and New Orleans. Of the west coast materials, it embraces collections made by Mr. Arnold and his son Dr. Ralph Arnold almost continually all the way from Puget Sound to Panama, and includes both the littoral species and the deeper water forms obtained by dredging. There are also a good many shells obtained by exchange and purchase from Europe and other parts of the world, and especially from the Mediterranean Sea, from the coasts of France, and from the Hawaiian Islands. A representative collection of fresh-water shells from various parts of the United States is also included in the materials.

The fossils, however, form the most important part of the collection. These embrace Paleozoic, Mesozoic, Tertiary and Pleistocene forms. The paleozoic materials include one of the best collections ever made from the famous crinoid-bearing Kinderhook beds (Carboniferous) at Le Grand, Iowa. Many of these fine specimens are types, and are figured in Wachsmuth and Springer's monograph on the crinoids. Of especial interest in connection with the collection of fossil crinoids is a beautiful specimen of a living crinoid from the China Sea.

The Mesozoic materials of the collection come from different parts of North America, notably from California, and the Dakotas, and from Europe.

The collection of Tertiary and Pleistocene fossils is among the best of the kind in existence, and, in many respects, it is unique. It includes a number of types and a large number of specimens that have been figured in publications upon the Tertiary and Pleistocene of the Pacific coast, notably in the papers published by Dr. Ralph Arnold, the distinguished son of the donor. Getting together this particular part of the collection has occupied Mr. Arnold's time for twenty-two years. At San Pedro, one of the richest and most important localities where collecting has been done, the collecting ground has been encroached upon by the sea and carried away for ballast until the fossil-bearing beds have now been nearly destroyed, and similar collections thus made impossible. There are besides full collections from all the known Pleistocene localities from Puget Sound to Scammon's Lagoon in Lower California. The collections from Santa Barbara and San Diego are large and especially fine. There is also much valuable material obtained by exchange from Dr. M. Cossman and Jean Miguel, of France, and from Dr. Koto, of Japan. Representative Tertiary and Pleistocene materials of the eastern United States have been received from Professor Gilbert D. Harris, of Cornell University, from T. H. Aldrich, of Birmingham, Alabama, from the Chicago Academy of Sciences, and from many other persons and institutions. It is estimated that the collection contains 30,000 species and considerably more than 30,000 duplicates.

The new exhibition cases in the geological department will be used for the display of the collection. It will occupy part of the large museum room on the ground floor adjoining the geological lecture room. It will be kept together, and will be known as the "Delos Arnold Collection."

Hon. Delos Arnold, of Pasadena, who made the collections of fossils, shells, minerals, etc., known as the "Delos Arnold Collection" lately presented by him to the department of geology in Stanford University, was born July 21, 1830, in Chenango County, N. Y. He was educated in the common schools of that state, and at Fredonia Academy in Chautauqua County, N. Y. He studied law at the Albany Law School, from which he graduated in 1853. In that same year he moved to Marshalltown, Iowa, and lived there until 1886. For several years he was district attorney and treasurer of Marshall County. He was appointed United States Assessor of Internal Revenue for the Sixth Iowa District by President Lincoln, and served four years. For twelve years he was a member of the Iowa legislature, having been four years member of the general assembly, and eight years member of the senate. He was also special state auditor to examine the accounts in connection with the state capitol of Iowa. In 1886 Mr. Arnold moved to Pasadena, California, and has lived there ever since. For ten years he was a member of the school board of the city of Pasadena.

THE DEPARTMENT OF MICROSCOPY OF THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

The regular meetings of the department of which Mr. John J. Schoonhoven, M.A., is president, and Miss Agnes Vinton Luther, secretary, will be held during the season on the second and fourth Tuesday evenings of each month. The proceedings at the meetings are as follows:

October 13—Conference on "The City's Water Supply," to be conducted by Mr. Daniel D. Jackson, S.B., director of the Mount Prospect Laboratory of the Division of Water Supply. The subject of the conference will be illustrated by lantern photographs.

October 27—Lecture by William H. Park, M.D., of the Research Laboratory of the Department of Health, New York City, on "The Recent Research Work of the Department of Health."

November 10—Conference on "Textile Fibers," to be conducted by Miss Agnes Vinton Luther, secretary of the department.

November 24—Lecture by Professor William Campbell, Ph.D., of Columbia University, on "The Microscopical Structure of Metals and Alloys, Native and Artificial."

December 8—Conference on "The Use of the Microscope in the Detection of Poisons in Chemical Analysis," to be conducted by Mr. Herbert B. Baldwin, chemist for the Board of Health, Newark.

December 22—Lecture by Professor Herbert W. Conn., Ph.D., of Wesleyan University, on "Rabies."

January 12—Conference on "Photography Applied to Microscopy," to be conducted by Messrs. George E. Ashby and J. P. Wintringham, members of the executive committee of the department.

January 26—Lecture on "The History and Recent Improvements in the Projection Microscope," with demonstrations, by Professor Simon Gage, Ph.D., of Cornell University.

February 9—Conference on "The Use of the

Microscope in the Manufacture of Paints," to be conducted by Mr. Maximillian Toch, president of the New York Chemical Society.

February 23—Lecture by Mr. John J. Schoonhoven, M.A., president of the department, on "Some Interesting Vegetable Parasites affecting Man and the Lower Animals."

March 9—Conference on "The Microscopical Examination of Milk." Harris Moak, M.D., professor of bacteriology, Long Island College Hospital, has been invited to conduct this conference.

The twenty-second annual exhibition of microscopic preparations and apparatus will be held in the new suite of rooms in the Academy of Music on Saturday afternoon and evening, March 13, 1909, by members of the department. Ninety-seven microscopes were in use during the evening at the last annual exhibition. There will be a private view of the exhibition for members and invited guests on Friday evening, March 12.

March 23—Conference on "The Microscopical Study of Insects," to be conducted by Mr. Carl Schaeffer, associate curator of entomology of the institute.

April 13—Conference on "The Use of the Microscope in Domestic Science." Miss Edith M. Greer, of the department of domestic science, has been invited to conduct this conference.

April 27—Conference to be conducted by Wallace Goold Levison, B.Sc., vice-president of the department of geology, on some subject in "Microscopical Mineralogy."

May 11—Conference to be conducted by Mrs. Helen W. Joy, member of the executive committee of the department, on "Vegetable Histology."

May 25—Conference on "Fresh-water Life," to be conducted by Professor Richard W. Sharpe, M.S., of the DeWitt Clinton High School, vice-president of the department of zoology.

THE ASSOCIATION OF COLLEGES IN NEW ENGLAND

The fifty-second annual meeting of the Association of Colleges in New England was held at Boston University on October 29 and 30. The twenty-one subjects suggested by the several colleges may be quoted as indicating current academic problems:

1. The future of colleges and universities which collect tuition fees. (Suggested by Harvard.)

2. What arrangements are possible or desirable in order to stimulate intellectual emulation among college students? (Suggested by Yale.)

3. Is it desirable and feasible to bring about an intercollegiate understanding tending to prevent unnecessary duplication of courses where instruction is expensive and students few in number? (Suggested by Yale.)

4. The desirability of exchanges for one year between professors in American colleges. (Suggested by Brown.)

5. When should education begin to be distinctively vocational? (Suggested by Vermont.)

6. The faculty supervision of student organizations. (Suggested by Vermont.)

7. The present trend away from the ideals of the liberal education. (Suggested by Williams.)

8. The control of attendance on college exercises: how much absence should be permitted? (Suggested by Williams.)

9. Scholarships, scholarship, and bribery. (Suggested by Middlebury.)

10. Should colleges, not having graduate schools, give the degree of Master of Arts, in course? (Suggested by Amherst.)

11. Shall the scale of units for entrance proposed by the Carnegie Foundation be doubled so as to avoid half-units? (Suggested by Amherst.)

12. The economic waste of the present method of conducting entrance examinations by the separate colleges. Will the colleges in New England unite upon the examinations of the College Entrance Board or some similar system of uniform examinations? (Suggested by Trinity.)

13. Allowed absences. (Suggested by Trinity.)

14. Is there any general usage at present in regard to the Day of Prayer for Colleges? (Suggested by Wesleyan.)

15. What is the proper attitude of college faculties towards hazing—prohibition or regulation? (Suggested by Wesleyan.)

16. Is the growing interest in vocational training endangering the ideals of liberal education? (Suggested by Boston.)

17. The universitizing of the college: its cause and cure. (Suggested by Clark.)

18. Can the evils of athletics be mitigated by an academic course leading to degrees in its historical, scientific, academic, social and other aspects? (Suggested by Clark.)

19. College requirements in English. (Suggested by Clark.)

20. Are the relations of the New England colleges to the high school on a sound basis? (Suggested by Clark.)

21. Reform in the college-entrance requirements

in Latin. (Presented by the Classical Association of New England.)

The colleges were represented as follows during the meeting:

Harvard University—President Charles W. Eliot; Jerome D. Greene, secretary.

Yale University—President Arthur T. Hadley; Edward P. Morris, professor of Latin.

Brown University—President William H. P. Faunce; Walter G. Everett, professor of philosophy and natural theology.

Dartmouth College—President Wm. J. Tucker; Frank H. Dickson, professor of economics.

University of Vermont—President Matthew H. Buckham; Max W. Andrews, professor of English.

Williams College—President Harry Augustus Garfield, Dean Frederick C. Ferry.

Bowdoin College—President William DeWitt Hyde; Frederick Willis Brown, professor of modern languages.

Middlebury College—President John M. Thomas; Myron R. Sanford, professor of Latin.

Amherst College—President George Harris; James W. Crook, professor of economics.

Wesleyan University—Acting President William North Rice; Karl P. Harrington, professor of Latin.

Tufts College—President Frederick W. Hamilton; Philip M. Hayden, instructor in modern languages.

Boston University—President William E. Huntington; Lyman C. Newell, professor of chemistry.

Clark University—President G. Stanley Hall; Carroll D. Wright, president of Clark College.

WINTER MEETING OF THE AMERICAN CHEMICAL SOCIETY

The Winter Meeting of the American Chemical Society will be held in Baltimore, Md., December 29 to January 1 inclusive. The meeting will be in affiliation with the American Association for the Advancement of Science and the Biological Section will hold a joint session with the Society of Biological Chemists.

The following members have consented to preside over sections and to aid in the preparation of the program for the meeting.

Agricultural and Food Chemistry—H. J. Wheeler.
Biological Chemistry—J. J. Abel.
Inorganic Chemistry—C. H. Herty.
Organic Chemistry—S. F. Acree.
Pharmaceutical Chemistry—Edw. Kremers.
Chemical Education—H. P. Talbot.
Fertilizer Chemistry—F. B. Carpenter.
Physical Chemistry—G. N. Lewis.
The Division of Industrial Chemists and Chemical Engineers will also hold a meeting presided over by the chairman of the division, A. D. Little.

Members desiring to present papers are requested to send title and brief abstracts to one of these persons or to the secretary of the society with the exception of the Section of Chemical Education where a special program is being arranged. The final program will be sent only to those members signifying their intention of being present at the meeting, or who make special request for same. No title can be placed on the final program that reaches the secretary later than December 10.

Chas. L. Parsons,
Secretary

Durham, N. H.

SCIENTIFIC NOTES AND NEWS

The president and council of the Royal Society have awarded medals as follows: the Copley medal to Dr. Alfred Russel Wallace, in recognition of the great value of his numerous contributions to natural history, and of the part he took in working out the theory of the origin of species by natural selection; the Rumford medal to Professor H. A. Lorentz, for his investigations in optical and electrical science; a Royal medal to Professor John Milne, for his preeminent services in the modern development of seismological science; a Royal medal to Dr. Henry Head, for his researches on the relations between the visceral and somatic nerves and on the functions of the afferent nerves; the Davy medal to Professor W. A. Tilden, for his discoveries in chemistry, especially on the terpenes and on atomic heats; the Darwin medal to Professor August Weismann, for his eminent services in support of the doctrine of evolution by means of natural selection; the Hughes medal to Professor Eugene Goldstein, for his discoveries on the nature of electric discharge in rarefied gases.

Colonel George H. Torney will succeed Brigadier General Robert M. O'Reilly as surgeon general of the army on January 14.

It is unofficially stated that Mr. William Marconi is to be awarded the next Nobel prize in physics.

A life-sized portrait of Dr. John Galbraith, professor of engineering at the University of Toronto, has been presented to the university on the occasion of the thirtieth anniversary of his appointment.

The Institution of Civil Engineers, London, has made the following awards for the year 1907–8: Telford gold medals to W. B. Parsons and Dr. H. Lapworth; a Watt gold medal to Sir Whately Eliot; George Stephenson gold medals to Sir John W. Ottley, K.C.I.E., Dr. A. W. Brightmore, J. S. Wilson and W. Gore.

The Bisset Hawkins gold medal of the Royal College of Physicians has been awarded to Sir Shirley Murphy, medical officer of health of the County of London, for his distinguished services in the cause of public health.

Provost Charles C. Harrison will represent the University of Pennsylvania at the Darwin celebration at Cambridge University in June next.

Dr. Ostwald Schmiedeberg, director of the Pharmacological Institute at Strasburg, has celebrated his seventieth birthday.

Dr. Ludwig Mond, F.R.S., has been decorated with the Grand Cordon of the Crown of Italy.

Dr. Carl L. Alsberg has resigned his position in the department of physiological chemistry of the Harvard Medical School, to take charge of the poisonous plant investigations in the Bureau of Plant Industries of the U. S. Department of Agriculture.

Professor Dorsey A. Lyon, of the department of metallurgy in Stanford University, has resigned to become manager of an electrical smelting plant.

Dr. H. Hergesell, director of the Meteorological Bureau for Alsace-Loraine, has been transferred to the Department of the Interior, Berlin.

King Haakon has headed the public subscription for Captain Amundsen's polar expedition with a donation of $5,000.

Dr. Siebers, of Giessen, is in charge of an expedition to Peru, supported by the Karl Ritter foundation of Leipzig.

Professor V. L. Kellogg, of Stanford University, now in Italy, has been granted leave of absence for the remainder of the year.

Kuo Feng-ning, of Shanghai, China, a delegate of the Chinese Fisheries Company to the recent International Fisheries Congress at Washington, and Kohang Yih, who is investigating tobacco growing in this country, are visiting our colleges of agriculture and experiment stations.

Sir Horace Plunket, formerly of the agricultural department in Ireland, has left for the United States, on invitation, to confer with the Commission on Country Life, appointed by President Roosevelt.

Dr. F. M. Smith, head of the department of agriculture of the Transvaal, South Africa, is visiting this country to gather information in agricultural education in view of a contemplated college of agriculture at Prætoria.

The Pathological Society of Philadelphia, at its meeting on October 22, elected the following officers: *President,* Dr. Joseph McFarland; *Vice-Presidents,* Drs. Edsall, Reisman, Kelly and Smith; *Secretary,* Dr. R. S. Lavenson; *Treasurer,* Dr. C. Y. White; *Recorder,* Dr. F. H. Klaer; *Curator,* E. H. Goodman.

Dr. E. E. Slosson, of the New York *Independent,* is collecting material for a series of articles on the leading universities of the United States. He has spent the past two weeks at Stanford University and the University of California.

In view of the development of flying machines and airships during the past few months, the American Society of Mechanical Engineers have arranged for an exhaustive paper on aeronautics by Major George O. Squier, of the Signal Corps, U.S.A., Washington, D. C., to be read at the annual meeting in New York, December 1–4. An evening lecture upon aeronautics will be given by

Lieutenant Frank P. Lahm, of the Signal Corps, illustrated with lantern views and moving pictures of the recent trials at Fort Myer.

A series of special lectures on general hygiene, provided for by the regents of the University of Wisconsin at their last meeting, is now being arranged by Dr. H. P. Ravenel, of the department of bacteriology. Among the speakers will be Professor William T. Sedgwick, of the Massachusetts Institute of Technology, who will speak on ventilation and water supply.

The faculty of Tulane University announces a course of extension lectures, which began October 28. The course includes a series of lectures by Professor George Dock, on "Ductless Glands," to be followed by lectures on special subjects, by Dr. Ch. Wardell Stiles, Public Health and Marine Hospital Service; F. Creighton Wellman, of the Department of Agriculture; Dr. William A. Evans, health commissioner of Chicago; Dr. W. H. Dalrymple, of the Louisiana State Department of Agriculture, and others.

Dr. Ch. Wardell Stiles, of the Public Health and Marine Hospital Service, gave two lectures with demonstrations at the University of Virginia on November 6 and 7. His subject was the biological, economical and medical aspects of the hook-worm disease in this country.

Professor W. M. Davis, of Harvard University, gave an illustrated lecture on the Colorado Cañon before the Natural History Section of the Versammlung der Deutschen Naturförscher und Aerzte in Cologne, on September 24, as well as at the meeting of the British Association earlier in the month.

A bronze tablet commemorative of the early geological work of the late Professor James Hall during the New York Survey of 1836–42 has been erected in Letchworth Park, the new state preserve on the Genesee River, by a few of the associates of Professor Hall's later years: Secretary Walcott, Professors Stevenson, Smock and Schuchert and Dr. Clarke.

Harvard University has received from the director and members of the Pasteur Institute of Paris a replica of the bronze bust of Pasteur by Paul Dubois. The bust will be erected at the Medical School.

The medical profession of Algiers has placed in the military hospital of Constantine, on the spot which served Laveran for a laboratory, and where he accomplished his memorable work, a medallion commemorating the discovery of the parasite of malaria in 1880. Another commemorative medallion has been placed in the hall of honor of the hospital by the military physicians.

William Keith Brooks, professor of zoology in the Johns Hopkins University since 1876, died on November 12, at the age of sixty years.

Otis Tufts Mason, head curator of the department of anthropology of the U. S. National Museum, and eminent for his contributions to anthropology, died in Washington on November 5, at the age of seventy years.

Professor William Edward Ayrton, professor of electrical engineering in the Central Technical College, London, died on November 8 at the age of sixty-one years.

There is a vacancy in the position of assistant (male) U. S. Naval Observatory, with pay at the rate of $1,000 per annum, and the Civil Service Commission will order an examination for eligibles for same in the near future. Those interested in such an examination, should inform the observatory in order that application blanks may be mailed to them.

An examination for admission to the grade of assistant surgeon in the Public Health and Marine-Hospital Service will be held on January 11, at Washington. Candidates must be between twenty-two and thirty years of age, and graduates of a reputable medical college. Assistant surgeons receive $1,600, passed assistant surgeons, $2,000, and surgeons, $2,500 a year. For further information application should be made to the Surgeon General, Public Health and Marine-Hospital Service, Washington, D. C.

SECRETARY WRIGHT has forwarded to the secretary of the treasury the detailed estimates for the war department for the next fiscal year. For the purchase of aerial machines, either dirigible balloons or aeroplanes, $500,000 is asked.

THE annual meeting of the American Anthropological Association will be held in Baltimore, December 28, 1908, to January 2, 1909, in affiliation with the American Folk-Lore Society and Section H of the American Association for the Advancement of Science. Titles (and abstracts) of papers should be sent immediately to Dr. George Grant MacCurdy, Yale University, New Haven, Conn., who is responsible for the combined program.

IN the Hall of Fossil Mammals of the American Museum of Natural History several important additions and changes have been made during the past few months. A specimen of the four-toed horse (*Orohippus osbornianus* Cope) from the Middle Eocene beds of the Bridger Basin, Wyoming, has been placed on exhibition. This was a small animal of about the same size as its ancestor in the Lower Eocene beds. It had four toes in the fore feet and three in the hind feet, but there are no vestiges of the fourth toe remaining. Last year's expedition to Egypt is brought to mind by an exhibit consisting of the skull and lower jaws of the Horned Arsinoithere. This gives one, too, some hint of the strange appearance of one of the animals inhabiting northeastern Africa in Upper Eocene time. The large skeleton of the great saber-tooth tiger, *Smilodon,* from the Pleistocene beds of South America, has been put into a case by itself, in which is also exhibited an oil painting by Charles R. Knight representing the animal as it is supposed to have appeared in life. There has been placed in the Amblypod Alcove at the west entrance to the hall a splendid composite skeleton of Uintatherium. This was a huge four-toed, elephantine, hoofed animal with large dagger-like tusks.

MR. H. M. TAYLOR, F.R.S., of Trinity College, Cambridge, has been instrumental in collecting about $2,500 for the publication of works of a scientific nature in embossed type for the use of the blind. The managers of the fund have agreed that the first three books in the publication of which they undertake to assist shall be "Sound and Music," by Mr. Sedley Taylor; "A Primer of Astronomy," by Sir Robert Ball, F.R.S.; and "An Introduction to Geology," by Dr. Marr, F.R.S.

ARRANGEMENTS have been made at Columbia University for a series of non-technical lectures on the various aspects of the science of meteorology, to be delivered on Tuesday afternoons at five o'clock, beginning January 12. These will include a general introductory lecture by President Woodward, of the Carnegie Institution of Washington (formerly professor of mechanics at Columbia, and the following lectures on specific topics: "The Geological Relation of Meteorology," by Professor A. P. Brigham, of Colgate University; "Climate in Some of its Relations to Man," by Professor R. DeC. Ward, of Harvard; "Astronomical Climate," by Professor William Libbey, of Princeton; "Storms and Weather Forecasting," by Willis L. Moore, chief of the United States Weather Bureau; "Circulation of the Atmospheres of the Sun and the Earth," by Professor F. H. Bigelow, of the Weather Bureau; "Exploration of the Atmosphere by Kites and Balloons," by Professor W. R. Blair, of the Weather Bureau; "Seismology," by Professor C. F. Marvin, of the Weather Bureau; "Atmospheric Phenomena and Physical Theory," by Professor J. H. Jeans, of Princeton University, and "Outstanding Problems in Meteorology," by Professor Cleveland Abbe, of the Weather Bureau.

THE *Medical Record* states that the first of the new buildings at Bellevue Hospital, New York City, has been opened. This has just been completed at a cost of something over a million dollars. The building is seven stories high, and contains two pavilions, known as A and B, of eight wards each, altogether accommodating about four hundred patients. The top floor will be devoted to wards for maternity cases, and the children's and medical wards will be housed on the lower floors. In the main building it will now be possible to have four wards for the tuberculosis patients, who have hitherto been housed in small wooden buildings along the river front. These will be abandoned, as well as the building outside the hospital grounds which has been used for maternity cases.

The Journal of the American Medical Association states that Dr. John Gorrie was the first to invent a practical ice-making machine. It continues: The point in regard to Dr. Gorrie's invention which does him most honor is that it was made for the comfort and welfare of his fever patients. In 1845, when Dr. Gorrie was practising in Apalachicola, that town, though the most important Florida seaport, being the outlet for all the cotton grown in the Chattahoochee valley in Georgia and Alabama, was seriously hindered in its growth by the prevalence of various fevers in the summers. Dr. Gorrie found it almost impossible to treat fever patients successfully during the hot weather. He realized that cooling the patient's room would undoubtedly be of benefit, and he, therefore, set himself to devising various methods of cooling air and water. In 1850 he succeeded in producing small blocks of ice about the size of the ordinary building brick. A French cotton buyer, M. Rosan, residing in Apalachicola, saw the machine in operation and induced the inventor to give a public demonstration at the leading hotel. Ice made with the machine, which was placed on a table in the dining-room, was served to all those present at a banquet. M. Rosan later returned to Paris and is known to have been in intimate association with M. Carré, whose process of making ice was not perfected until 1855. There seems no doubt then that the Frenchman was spurred to renewed efforts, if not actually prompted to the idea of his invention, by the news of the successful experiment made by the American physician.

PRESIDENT ELIOT'S RESIGNATION

After a football mass meeting in the Harvard Union the students went in a body to President Eliot's house and he made to them a brief address which is reported in the *Transcript* as follows:

This is a great surprise, and I greatly appreciate your coming. Yesterday I was asked to talk upon the reasons for my resignation, but I refused. To-night I think I should like to say a few words to you on the subject.

I have heard a number of reasons suggested as the explanation of my resigning. Now I am not sick, I am not tired, and I am in good health so far as I am aware. My faculties and health are still good, I am glad to say. My resignation is meant to precede the time when they may cease to be so. When a man has reached the age of seventy-four it is time to look for rest and retirement. Dr. Arnold, of Rugby, used to say that a man was no longer fitted to be headmaster of a public school when he could not come up the steps two at a time. Now I can still do that.

I don't like to have my coming retirement spoken of with regret. It is touching to find that feeling, but I think it is something to be looked forward to with hope. We must all set to work to find some young, able, active man for the place. He can be found; we shall find him. We need a man who will take up this extremely laborious and extremely influential position with untiring energy and carry this university to a higher plane than it now occupies. It has been the foremost American university for 270 years.

The occupation which has been mine for a lifetime has been a most pleasant one, and I regret that it is about to terminate. Forty years of service has been given me in the pursuance of a profession that has no equal in the world. This university has grown into great proportions. It is now the task of all of us to find a man who can enlarge it still more and make it still greater. Good-night.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Richard C. MacLaurin, for the past year professor of mathematical physics in Columbia University and previously professor of mathematics in the University of New Zealand, has accepted the offer of the presidency of the Massachusetts Institute of Technology.

The appropriation by the New York City Board of Estimate and Apportionment of more than $586,000 for the maintenance of the City College next year, of which amount $404,000 will be devoted to instructional purposes, gives an increase of $50,000 over the total appropriations for the present year. Forty thousand dollars of the increase is in the allotment for instructional purposes.

Cooper Medical College, San Francisco, has been made the medical department of Stanford University.

The Keokuk Medical College, of Keokuk, Iowa, has been merged with the College of Medicine of Drake University, at Des Moines.

There have lately been added a thousand acres to the reservation of the Forest Summer School of Yale University at Milford, Pa. Students of the Scientific School seeking advanced courses in forestry must take extra scientific courses in the senior year and pass two sessions at the Forest Summer School, to which seven new courses have been added.

The new building for biology and geology at Amherst College has reached a point where it is nearly ready for its roof. It has a frontage of about 140 feet and is two stories high. The construction is of reinforced concrete.

The new directory of the University of Wisconsin, now in press, shows 3,237 students in attendance, exclusive of the winter dairy and agriculture courses and the summer session. With these added the total attendance will exceed 4,500. The freshman class this year numbers 945, an increase of 106 over that of last year.

At a meeting of the board of trustees of the University of Arkansas, on November 5, Dr. C. F. Adams was made acting dean and director of the College of Agriculture and Agricultural Experiment Station, succeeding W. G. Vincenheller, resigned.

Dr. Frederic Brush, of Boston, has been appointed superintendent of the New York Post-graduate Medical School and Hospital.

Dr. W. A. Syme has been promoted from an instructorship in chemistry to be assistant professor of chemistry in the North Carolina College of Agriculture and Mechanic Arts, and Mr. Hubert Hill, B.S., M.S. (University of North Carolina), has been appointed instructor in chemistry. Mr. J. K. Plummer, B.S. (North Carolina A. & M. College), has been appointed assistant chemist of the Experiment Station.

Reginald E. Hore, instructor in petrography at the University of Michigan, has resigned, to take a position of lecturer on geology at the School of Mining, Kingston, Canada.

Mr. Ellis L. Edwards (Oklahoma, '05), lately a graduate student at the University of Nebraska, has been appointed tutor in geology at the University of Texas.

Dr. T. R. Elliott, late scholar of Trinity College, Cambridge, has been elected to a fellowship at Clare College. Dr. Elliott was placed in the first class of the Natural Sciences Tripos in 1900 and 1901.

The following have been elected to fellowships at St. John's College, Cambridge: Mr. W. L. Balls, M.A., first class of the natural sciences tripos (botany); bracketed for the Walsingham medal. Mr. Balls is at present engaged in scientific investigations connected with cotton in Egypt. Mr. J. A. Crowther, B.A., first class of the natural sciences tripos (physics); Hutchinson research student at St. John's College; research student at Emmanuel College; Mackinnon student of the Royal Society. Mr. Crowther is at present residing in Cambridge and is engaged in physical research.

Dr. F. W. Lamb has resigned his post as assistant lecturer in physiology at University College, Cardiff, on his appointment as senior demonstrator in physiology at Victoria University, Manchester, and the council have appointed Mr. R. R. M'Kenzie Wallace, of Cambridge University, to succeed him.

DISCUSSION AND CORRESPONDENCE

THE TRAINING OF INDUSTRIAL CHEMISTS

To the Editor of Science: The address of Professor F. S. Kipping to the Chemical Section of the British Association, at the recent Dublin Meeting, and reported in abstract in the current issue of Science (October 30, 1908), contains some opinions which deserve the attention of all thoughtful teachers of industrial chemistry. The critical condition of

England, the realization of this situation, and the scholarship and standing of Professor Kipping, all vouch for the sincerity of the views expressed; and these considerations make it more surprising that this able student and teacher should, as reported, deliberately advise against the methods of teaching industrial chemistry which are now recognized as capable of giving practical results. The unfortunately conservative views expressed are still more interesting, because Professor Kipping explicitly states that "This section . . . does not attempt to distinguish pure from applied chemistry." This sentence should be noted; for it implicitly recognizes the common sense of the question, What is it good for; a question which should be the text and guide of all teaching and research.

The views of Professor Kipping are told in these words:

> On consulting the opinions of the manufacturers, it would seem that they attach great importance to what is called the "practical side"; they believe that, in addition to a knowledge of theoretical chemistry, the prospective works-chemist should also have some acquaintance with engineering, should understand the apparatus and machinery used in the particular manufacturing operations with which he is going to deal, and should have had practical experience in working the given process. . . . The arguments in favor of this view, that it is a hybrid chemist-engineer who is required in a chemical works, seem to me to be fundamentally unsound, and the kind of training suggested by them for the works-chemist can only result in the production of a sort of combined analytical machine and foreman. . . . We can not possibly expect such a poorly trained jack-of-all-trades to run a chemical works successfully in the face of competition directed by a large staff of scientific experts in chemistry and engineering.

These quotations are worth reading carefully; for they show two things: one, that I have not misrepresented Professor Kipping; and the other, that he has considered the situation with some care. But the quotations also show another thing, namely, that Professor Kipping has never been in active responsibility of a chemical works and really does not understand practical industry; and because of his own work and standing, his address may cause much hindrance and damage among the readers of SCIENCE. I venture to argue that the views of Professor Kipping are wrong; and that, in view of the necessities of American chemical engineering, at least, they are dangerous. What is needed is just this "combined analytical machine and foreman."

In discussing the broader relations of industrial education, Dr. Andrew S. Draper, state commissioner of education of New York, has most wisely pointed out the over-balance of intellectualism as compared with industrialism in our whole scheme of education; and this applies also with force and reason to our splendid system of training chemists in technical school, college and university. We are in no danger now—it may have been different twenty years ago—from the *practical* trenching on the *theoretical*. We have well-trained students of chemistry, trained in theory and research, by the hundreds; but they were started in a theoretical atmosphere, and they find exceeding difficulty in getting out of that atmosphere. These fine young students have information by the brainful, but they are "muscle-bound," to use the metaphor of an eminent professional athlete. And worse than that, these prodigies of academic training have not the faintest notion of how to *apply* one thousandth part of what they know in a merely intellectual way. What these graduates in chemistry might do if they could have learned the work-shop ideas of the *use*, the *need*, the *trouble*, the *remedy*—what they might do if they had some notion of this practical side, can be only surmised; but industrial necessities demand that the obvious gap in our system of chemical training be filled up without delay.

It must be noted that it takes all kinds of men to make a world. For one superintendent of a chemical works, there must be half a dozen foremen, and perhaps a dozen analysts and assayers; and it is desirable that every workman should know something of both the theory and practise of his trade. If a young man is content to plan for a subordinate position, as a mere analyst or research chemist—and I should use the word, "mere," with care, especially when one recalls such assemblies of scholars as are gathered in such a research laboratory as that of the Badische Anilin-und-Soda Fabrik, but if a young man plans for such a position, the remarks of Professor Kipping may well apply. But that suits well with the conditions of the past; what we are concerned with is what touches the present needs.

One feature of American manufacture is the remarkable development of machinery and power application; and a great lack in this development is the very absence of what should be the chemical-engineering side of it. Now such a nation as Germany has both sides. Why should not America also have both sides? But the only way to reform is to reform; and now that we see the need, it is only necessary to follow in the path indicated. We have a store of well-trained chemists. We have a store of engineers. We lack the adequate supply of practical chemical engineers. It is easy to produce this needed supply—by teaching the chemist engineering; and by giving him teachers who have been and are in touch with the practical. Moreover, there is a great need of reforming the methods of teaching chemistry. With the safeguarding of the curriculum by employing men who know and respect theory, it is feasible to start the student with the practical idea; then he will never get away from it, he will see it always, he will love it and he will use it. For he will learn the dignity and worth of putting theory into overalls; and in turn he will learn the method and value of dressing practise with the dignity of theory.

CHARLES S. PALMER

NEWTONVILLE, MASS.

AURORAL DISPLAYS

IN the issue of SCIENCE dated July 10, I described a remarkable illumination of the sky at Sandy Hook, N. J., on the evening of March 27. Since that date I have witnessed two more sky glows, one on the night of August 18, and another on September 4. I had been quite prepared for further exhibitions of this kind, as a dispatch to the New York *Sun* from Washington, August 8, 1908, stated that there had been an unusual number of auroral displays or sky glows visible in Europe and the eastern part of the United States.

On August 18, I was at Murray Bay, Canada, on the lower St. Lawrence. The night of August 17–18 was cool, rainy and foggy. The afternoon of the eighteenth was windy and clear, and the evening was cool, calm and clear. The few days previous had been unusually warm. On the eighteenth, about 8 P.M., I first noted a rich glow in the west. This was followed, shortly afterwards, by the appearance of shafts spreading from about ten degrees north of west around by the north to almost due east. The illumination in some cases reached almost to the zenith. The shafts appeared and vanished with bewildering rapidity, and quite a number of spiral luminous clouds and persistent bright patches were visible. The illumination lasted until about ten o'clock. There was no moon, yet the general effect of the display was a diffused light about equal to that given by the moon at a quarter-phase.

The exhibition of the night of September 4 was noted at Fort Terry on Plum Island about ten miles from New London, Conn. The same succession in weather conditions had prevailed; hot weather followed by heavy rains, and clear cooler weather. The first indication was at 7:15 P.M., and consisted of a streamer about 60 degrees in length, rising from the horizon about ten degrees west of north. Other streamers in great number but much more attenuated appeared east of north. Some of these faded very quickly, to be followed by new ones, while others were quite persistent, and had a distinct motion towards the west. At about 8 o'clock a bright flat glow was noted almost due north, and shortly afterwards the northern illumination faded. At about 8:45 some peculiar striated luminous clouds appeared in the southwest, followed in turn by a few pale streamers due north. The display closed altogether about 9:30 P.M. It should be noted that the sky became somewhat cloudy towards the end of the display and that the moon in the first quarter was unobscured by clouds most of the time.

Fort Terry, N. Y., W. E. Ellis
September 4, 1908

P. S.—Since furnishing the above, Mr. Donald Robertson, of Brooklyn, N. Y., writes me:

I saw another illumination last Friday, the fourth of September. I was at Lake Placid in the Adirondacks and had a fine view of it. It began at about eight o'clock and lasted until about nine or ten—I do not know which, as there was always a glow in the sky from eight to ten. In most respects, it resembled the one we saw at Murray Bay, but there was one difference. The heavens were lit up brighter than on August 18 and there were at times rainbow colors to be seen in the north.

I also wish to add that there was nothing in the displays of August 18 and September 4 that remotely resembled the steady eastern-western luminous patches of March 27. I am still of the opinion that the last was something more than an auroral exhibition.

Since writing my former account I have received several letters from scientists furnishing me opinions and latest explanations of auroral phenomena. The explanation that I advanced was not so much at variance with latest views.

In nearly all of the theories that have come to my notice, it is assumed that the sun is the only source of cathode rays, or the sun's action produces the cathode rays in our own atmosphere. The possibility that the earth may emit its own cathode rays does not appear to have been considered. W. E. Ellis

Fort Terry, N. Y.,
September 9, 1908

To the Editor of Science: In your issue of July 10 Mr. Wilmot E. Ellis refers to a remarkable case of illumination of the heavens which was observed in New Jersey on March 27 of this year. I was privileged to witness this same phenomenon from the uppermost deck of the R.M.S. *Adriatic* about 530 knots due east from Sandy Hook Light Ship. I had on several previous occasions observed spots or streaks of small dimensions in various parts of the northern heavens, sometimes rivaling in brightness the Milky Way itself, but never had I known of sky-brightness as extensive and as pronounced as I did in this case. The night was perfectly clear and Venus shone so brightly that a streak of light was thrown upon the surface of the ocean. I watched the phenomenon during the last twenty minutes of its manifestation, the general characteristics being as recorded by other observers, though I believe its general position was lower on the western horizon. I noticed no trembling whatever in the shafts of light which developed towards the last.

I can hardly agree with your correspondent as to the nature of this brightness. His theory is practically that proposed by Chaplain Jones, U.S.N., in 1855 for the zodiacal light. I do not pretend to deny a corona to the earth and moon, but if due to disintegration of matter, as Mr. Ellis suggests, it is evident that to allow for an applicable corona we should require a degree of ionization of the atmosphere close to the earth—apart from that due to sunlight—incomparably greater than what we observe.

I have long believed that sky-brightness was either due to an after-glow on banks of moisture or dust in the upper reaches of the atmosphere, or else to the burning of cosmic dust clouds as the earth's atmospheric mantle passed through them. These dusts might either be traveling in set orbits like meteorites, or more probably they would emanate from the sun, either as a continuous outgrowing corona, or likely enough as an intermittent discharge from spots. Sunspot areas are, if anything, hotter than the rest of the photosphere, which would be explained by the heat-retaining power of material dusts (probably gaseous in character) present in the direct line of bolometric measurement. The magnetic disturbances often observed shortly after sunspot eruptions would be explained by the bridging of space by these atomic dusts, and their effect as ions or carriers of electricity from the earth to the sun. The time elapsing between the eruption and the magnetic effects would indicate the speed of travel of these particles which might be compared with the growth of solar red-flames. It is not difficult to reconcile a theory such as this with that of Arrhenius.

Alfred Sang

RECESSIVE CHARACTERS

For the past two years there has been exhibited at the Trenton (New Jersey) Agricultural Show a cow without trace of the body hairs. This cow was crossed with a normal bull, according to the owner, Mr. Frank Fraunfelter, of Pennsylvania, and a male calf was born last September which has the ordinary hairy coat. This result indicates that the presence of the hair follicles is dominant over their absence. This adds another case to the law that the presence of a quality is dominant over its absence or that a retrogressive or retarded condition is recessive to the more developed conditions. C. B. Davenport

QUOTATIONS

THE PRESIDENCY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The Institute of Technology has now solved a problem of some delicacy and difficulty in selecting for the head of that institution Professor Richard C. MacLaurin, at present at the head of the mathematical physics department of Columbia University, and he has accepted the honor and the responsibility. The institute has been under capable direction during the nearly two years that have elapsed since the resignation of President Pritchett. Acting President Noyes has maintained its high standards and manifested a degree of executive skill that probably would have given him the full title and lodged the full authority of the position in his hands had he been disposed to accept them. But his chosen field of chemical research has possessed more attractions for him. In it he has opportunity to blaze new trails in scientific advance, and he is to be commended for his clear and loyal following of his own light and leading in this matter.

The new president evidently understands in its general features the nature of the work to which he has been called, and his record in educational service indicates that he is one who readily becomes master of detail. The experience will be not less new to him than to the institution, which now for the first time will be under the direction of a man born in another country and trained in foreign schools and universities. That is not necessarily an objection. It may prove a positive gain. Professor MacLaurin is a comparatively young man. His attainments are more than excellent; they are extraordinary, and few men of his years have won more flattering recognition from sources that bear the stamp of authority.

Of course, mere scholarship, even of the highest order, is not enough to meet all the requirements of this new responsibility. His executive ability and his adaptability can be proved only by actual service. But Scotch scholars are thorough; their standards are high and shrewdness and personal tact are among their national characteristics. When Princeton called Dr. McCosh to the presidency, he was a man well along in years, but a famous metaphysician, and he filled the place with distinction. The institute does not need metaphysicians, and the new president has not turned his researches in that direction. He has made great advances in modern science; he is learned in the principles of law and is undoubtedly an enthusiast with respect to the various lines of research with which he has been so conspicuously identified. The institute authorities, the alumni and the public have a well-grounded hope that under his administration a new era of prosperous service will open up for this famous school.—*The Boston Transcript.*

BURDENS OF COLLEGE PRESIDENTS

President Eliot's impending retirement from the presidency of Harvard is bound to give an impetus to the movement to divide the functions of that office. "The governing boards and the alumni will understand better in six months than they do even now what a void Eliot will leave," writes one of the most prominent of the Boston alumni. But this is not only because Mr. Eliot towers above all other college presidents and is the foremost American citizen. The magnitude of his office is such that it would be a most difficult task to fill it, had it been held by a man of far smaller intellectual calibre. The administrative work alone would tax the abilities of our greatest corporation heads, while the outlining of its courses of study calls for educational statesmanship of the first rank. . . .

In President Eliot's case, he has borne the multifarious burdens, including the duty of meeting with the governing bodies and the faculty, at the expense, we are tempted to say, of the student body. By this we mean no criticism; it is a fact, however, that he has generally been a stranger, or a great name, to the undergraduate body. Close relations with it have been humanly impossible; all one could ask was the necessary intercourse with the leaders of the teaching staff of *only* 566 persons. So when one of the leading undergraduates was asked by a reporter the opinion of that body as to the president's retirement, he naïvely answered to the effect that "few of us know him, but all regret the change"! True, Mr. Eliot has for some years past annually met the newly entering class with one of those exquisite addresses of counsel and inspiration that will have high place among the enduring monuments he has, unconsciously enough, builded to himself. But beyond that the influence of his noble personality and his lofty personal life have penetrated to the undergraduate hardly more than to the general public all over the country. This has been a grave loss to college and nation, for the moulding of character is, after all, the primary duty of a university; even of a teacher of science, as Professor Arthur A. Noyes of the Institute of Technology admirably points out in the current Science. "To begin with," he says, "we [the teachers] set him [the student] the example of rendering unselfish service to others by giving him individual aid. . . ." And it is individual moral aid that the Harvard student often so sadly lacks. Who in our time has been better fitted to extend it than President Eliot?

Then there is the faculty. It takes a great general to inspire 566 teachers; to recruit their forces, to recognize the worthy and discard the drones or the inefficient; to lead them on over the breastworks of tradition to new fields of honor and of service. That would seem in itself to be a sufficient life's work for any one man. And so we confess to having been surprised to learn last year that a majority of a joint committee of the Overseers and the corporation, including President Eliot, found, after inquiry, that "the president of the university does not need to be relieved of any function that he now performs; but that he ought to be relieved of details in many directions, and to have more assistance than he now has." Would they have been able to report the same with any one else as president? Will the governing boards not yet come to filling President Eliot's place with two men, one a rector in charge of everything pertaining to the scholastic work, the students, and the teachers, and the other a man of the type of the late William H. Baldwin, Jr., of the Long Island Railway, of marked business ability, of winning and upright personality—qualified to represent the university in all of its relations to the public and the nation?—New York *Evening Post.*

SCIENTIFIC BOOKS

First Course in Biology. By L. H. Bailey and W. M. Coleman. New York, The Macmillan Co. 1908.

The present work is divided into three parts, the first of which is devoted to botany and is written by Professor Bailey, while the second and third parts dealing respectively with zoology and physiology are by Professor Coleman. As is remarked in the preface, there is a tendency in secondary education to introduce unit courses in biology in place of isolated courses in botany, zoology and physiology, and the authors have aimed to prepare a book which presents the elements of biology as exemplified by plants, animals and man, rather than separate treatises on different fields of biological science. The book is designed to afford material for three half years, but the ground may be covered in a single year by omitting the matter in fine print.

There is a useful introductory chapter on the elementary facts of chemistry which are essential for the understanding of the biological discussions which follow. Then the student is plunged at once into accounts of variation, struggle for existence, survival of the fit, and plant societies—topics which more frequently form the end, instead of the beginning, of text-books, although as here presented they can readily be grasped by the beginning student and may serve to enliven his interest in and appreciation of what is to come. Most of the botanical section is devoted to the structure, physiology and adaptations of flowering plants, the cryptogams being dealt with in the last chapter in fine print which is designed to be omitted should time not be adequate for the complete course. Many teachers may criticize the limitation of the work so largely to the flowering plants and the inadequate conception it gives of the diversity and general development of the vegetable kingdom. One must of necessity sacrifice important subjects in an elementary text, and it is quite natural that the writer who stands so prominent as an authority in horticulture and agriculture should emphasize, perhaps unduly, those parts of the subject which are more directly concerned with these branches. Professor Bailey has brought the student more closely in touch with the practical aspects of botany than is usually done, and this is a valuable feature of his part of the book, even from the standpoint of the teacher of pure science. The text is clearly written and illustrated with many good figures most of which are new, and there are lists of questions and helpful suggestions for work at the close of the various chapters.

The zoological part of the work suffers considerably in comparison with the preceding. Errors are numerous and frequently serious, while there are many more statements which are misleading or inadequate. Space will not permit us to point these out in detail, but the following will serve to indicate sufficiently, I think, the general character of the work. After describing *Amœba* and *Paramœcium* we have the statement: "Other classes of Protozoans are the infusorians, which have many waving cilia (Fig. 17) or one whip-like flagellum (Fig. 18), and the foraminifers which possess a calcareous shell pierced with holes (Fig. 19)." In the first place the infusorians do not, as the statement implies, form another class in addition to that represented by *Paramœcium*, they do not in most recent systems of classification and certainly should not include the flagellata, many of which have two or more flagella instead of one; nor are the foraminifera ranked as another class distinct from the rhizopods to which *Amœba* belongs, but as a subordinate division of the same group; they do not all possess a calcareous shell; in large numbers of species the shell is not pierced with holes; and the figure which is supposed to represent one of them is a picture of a radiolarian!

In Fig. 23 what are called the eggs of the fresh-water sponge are doubtless the gemmules. After informing us that in sponges "the ciliated cells and the reproductive cells are the only specialized cells," and that "slow-growing sponges grow more at the top and form tall, simple, tubular or vase-like animals. Fast-growing sponges grow on all sides at once and form a complicated system of canals, pores, and oscula," we are given an illuminating account of how sponges may have arisen from unicellular ancestors.

> Several one-celled animals happened to live side by side; each possessed a thread-like flagellum or whip-lash for striking the water. By lashing the water they caused a stronger current than protozoans living singly could cause. Thus they obtained more food and multiplied more rapidly than those living alone. The habit of working together left its impress on the cells and was transmitted by inheritance. Cell joined to cell formed a ring; ring joined to ring formed a tube which was still more effective than a ring in lashing the water into a current and bringing fresh food (particles of dead plants and animals) and oxygen.

Comments are superfluous.

In the description of the nettling cells of hydra the fact is announced that after their discharge "when the pressure is withdrawn the thread goes back as the finger of a glove may be turned back into the glove by turning the finger outside in." In the same chapter occurs also the misstatement that "the hydra is the only fresh-water representative" of the "branch polyps (sometimes called Cœlenterata)." And the figure of hydras on pond-weed is inverted, giving one the impression that animals are growing on the stems up in the air.

In the chapter on Echinoderms the following sentences are from one point of view very instructive: "The sand dollars are lighter colored than the sea urchin. Why?" Here the bright pupil is probably expected to hold up his hand and, without ever having seen a sand dollar, much less observed one in its natural habitat, explain the matter, after the common fashion, as a case of protective coloration. The explanation fits the case all the better if it is not known that many species of sand dollars when alive in the water and still containing a large amount of purple pigment are anything but light colored and do not become so until they are bleached out or denuded of spines or both. "Starfish," the author tells us, "are brown or yellow. This makes them inconspicuous on the brown rocks or yellow sands of the seashore." In this as in several other cases the author seems naïvely unaware of the danger of making general statements on the basis of a few instances. Only a slight investigation of the colors of different starfish would make him acquainted with species of red, orange, purple or other color of the most conspicuous kind, and would doubtless have shaken his faith in the general occurrence of protective coloration in this group. The flat form and light thin walls of the sand dollars are explained as an adaptation to prevent their sinking into the sand. This may be the case, but the author is a little venturesome when he relates that "the five-holed sand cake or sand dollar has its weight still further diminished by the holes, which also allow it to rise more easily through the water." Whether he conceives these creatures to have the faculty of rising and swimming about like fishes is not entirely clear, but the possession of some means of locomotion above the bottom seems to be implied.

In regard to the common earthworm whose structure is correctly described in so many text-books it is surprising to find the author falling into several errors. The eggs are said, on page 46, to pass out of two pairs of openings in the fourteenth and fifteenth segments, while on page 47 they are said to pass into the collar-like case as it passes the fifteenth and sixteenth segments—two contradictory statements, neither of which is correct. A structure marked *ES* in Fig. 77 is called egg gland, while other bodies marked o_1 and o occurring in the twelfth and thirteenth segments respectively are not given any further explanation. The word clitellum is employed for the chitinous capsule which surrounds the eggs instead of the glandular region of the body by which the capsule is secreted.

After warning us that "the name 'worm' is often carelessly applied" and that it should be given "only to segmented animals without jointed appendages" we are given a classification of the "four classes in the branch Vermes," two classes of which, the round-worms and the rotifers, are not segmented forms at all, while in the third class, the flat-worms, segmented forms occur only in one of the subordinate divisions. The first class is designated "*earthworms,* including sand-worms and leeches," which is something of a sacrifice of accuracy to simplicity of terminology.

On page 79 we meet with the statement that:

> It is probable that the large or compound eyes of insects only serve to distinguish bright objects from dark objects. The simple eyes afford distinct images of objects within a few inches of the eye.

It would be difficult to give an account more at variance with the facts, and we recommend the perusal of Forel's "Expériences sur les Sensations des Insectes" before the issue of a second edition. On the same page occurs a section upon "Inherited Habit or Instinct," in which the mode of origin of instincts is described and summarized in the sentence "Repeated acts constitute a habit, and an inherited habit is called an instinct." We do not criticize the writer for espousing a view of the origin of instincts now largely discredited and accepted by practically none in the unqualified form here set forth, but if the subject is discussed at all the student should not be given but one interpretation and taught dogmatically that it is the correct one. The table for classifying insects on page 82 contains many errors; statements either the reverse of the truth or otherwise faulty occur in six out of the ten short diagnoses of the orders.

The inaccuracies, of which many more examples could be pointed out, are not the only features that call for criticism. They constitute rather a symptom of debility in other directions. Students of science will gain little profit from a book in which there is a lack of clearness and cogency of thought, and the choice of the text in its present condition for a class in zoology would be one to be deplored.

In dealing with physiology the author is apparently more at home. At least there are fewer errors. There is, however, a very inaccurate original diagram of the sympathetic nervous system, and there are several statements that require emendation. The outlines for practical laboratory experiments form a commendable feature of this part of the work, and the general plan of having physiology follow a course in zoology leading gradually up to the study of man is an excellent one, but it is regrettable that it should have fallen so far short of the ideal in its execution.

S. J. H.

Typhoid Fever. Its Causation, Transmission and Prevention. By GEORGE C. WHIPPLE, Consulting Engineer. With an Introductory Essay by WILLIAM T. SEDGWICK, Professor of Biology, Massachusetts Institute of Technology. New York, John Wiley and Sons; London, Chapman and Hall, Limited. 1908.

The publication of a work by a layman on a subject usually regarded as medical is something of an innovation, and a welcome one. It is curious that the preventable diseases, which from the prophylactic standpoint present so many aspects of a technical, but not a purely medical, character, have not been discussed more frequently by sanitarians in works, like this of Mr. Whipple, which are in a form which commends them to the general reading public. The medical profession has often been accused, and justly so, of being too secretive regarding medical affairs. There is an undoubted and salutary reaction within the profession against this policy of secretiveness, and books like Mr. Whipple's will help along this reaction.

Mr. Whipple's work does not go into details regarding the purely clinical aspects of typhoid fever, but merely sketches this side of the disease, and relates for the most part, as the subtitle indicates, to the causation, transmission and prevention of the disease. These subjects are covered in a series of chapters dealing with the life history of the typhoid bacillus within and without the body, the lines of defense against its entrance, statistics dealing with the distribution and epidemiology of the disease, its relation to water supplies, and a brief chapter on the financial loss caused by its prevalence. Useful appendices deal with the use of disinfectants, the rôle of house flies in the spread of the disease, death rates, water analysis, the viability of the germ, and the literature of the subject. The book is well printed, and is admirably illustrated by numerous charts, and an ingenious frontispiece which shows the methods of transmission and means of protection.

The work differs from most of those available to the public in the simplicity of its language, which can be understood by any intelligent layman. It differs from most medical treatises on Typhoid Fever in the emphasis placed on the transmission and prevention of the disease, and in the wealth of statistical detail available to support the various statements. We could have wished that there was more in the book concerning what has actually been accomplished in the prevention of the disease when due to contact rather than water or food transmission. Koch's work at Trier, which shows what can be done to stamp out the disease under certain circumstances, might have been quoted. Though Mr. Whipple's profession naturally impresses upon him most forcibly the dangers of water and food transmission, he recognizes the importance of contact, but does not, we believe, emphasize it so forcibly as is desirable. In the main the work is an admirable one, and worthy of the highest commendation. Professor Sedgwick's introduction is an interesting historical summary of the development of our knowledge of the disease.

GEORGE BLUMER

SPECIAL ARTICLES

NOTE ON THE FORMULAS FOR ENERGY STORED IN ELECTRIC AND MAGNETIC FIELDS

Consider a charged sphere. Let it grow in size. The potential decreases for the same charge as the radius increases. Hence the potential energy also decreases. The tubes of force, everywhere pulling the surface out toward infinity, are losing the potential energy of their stretched condition, and at infinity they have closed up and the potential energy has disappeared from the potential state.

We may then consider the energy as residing, not in the sphere but in the dielectric outside, and that the amount of energy that disappears from the potential state at each step is entirely in the spherical shell of the dielectric, which makes up the difference in volume between the successive steps in the growth of the sphere. We have then, only to calculate the difference in potential energy for two slightly different radii of the sphere and divide by the volume of the spherical shell, and we shall have the density of the energy in the electric field. It is to be noted that the electric field at any point outside the sphere is unchanged by the growth of the sphere, since the number of tubes of force, and hence the amount of their crowding, depends only on the charge and not on the size of the sphere.

Let r be the radius of the sphere, v the volume, e the charge, E the electric field, ψ the potential, P the potential energy, ϵ the dielectric constant.

By definition ψ is the work necessary to carry unit charge from infinity to the sphere, or

$$\psi = \int_{\infty}^{r} E dr = \int_{\infty}^{r} (e/r^2) dr = e/r, \qquad (1)$$

which might have been written immediately, since the capacity of a sphere is r. Also by definition

$$E = d\psi/dr = d/dr(e/r) = e/r^2. \qquad (2)$$

We have also

$$P = \tfrac{1}{2}\psi e. \qquad (3)$$

From (1) and (3),

$$P = e^2/2r.$$

Differentiating, we get the change in potential energy due to a small change in radius,

$$dP = - e^2 dr/2r^2,$$

the negative sign meaning a decrease in energy for an increase in radius. The volume of the shell is $4\pi r^2 dr$, and the loss of potential energy per cm^3 is, by equation (2),

$$dP/dv = - e^2/8\pi r^4 = - E^2/8\pi.$$

Hence the energy in the dielectric is $E^2/8\pi$ ergs per cm^3.

If $\epsilon \neq 1$, the charge for the same ψ and the same E is greater and we have to write $\epsilon\psi$ and (ϵE) instead of ψ and E in equations (1) and (2), to make them hold numerically. This followed through gives, finally,

$$E(\epsilon E)/8\pi.$$

The expression for the energy in a magnetic field follows in exactly the same way; we have only to substitute m for e and H for E in the equations above. We may take a sphere of very great permeability as an isolated pole m. Should it seem clearer, this sphere may be thought of as the pole piece of a long magnet of infinitesimal diameter reaching to infinity, where the other pole piece forms another spherical shell. The tubes of force tend to shorten as in the electrostatic field, closing up when the sphere grows to infinite radius.

The energy per cm^3 comes out $H^2/8\pi$.

If all surrounding space is filled with a medium whose permeability is μ instead of *1*, the number of tubes for the same H is μ times as great. So, as before, we must use $\mu\psi$ and (μH) in equations (1) and (2), which, traced through, give $H(\mu H)/8\pi$ ergs per cm^3.

The first three derivations are rigorous, but awkward questions arise as to what the H and the B, in the last case, represent physically. Yet it can be made satisfactory by supposing that the long thin magnet is divided into two parts, one supplying H tubes of force, and the other supplying $(\mu - 1)\ H$ tubes, the former being rigidly magnetized.

From the method of this derivation it follows without additional proof that the tension along the lines of force is numerically equal to the energy density.

P. G. Agnew
Washington, D. C.

A VACUUM STOPCOCK

During the winter of 1908 work was undertaken on the gas production of *Bacillus coli* in synthetic culture media. The method of work consisted of growing the organism in high vacuum. In the course of this work considerable difficulty was experienced in maintaining absolutely tight stopcocks and as a result a stopcock was devised that appears to satisfy the conditions for a gas-tight stopcock.

The ordinary stopcocks had to be reground with jeweler's rouge, and while this precaution rendered the stopcock gas-tight under constant temperature conditions, it was found that the changes in temperature from room to incubator caused the two ground surfaces, assisted by the resilience of the lubricant, to separate and thus make the stopcock leak. To overcome these difficulties the stopcock had to be tied into place and mercury placed in the exposed lead.

The stopcock devised to overcome these difficulties is explained by the two diagrams. The passage from X to Y leads through an obliquely drilled plug as in the ordinary improved vacuum stopcock. At A a small bulb takes the place of the ordinary open end. Into the center of the plug, and in the same plane as the oblique drilling, a drilling is made as far as the level of the lead X. From

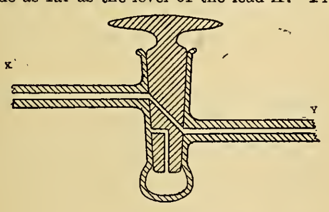


Fig. 1

this point it continues at a right angle as indicated in the diagram. The operation of the stopcock is as follows. The stopcock being in the position indicated in Fig. 1, the plug is turned through 180°, thus bringing it into the position indicated in Fig. 2. The stopcock is then connected with the pump and the small bulb exhausted. Turning the plug through another 180° will open the passage from X to Y and then it may be opened and closed at will without the small bulb A ever coming into communication with the passage.

In the above arrangement the atmosphere is exerting its pressure to hold the plug in place, thus overcoming the resilience of the

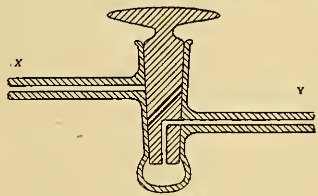


Fig. 2

lubricant and pressing the two ground surfaces together constantly, in spite of the temperature changes that tend to let one surface expand away from the other. The lubricant is composed of gutta-percha, hard paraffin wax and a heavy mineral oil; and answers admirably. Many similar lubricants are described in the literature.

The above stopcocks were very neatly constructed by Eimer and Amend.

Brown University Frederick G. Keyes

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and fortieth regular meeting of the society was held at Columbia University on Saturday, October 31. A single morning session sufficed for the brief program. The president of the society, Professor H. S. White, occupied the chair. The attendance included twenty-one members. The following new members were elected: Professor J. A. Brewster, St. Angela's College; Professor W. H. Butts, University of Michigan; Dr. C. F. Craig, Cornell University; Professor T. A. Martin, Mt. Union College; Professor M. T. Peed, Emory College; Mr. G. E. Roosevelt, New York City; Mr. L. M. Saxton, College of the City of New York. Four applications for membership were received. The total membership of the society is now 605.

A list of nominations of officers and other members of the council was adopted and ordered placed on the official ballot for the annual election at the December meeting. It was decided to hold the annual meeting at Baltimore, on Wednesday and Thursday, December 30–31, in affiliation with the American Association for the Advancement of Science.

The following papers were read at this meeting:

R. D. Carmichael: "On the theory of functions of a triple variable."

R. D. Carmichael: "Notes on the simplex theory of numbers."

Edward Kasner: "Conformality and functions of two or more complex variables (second paper)."

G. A. Miller: "On groups generated by two operators satisfying the equation $s_1 s_2 = s_2 s_1$."

E. B. Wilson: "The number of types of collineations."

Frank Irwin: "The invariants of linear differential expressions."

A. E. Landry: "A geometrical application of binary syzygies."

The Southwestern Section of the society will hold its second regular meeting at the University of Kansas, on Saturday, November 28. The Chicago Section will meet at the University of Chicago on Friday and Saturday, January 1–2.

At the annual meeting of the society at Baltimore President White will deliver his retiring address on "Bezout's theory of resultants and its influence on geometry."

F. N. Cole,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The second regular meeting of the session of 1908–9 was held at the Chemists' Club on November 6.

The Nichols medal, awarded annually for the best paper read before the section, was presented to W. A. Noyes and H. C. P. Weber for their paper on "The Atomic Weight of Chlorine."

Dr. L. H. Baekeland, chairman of the section, spoke as follows:

"A few years ago our distinguished fellow member, Dr. W. H. Nichols, donated to this section of our society a fund wherewith to offer a gold medal every year for the best paper read at our meetings.

"I remember that, when this generous offer was made, I felt somewhat uncertain about the ultimate result. I knew that in this country of unbounded generosity it was easy to find a warm-hearted donor; I knew that it was easy enough to find an artist to make the medal an undoubted work of art; but I knew also that the Nichols medal would only be consecrated to its proper value, not in relation to the amount of gold it contains, nor in relation to its artistic value, but solely and exclusively by the quality of the work rewarded by it.

"Last year our section was unusually fortunate in the variety and the quality of the papers which were read before its meetings.

"Among several excellent papers, four attracted special attention:

"'The Atomic Weight of Chlorine,' H. C. P. Weber and W. A. Noyes.

"'The Extraction of Potash from Feldspathic Rocks,' A. S. Cushman.

"'The Ignition Temperature of Gaseous Mixtures,' K. G. Falk.

"'Drop Weights and the Law of Tate. The Determination of the Molecular Weight in the Liquid State by the Law of Tate,' J. L. R. Morgan and Reston Stevenson.

"Every one of these papers was fully worthy of the Nichols medal. Yet it was the general verdict as decided by vote that the paper of Weber and Noyes should be classed first.

"When I wrote to these gentlemen the announcement of the result, they acknowledged my letter and showed their equanimity by stating that they would have considered it an honor even if their work had been classed second to the three other excellent papers.

"To those here present who remember the struggling times of our society, when not so many years ago it was hard to get a dozen of us together at a meeting; when original research work in America was very scarce and weak in almost all departments of science, it certainly must appear as an inspiring symptom of fully awakened scientific activity that so many papers read before the New York Section alone should have been worthy of consideration for the Nichols prize.

"And now that the donor of the medal has done us the honor to-night of being among us, I request him to add to the luster of the occasion by presenting the medal himself."

Dr. Nichols, after giving a short account of the circumstances attending the foundation of the medal fund, presented the medals to the two successful autnors.

Dr. Noyes in reply expressed the appreciation of himself and Dr. Weber of the honor conferred upon them and gave a brief résumé of the prize paper. He was followed by Dr. Weber, who spoke of some further work along the same lines on the atomic weight of bromine.

The remainder of the evening was devoted to a paper by Dr. J. E. Teeple on "An Enzyme Splitting Sugar into Acids."

C. M. Joyce,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 27, 1908

CONTENTS

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

URANIUM AND GEOLOGY—II

RADIO-ACTIVE DEPOSITS AND THE INSTABILITY OF THE CRUST

AT the meeting of the British Association held last year at Leicester, I read a note on the thermal effects which might be expected to arise at the base of a sedimentary accumulation of great thickness due to the contained radium.

The history of mountain-building has repeated itself many times: ages of sedimentation, with attendant sinking of the crust in the area of deposition, then upheaval, folding up of the great beds of sediment, and even their over-thrusting for many miles. So that the mountain ranges of the world are not constituted from materials rising from below, save in so far as these may form a sustaining core, but of the slowly accumulating deposits of the ages preceding the upheaval.

The thickness of collected sediments involved in these great events is enormous, and although uncertainty often attends the estimation of the aggregate depths of sedimentation, yet when we consider that unconformities between the deposits of succeeding eras represent the removal of vast masses of sediment to fresh areas of deposition, and often in such a way as to lead to an under-estimate of the thickness of deposit, the observations of the geologist may well indicate the minor and not the major limit. Witness the mighty layers of the Huronian, Animikean and Keweenawan ages where deposits measured in miles of thickness are succeeded by unrecorded intervals of time, in which we know with certainty that the tireless forces of denudation labored to undo their former work. Each era represents a slow and measured pulse in the earth's crust, as if the overloading and sinking of the surface materials induced the very conditions required for their reelevation. Such events, even in times when the crust was thinner and more readily disturbed than it is now, must have taken vast periods of time. The unconformity may represent as long a period as that of accumulation. In these Proterozoic areas of America, as elsewhere on the globe and throughout the whole of geological history, there has been a succession in time of foldings of the crust always so located as to uplift the areas of sedimentation, these upheavals being sundered by long intervals during which the site of sedimentation was transferred and preparation made for another era of disturbance. However long deferred, there seems to be only the one and inevitable ending, inducing a rhythmic and monotonous repetition surely indicative of some cause of instability attending the events of deposition.

The facts have been impressively stated by Dana:

> A mountain range of the common type, like that to which the Appalachians belong, is made out of the sedimentary formations of a long preceding era; beds that were laid down conformably, and in succession, until they had reached the needed thickness; beds spreading over a region tens of thousands of square miles in area. The region over which sedimentary formations were in progress in order to make, finally, the Appalachian range, reached from New York to Alabama, and had a breadth of 100 to 200 miles, and the pile of horizontal beds along the middle was 40,000 feet in depth. The pile for the Wahsatch Mountains was 60,000 feet thick, according to King. The beds for the Appalachians were not laid down in a deep ocean, but in shallow waters, where a gradual subsidence was in progress; and they at last, when ready for the genesis, lay in a trough 40,000 feet deep, filling the trough to the brim. It thus appears that epochs of mountain-making have occurred only after long intervals of quiet in the history of a continent.

The generally observed fact that the deposition of sediments in some manner involves their ultimate upheaval has at various times led to explanations being offered. I think I am safe in saying that although the primary factor, the compressive stress in a crust which has ceased to fit the shrinking world within it, has probably been correctly inferred, no satisfactory explanation of the connection between sedimentation and upheaval has been advanced. The mere shifting upwards of the isogeotherms into the deposits, advanced as a source of local loss of rigidity by Babbage and Herschel, need not involve any such loss so long as the original distance of the isogeotherms from the surface is preserved.

We see in every case that only after great thickness of sediments has accumulated is the upheaval brought about. This is a feature which must enter as an essential condition into whatever explanation we propose to offer.

Following up the idea that the sought-for instability is referable to radio-thermal actions, we will now endeavor to form some approximate estimate of the rise of temperature which will be brought about at the base of such great sedimentary accumulations as have gone towards mountain-building, due to the radium distributed throughout the materials.

The temperature at the base of a feebly radio-active layer, such as an accumulation of sediments, is defined in part by radio-active energy, in part by its position relative to the normal isogeotherms, whether these latter are in turn due to or influenced by radio-thermal supplies or not. It is convenient, and I think allowable, to consider these two effects separately, and deal with them as if they were independent, the resultant state being obtained by their summation.

In dealing with the rise of temperature at the base of a radio-active layer we arrive at an expression which involves the square of the depth. This is a very important feature in the investigation, and leads to the result that, for a given amount of radium, diffuse distribution through a great depth of deposit gives rise to a higher basal temperature than a more concentrated distribution in a shallower layer.

But this will not give us the whole effect of such a deposit. Another and an important factor has to be taken into account. We have seen that the immediate surface rocks are of such richness in radium as to preclude the idea that a similar richness can extend many miles inward.

Now, it is upon this surface layer that the sediments are piled, and as they grow in thickness this original layer is depressed deeper and deeper, yielding under the load until at length it is buried to the full depth of the overlying deposit. This slow and measured process is attended by remarkable thermal effects. The law of the increase of temperature with the square of the depth comes in, and we have to consider the temperature effect not merely at the base of the deposited layer, but that due to the depression and covering over of the radium-rich materials upon which the sediments were laid down.

The table which follows embodies an approximate statement of the thermal results of various depths of deposit supposed to collect under conditions of crustal temperature such as prevail in this present epoch of geological history.

I have deferred to the conclusion of this address an account of the steps followed in obtaining the above results. It is clearly impossible, within the limited time allotted to me, to make these quite clear. It must suffice here merely to explain the significance of the figures.

Thickness of Sedimentary Deposit Kilometers	Resulting Rise of Isogeotherms Kilometers	Weakening of Earth's Crust as Defined by the Rise of the Geotherm at 40 Kilometers Kilometers
6	7.4	40 to 32.6
8	10.2	40 to 29.8
10	13.3	40 to 26.7
12	16.7	40 to 23.3
14	20.4	40 to 19.6

The first column gives the depth of sedimentary deposit supposed to be laid down on the normal radio-active upper crust of a certain assumed thickness and radioactivity. From the rise of temperature which occurs at the base of this crust (due to the radio-activity, not only of the crust, but of the sediments) the results of the second column are deduced, the gradient or slope of temperature prevailing beneath being derived from the existing surface gradients corrected for the effects of the radio-thermal layer. The third column is intended to exhibit the effect of this shift of the geotherms in reducing the strength of the crust. I assume that at a temperature of 800° the deep-seated materials lose rigidity under long-continued stress. The estimated depth of this geotherm is, on the assumptions, about 40 kilometers. The upward shift of this geotherm shows the loss of strength. Thus in the case of a sedimentary accumulation of 10 kilometers the geotherm defining the base of the rigid crust shifts upwards by 13 kilometers, so that there is a loss of effective section to the amount of 30 per cent.

As regards the claims which such figures have upon our consideration, my assumptions as to thickness and radio-activity of the specially rich surface layer are, doubtless, capable of considerable amendment. It will be found, however, that the assumed factors may be supposed to vary considerably, and yet the final results prove such as, I believe, can not be ignored. Indeed, those who are in the way of making such calculations, and who enter into the question, will find that my assumptions are not specially favorable, but are, in fact, made on quite independent grounds. Again, a certain class of effects has been entirely left out of account, effects which will go towards enhancing, and in some cases greatly enhancing, the radio-thermal activity. I refer to the thickening of the crust arising from tangential pressure, and, at a later stage, the piling up and overthrusting of mountain-building materials. In such cases the temperature of the deeper parts of the thickened mass must still further rise under the influence of the contained radium. These effects only take place, indeed, after yielding has commenced, but they add to the element of instability which the presence of the accumulated radio-active deposits occasions, and doubtless increase thermal metamorphic actions in the deeper sediments, and result in the refusion of rocks in the upper part of the crust.[19]

The effect of accumulated sediment is thus necessarily a reduction in the thickness of that part of the upper crust which is capable of resisting a compressive stress. Over the area of sedimentation, and more especially along the deepest line of synclinal depression, the crust of the globe for a period assumes the properties belonging to an earlier age, yielding up some of the rigidity which was the slow inheritance of secular cooling. Along this area of weakness—from its mode of formation generally much elongated in form—the stressed crust for many hundreds, perhaps thousands, of miles finds relief, and flexure takes place in the only possible direction; that is, on the whole upwards. In this way the prolonged anticline bearing upwards on its crest the whole mass of deposits is formed, and so are born the mountain ranges in all their diversity of form and structure.

We have in these effects an intervention of radium in the dynamics of the earth's crust, which must have influenced the entire history of our globe, and which, I believe, affords a key to the instability of the crust. For after the events of mountain-building are accomplished, stability is not attained, but in presence of the forces of denudation the whole sequence of events has to commence over again. Every fresh accession of snow to the firn, every passing cloud contributing its small addition to the torrent, assists to spread out once more on the floor of the ocean the heat-producing substance. With this rhythmic succession of events appear bound up those positive or negative movements of the strand which cover and uncover the continents, and have swayed the entire course of evolution of terrestrial life.

Oceanic Deposits.—The displacements of the crust which we have been considering are now known to be by no means confined to the oceanic margins. The evidence seems conclusive that long-continued movements have been in progress over certain areas of the sea floor, attended with the formation of those numerous volcanic cones upon which the coral island finds foundation. Here there are plainly revealed signs of instability and yielding of the crust (although, perhaps, of minor intensity) such as are associated with the greater movements which terminate in mountain-building. I think it will be found, when the facts are considered, that we have here

[19] Professor C. Schmidt (Basel) has recently given reasons for the view that the Mesozoic schists of the Simplon at the period of their folding were probably from 15,000 to 20,000 meters beneath the surface (*Ec. Geol. Helvetiæ*, Vol. IX., No. 4, p. 590). As another instance consider the compression of the Laramide range (Dawson, *Bull. Geol. Soc. Am.*, XII., p. 87).

phenomena continuous with those already dealt with, and although the conditional element of a sufficient sedimentary accumulation must remain speculative, the evidence we possess is in favor of its existence.

One of the most interesting outstanding problems of deep-sea physiography is that of the rates of accumulation of the several sorts of deposit. In the case of the more rapidly collecting sediments there seems no serious reason why the matter should not be dealt with observationally. I hope it may be accomplished in our time. For my present purpose I should like to know what may or may not be assumed in discussing the accumulation of radio-active sediments on the ocean floor.

As regards the rate of collection of the non-calcareous deposits, the nearest approach to an estimate is, I think, to be obtained from the exposed oceanic deposits of Barbados. In the well-known paper of Jukes Brown and Harrison[20] on the geology of that island, it is shown that the siliceous radiolarian earths and red clays aggregate to a thickness of about 300 feet. These materials are true oceanic deposits, devoid of terrigenous substances. They collected very probably during Pliocene and, perhaps, part of Pleistocene times. Now, there is evidence to lead us to date the beginning of the Pliocene as anything from one million to three million years ago. The mean of these estimates gives a rate of collection of 5 millimeters in a century. This sounds a very slow rate of growth, but it is too fast to be assumed for such deposits generally. More recent observations might, indeed, lead us to lengthen the period assigned to the deposition of these oceanic beds; for if, following Professor Spencer,[21] we ascribe their deposition to Eocene times, a less definite time-interval is indicated; but the rate could hardly have been less than 3 millimeters in a century. The site of the deposit was probably favorable to rapid growth.

We have already found a maximum limit to the average thickness of true oceanic sediments; and such as would obtain over the ocean floor if the rate of collection was everywhere the same and had so continued during the past. If there is one thing certain, however, it is that the rates of accumulation vary enormously. The 1,200 or 1,500 feet of chalk in the British Cretaceous, collected in one relatively brief period of submergence, would alone establish this. Huxley inferred that the chalk collected at the rate of one inch in a year. Sollas showed that the rate was more probably one inch in forty years. Sir John Murray has advanced evidence that in parts of the Atlantic the cables become covered with *Globigerina* ooze at the rate of about ten inches in a century. Finally, then, we must take it that the fair allowance of one seventh of a mile may be withheld in some areas and many times exceeded in others.

Now it is remarkable that all the conditions for rapid deposition seem to prevail over those volcanic areas of the Pacific from which ascend to the surface the coral islands—abundant pelagic life and comparatively shallow depths. Indeed, I may remind you that the very favorable nature of the conditions enter into the well-known theory of coral island formation put forward by Murray.

The islands arise from depths of between 1,000 and 2,000 fathoms. These areas are covered with *Globigerina* ooze having a radio-activity of about 7 or 8. The deeper-lying deposits around—red clay and radiolarian ooze—show radio-activities up to and over 50. From these no volcanic islands spring.

These facts, however, so far from being

[20] *Q. J. G. S.*, XLVIII., p. 210.

[21] *Ibid.*, LVIII., pp. 354 ff.

opposed to the view that the radio-activity and crustal disturbance are connected, are in its favor. For while those rich areas testify to the supply of radio-active materials, the slow rate of growth prevailing deprives those deposits of that characteristic *depth* which, if I may put it so, is of more consequence than a high radio-activity. For the rise in temperature at the base of a deposit, as already pointed out, is proportional to the square of the thickness; in reality the dilution of the supplies of uranium which reach the calcareous oozes flooring the disturbed areas is a necessary condition for any effective radio-thermal actions.

It might appear futile to consider the matter any closer where so little is known. But in order to give an idea of the quantities involved I may state that, if my calculations are correct, a rate of deposit comparable with that of the chalk prevailing for ten million years would, on assumptions similar to those already explained when discussing the subject of mountain-building, occasion a rise of the deeper isogeotherms by from 20 to 30 per cent. of their probable normal depth.

In making these deductions as to the influence of radium in sedimentary deposits, I have so far left out of consideration the question of the time which must elapse in order that the final temperature-rise in the sediments must be attained. The question we have to answer is: Will the rate of rise of temperature due to radium keep pace with the rate of deposition, or must a certain period elapse after the sedimentation is completed to any particular depth, before the basal temperature proper to the depth is attained?

The answer appears to be, on an approximate method of solution, that for rates of deposition such as we believe to prevail in terrigenous deposits—even so great as one foot in a century, and up to depths of accumulation of 10 kilometers and even more—the heating waits on the sedimentation. Or, in other words, there is thermal equilibrium at every stage of growth of the deposit; and the basal temperature due to radioactive heating may at any instant be computed by the conductivity equation. For accumulations of still greater magnitude the final and maximum temperature appears to lag somewhat behind the rate of deposition.

From this we may infer that the great events of geological history have primarily waited upon the rates of denudation and sedimentation. The sites of the terrigenous deposits and the marginal oceanic precipitates have many times been convulsed during geological time because the rates of accumulation thereon have been rapid. The comparative tranquility of the ocean floor far removed from the land may be referred to the absence of the inciting cause of disturbance. If, however, favorable conditions prevail for such a period that the local accumulations attain the sufficient depth, here, too, the stability must break down and the permanency be interrupted.

Upheaval of the ocean floor, owing to the laws of deep-sea sedimentation, should be attended with effects accelerative of deposition—a fact which may not be without influence. But although ultimately sharing the instability of the continental margins, the cycle of change is tuned to a slower periodicity. From the operation of these causes, possibly, have come and gone those continents which many believe to have once replaced the wastes of the oceans, and which with all their wealth of life and scenic beauty have disappeared so completely that they scarce have left a wreck behind. But those forgotten worlds may be again restored. The rolled-up crust of the earth is still rich in energy borrowed from earlier times, and the slow but mighty influences of denudation and deposition are forever at work. And so, perchance, in some remote age the vanished Gondwána Land, the lost Atlantis, may once again arise, the seeds of resurrection even now being sown upon their graves from the endless harvests of pelagic life.

John Joly

REPORT OF THE INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS, 1908

The report shows that delegates were present from 21 countries, and also from the following British dependencies, namely, Australia, Canada, India and the Crown Colonies.

The total number of delegates to the conference was 43, and their names are set out in schedule A. The conference and its technical committee each held five sittings. As a result of its deliberations, the conference adopted the resolutions and specifications set out in schedule B, and requested the delegates to lay them before their respective governments with a view to obtaining uniformity in the legislation with regard to electrical units and standards.

The conference recommends the use of the Weston normal cell as a convenient method of measuring both electromotive force and current when set up under the conditions specified in schedule C.

In cases in which it is not desired to set up the standards provided in the resolutions of schedule B, the conference recommends the following as working methods for the realization of the international ohm, the ampere and the volt:

1. *For the International Ohm.*—The use of copies, constructed of suitable material and of suitable form and verified from time to time, of the international ohm, its multiples and sub-multiples.

2. *For the International Ampere.*—(*a*) The measurement of current by the aid of a current balance standardized by comparison with a silver voltameter; or

(*b*) The use of a Weston normal cell whose electromotive force has been determined in terms of the international ohm and international ampere, and of a resistance of known value in international ohms.

3. *For the International Volt.*—(*a*) A comparison with the difference of electrical potential between the ends of a coil of resistance of known value in international ohms, when carrying a current of known value in international amperes; or

(*b*) The use of a Weston normal cell whose electromotive force has been determined in terms of the international ohm and the international ampere.

The duty of specifying more particularly the conditions under which these methods are to be applied has been assigned to the permanent commission, and, pending its appointment, to the scientific committee, to be nominated by the president (see schedule D), who will issue a series of notes as appendix to this report.

The conference has considered the methods that should be recommended to the governments for securing uniform administration in relation to electrical units and standards, and expresses the opinion that the best method of securing uniformity for the future would be by the establishment of an international electrical laboratory with the duties of keeping and maintaining international electrical standards. This laboratory to be equipped entirely independently of any national laboratory.

The conference further recommends that action be taken in accordance with the scheme set out in schedule D.

SCHEDULE A.—LIST OF COUNTRIES AND DELEGATES

America (United States).—Dr. S. W. Stratton; Dr. Henry S. Carhart; Dr. E. B. Rosa.

Austria.—Dr. Viktor Edler von Lang; Dr. Ludwig Kusminsky.

Belgium.—Professor Eric Gérard; M. Clement.

Brazil.—Mr. L. Weiss.

Chile.—Don Victor Eastman.

Colombia.—Don Jorge Roa.

Denmark and Sweden.—Professor S. A. Arrhenius.

Ecuador.—Sr. Don Celso Nevares.

France.—Professor Lippmann; M. R. Benoît; M. de Nerville.
Germany.—Professor Warburg; Professor Jaeger; Professor Lindeck.
Great Britain.—The Right Hon. Lord Rayleigh (President); Professor J. J. Thomson; Sir John Gavey; Dr. R. T. Glazebrook; Major W. A. J. O'Meara; Mr. A. P. Trotter.
Guatemala.—Dr. Francisco de Arce.
Hungary.—Joseph Váter; Dr. Desiré Harsanyi.
Italy.—Professor Antonio Ròiti.
Japan.—Dr. Osuke Asano; Mr. Shigeru Kondo.
Mexico.—Don Alfonso Castelló; Don José Maria Perez.
Netherlands.—Dr. H. Haga.
Paraguay.—M. Maximo Croskey.
Russia.—Dr. N. Engoroff, Col. L. Swentorzetzky.
Spain.—Don José Maria Madariaga; Don A. Montenegro.
Switzerland.—Dr. Fr. Weber; Dr. Pierre Chappuis; Dr. J. Landry.

BRITISH COLONIES

Australia.—Mr. Cecil W. Darley; Professor Threlfall.
Canada.—Mr. Ormond Higman.
Crown Colonies.—Major P. Cardew.
India.—Mr. M. G. Simpson.
Secretaries.—Mr. M. J. Collins; Mr. W. Duddell; Mr. C. W. S. Crawley; Mr. F. E. Smith.

SCHEDULE B.—RESOLUTIONS

I. The conference agrees that as heretofore the magnitudes of the fundamental electric units shall be determined on the electromagnetic system of measurement with reference to the centimeter as the unit of length, the gram as the unit of mass and the second as the unit of time.

These fundamental units are (1) the ohm, the unit of electric resistance which has the value of 1,000,000,000 in terms of the centimeter and second; (2) the ampere, the unit of electric current which has the value of one tenth (0.1) in terms of the centimeter, gram and second; (3) the volt, the unit of electromotive force which has the value 100,000,000 in terms of the centimeter, the gram and the second; (4) the watt, the unit of power which has the value of 10,000,000 in terms of the centimeter, the gram and the second.

II. As a system of units representing the above and sufficiently near to them to be adopted for the purpose of electrical measurements and as a basis for legislation, the conference recommends the adoption of the international ohm, the international ampere and the international volt defined according to the following definitions.

III. The ohm is the first primary unit.

IV. The international ohm is defined as the resistance of a specified column of mercury.

V. The international ohm is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of a length of 106.300 centimeters.

To determine the resistance of a column of mercury in terms of the international ohm, the procedure to be followed shall be that set out in specification I. attached to these resolutions.

VI. The ampere is the second primary unit.

VII. The international ampere is the unvarying electric current which, when passed through a solution of nitrate of silver in water, in accordance with the specification II. attached to these resolutions, deposits silver at the rate of 0.00111800 of a gram per second.

VIII. The international volt is the electrical pressure which, when steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere.

IX. The international watt is the energy expended per second by an unvarying electric current of one international ampere under an electric pressure of one international volt.

SPECIFICATION I.—SPECIFICATION RELATING TO MERCURY STANDARDS OF RESISTANCE

The glass tubes used for mercury standards of resistance must be made of a glass such that the dimensions may remain as constant as possible. The tubes must be well annealed and straight. The bore must be as nearly as possible uniform and circular, and the area of cross-section of the bore must be approximately one square millimeter. The mercury must have a resistance of approximately one ohm.

Each of the tubes must be accurately calibrated. The correction to be applied to allow for the area of the cross-section of the bore, not being exactly the same at all parts of the tube, must not exceed 5 parts in 10,000.

The mercury filling the tube must be considered as bounded by plane surfaces placed in contact with the ends of the tube.

The length of the axis of the tube, the mass of mercury the tube contains, and the electrical resistance of the mercury are to be determined at a temperature as near to 0° C. as possible. The measurements are to be corrected to 0° C.

For the purpose of the electrical measurements, end vessels carrying connections for the current and potential terminals are to be fitted on to the tube. These end vessels are to be spherical in shape (of a diameter of approximately 4 centimeters), and should have cylindrical pieces attached to make connections with the tubes. The outside edge of each end of the tube is to be coincident with the inner surface of the corresponding spherical end vessel. The leads which make contact with the mercury are to be of thin platinum wire fused into glass. The point of entry of the current lead and the end of the tube are to be at opposite ends of a diameter of the bulb; the potential lead is to be midway between these two points. All the leads must be so thin that no error in the resistance is introduced through conduction of heat to the mercury. The filling of the tube with mercury for the purpose of the resistance measurements must be carried out under the same conditions as the filling for the determination of the mass.

The resistance which has to be added to the resistance of the tube to allow for the effect of the end vessels is to be calculated by the formula:

$$A = \frac{0.80}{1,063\pi}\left(\frac{1}{r_1} + \frac{1}{r_2}\right) \text{ ohm},$$

where r_1 and r_2 are the radii in millimeters of the end sections of the bore of the tube.

The mean of the calculated resistances of at least five tubes shall be taken to determine the value of the unit of resistance.

For the purpose of the comparison of resistances with a mercury tube the measurements shall be made with at least three separate fillings of the tube.

SPECIFICATION II.—SPECIFICATION RELATING TO THE DEPOSITION OF SILVER

The electrolyte shall consist of a solution of from 15 to 20 parts by weight of silver nitrate in 100 parts of distilled water. The solution must only be used once, and only for so long that not more than 30 per cent. of the silver in the solution is deposited.

The anode shall be of silver, and the cathode of platinum. The current density at the anode shall not exceed 1/5 ampere per square centimeter and at the cathode 1/50 ampere per square centimeter.

Not less than 100 cubic centimeters of electrolyte shall be used in a voltameter.

Care must be taken that no particles which may become mechanically detached from the anode shall reach the cathode.

Before weighing, any traces of solution adhering to the cathode must be removed, and the cathode dried.

SCHEDULE C.—WESTON NORMAL CELL

The Weston normal cell may be conveniently employed as a standard of electric pressure for the measurement both of e.m.f. and of current, and when set up in accordance with the following specification, may be taken, provisionally,[1] as having, at a temperature of 20° C., an e.m.f. of 1.0184 volts.

SPECIFICATION RELATING TO THE WESTON NORMAL CELL

The Weston normal cell is a voltaic cell which has a saturated aqueous solution of cadmium sulphate ($CdSO_4$ 8/3 H_2O) as its electrolyte.

The electrolyte must be neutral to Congo red.

The positive electrode is mercury.

The negative electrode of the cell is cadmium amalgam consisting of 12.5 parts by

[1] See duties of the scientific committee, schedule D.

weight of cadmium in 100 parts of amalgam.

The depolarizer, which is placed in contact with the positive electrode, is a paste made by mixing mercurous sulphate with powdered crystals of cadmium sulphate and a saturated aqueous solution of cadmium sulphate.

The different methods of preparing the mercurous sulphate paste are described in the notes.[2] One of the methods there specified must be carried out.

For setting up the cell, the H form is the most suitable. The leads passing through the glass to the electrodes must be of platinum wire, which must not be allowed to come into contact with the electrolyte. The amalgam is placed in one limb, the mercury in the other.

The depolarizer is placed above the mercury and a layer of cadmium sulphate crystals is introduced into each limb. The entire cell is filled with a saturated solution of cadmium sulphate and then hermetically sealed.

The following formula is recommended for the e.m.f. of the cell in terms of the temperature between the limits 0° C. and 40° C.

$$E_t = E_{20} - 0.0000406\,(t - 20^\circ) - 0.00000095\,(t - 20^\circ)^2 + 0.00000001\,(t - 20)^3.$$

SCHEDULE D

1. The conference recommends that the various governments interested establish a permanent international commission for electrical standards.

2. Pending the appointment of the permanent international commission, the conference recommends[3] that the president, Lord Rayleigh, nominate for appointment by the conference a scientific committee of 15 to advise as to the organization of the permanent commission, to formulate a plan for and to direct such work as may be necessary in connection with the maintenance of standards, fixing of values,[4] intercomparison of standards and to complete the work of the conference.[5] Vacancies on the committee to be filled by cooptation.

3. That laboratories equipped with facilities for precise electrical measurements and investigations should be asked to coöperate with this committee and to carry out, if possible, such work as it may desire.

4. The committee should take the proper steps forthwith for establishing the permanent commission, and are empowered to arrange for the meeting of the next conference on electrical units and standards, and the time and place of such meeting should this action appear to them to be desirable.

5. The committee or the permanent international commission shall consider the question of enlarging the functions of the international conference on weights and measures, with a view to determining if it is possible or desirable to combine future conferences on electrical units and standards with the international conference on weights and measures, in place of holding in the future conferences on electrical units and standards. At the same time it is the opinion of the conference that the permanent commission should be retained as a distinct body, which should meet at different places in succession.

OTIS TUFTON MASON

On November 5, 1908, death claimed Professor Otis T. Mason, for the past six years head curator of the Department of Anthro-

[2] Notes on methods pursued at various standardizing laboratories will be issued by the scientific committee or the permanent commission, as an appendix to this report.

[3] In accordance with the above, Lord Rayleigh has nominated the following committee, which has been approved by the conference, viz: Dr. Osuke Asano, M. R. Benoît, Dr. M. N. Egoroff, Professor Eric Gérard, Dr. R. T. Glazebrook, Dr. H. Haga, Dr. L. Kusminsky, Professor G. Lippmann, Professor A. Ròiti, Dr. E. B. Rosa, Dr. S. W. Stratton, Mr. A. P. Trotter, Professor E. Warburg, Professor Fr. Weber.

[4] This will include the reconsideration, from time to time, of the E.M.F. of the Weston normal cell.

[5] With this object the committee are authorized to issue as an appendix to the report of the conference notes detailing the methods which have been adopted in the standardizing laboratories of the various countries to realize the international ohm and the international ampere, and to set up the Weston normal cell.

pology in the United States National Museum, one of the founders and past president of the Washington Anthropological Society, and an eminent worker in ethnology of world-wide reputation.

Professor Mason was born in Eastport, Maine, April 10, 1838, and was a descendant of several of the oldest American families. He graduated in 1861, master of arts, from the Columbian University, in Washington, D. C., and was later made doctor of philosophy and doctor of laws by the same institution. From 1862 to 1884, he was principal of the Columbian Preparatory School.

His anthropological researches began at the Smithsonian Institution, in 1872. In 1874, he was made a collaborator in ethnology, and began to arrange the hitherto unclassified anthropological collections. From these beginnings have grown the present ethnological and archeological exhibits of the National Museum, and its department of anthropology.

In 1884, Professor Mason gave up the directorship of the Columbian Preparatory School and thenceforth devoted all his time to the United States National Museum, as curator of ethnology, and, finally, as the head of the much-enlarged and reorganized department.

Professor Mason was an invaluable officer of the Smithsonian Institution; a gentleman of the old school—delighting all who came in contact with him by his cheer, bravery under many personal adversities, ready wit, and optimism; a rare friend, help, and a constant inspiration to his associates; and a highly prolific and able worker in his chosen branch of research. He contributed to the literature of archeology and especially ethnology, uninterruptedly (excepting during his periods of illness) from 1874 until the end—his last completed paper appearing from the printer's hands on the day of his burial. He further contributed to the progress of anthropology by his museum exhibits, by special exhibits during expositions, and by courses of lectures in the Columbian University as well as outside of Washington. He organized and promoted the Saturday lectures in the National Museum. He was for years an associate editor of the *American Naturalist*, and assisted in Harper's "Annual Record of Science and Industry." In 1879, in company with J. M. Toner and Garrick Mallery, he participated in the first steps which resulted in the foundation of the Washington Anthropological Society. In 1889, his studies were declared by the French minister of instruction to be of public utility. In 1890, he was appointed a member of the national board of geographic names; and in the course of time he became a member of the leading anthropological societies in our own country and abroad.

The scientific work of Professor Mason was directed mainly to the American natives and covered a vast field of human activities. He was not able to personally carry on field work, but he described with rare precision and care the collections gathered in the Smithsonian Institution, and he brought together and collated much dispersed knowledge. And he had the rare gift of presenting the scientific data in such a style and manner that his works can be read with profit and pleasure by men and women of intelligence in all vocations. In some of the fields which he cultivated, such as that of American basketry, he covered the subject until but little can be added.

Most of Professor Mason's writings were published in the media of the Smithsonian Institution. A few of his principal contributions to science are: "The Latimer Collection of Antiquities from Porto Rico" (1876); "Throwing-Sticks in the National Museum" (1884); "Cradles of the American Aborigines" (1887); "Aboriginal Skin-Dressing" (1889); "North American Bows, Arrows, and Quivers" (1893); "Primitive Travel and Transportation" (1894); "Migration and the Food Quest" (1894); "Aboriginal American Harpoons" (1900); "Aboriginal American Basketry" (1884 and 1902); and many contributions in the "Handbook of American Indians" (1907, B. A. E.).

During the last four years, Professor Mason's aim, only partly accomplished, was to describe, in a thorough manner, the basketry, traps, etc., of Malaysia, represented in the National Museum by the rich W. L. Abbott collections.

Professor Mason's illness dated from 1898, when he was stricken with hemiplegia. From this, he was slowly but steadily recovering until the summer of this year, when his health commenced again to fail. As late as the 17th of October, he was still attending to his duties in the National Museum, but from that day on he rapidly failed, until the fatal termination.

His name, cherished by all those who knew him personally, will range in the history of anthropology side by side with those of Powell, Brinton and Gallatin. Aleš Hrdlička

THE CONVOCATION WEEK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND AFFILIATED SOCIETIES

The preliminary announcement of the sixtieth meeting of the American Association to be held in Baltimore from December 28, 1908, to January 2, 1909, has now been issued by the permanent secretary. The first general session of the association will be held at 10 o'clock on the morning of December 28, in McCoy Hall, the Johns Hopkins University. The meeting will be called to order by the retiring president, Professor E. L. Nichols, who will introduce the president of the meeting, Professor T. C. Chamberlin. Addresses of welcome will be delivered by Dr. Ira Remsen, president of the Johns Hopkins University, and by Dr. Wm. H. Welch, chairman of the local committee for the meeting, and President Chamberlin will reply.

Most of the sections of the association and of the affiliated societies will meet at the Johns Hopkins University or the Baltimore City College or Baltimore Medical College adjoining, or else at the Johns Hopkins Medical School. The School Board of Baltimore City, the Baltimore Woman's College, the Bryn Mawr Preparatory School and the Maryland Academy of Sciences have placed other rooms at the disposal of the committee.

At 8 o'clock P.M., on Monday, the retiring president will give his address in McCoy Hall. At the close of the address a reception will be tendered by President Remsen and the board of trustees of the Johns Hopkins University. On the afternoons of Tuesday, Wednesday and Thursday the addresses of the vice-presidents will be given. They are as follows: E. O. Lovett, Princeton; D. C. Miller, Cleveland; H. P. Talbot, Boston; O. H. Landreth, Schenectady; J. P. Iddings, Chicago; E. B. Wilson, New York; C. E. Bessey, Lincoln; Franz Boas, New York; J. F. Crowell, New York; Ludvig Hektoen, Chicago; Elmer Ellsworth Brown, Washington.

On these and the following days the sections and societies will hold their regular sessions. It is expected that there will be joint meetings when the same subjects are covered, and that some meetings will be arranged for of general interest to all members of the association. No definite arrangements are announced for the general evening functions after Monday night. Dinners and meetings of special societies and groups, smokers and informal meetings, may be arranged.

On Thursday, December 31, a meeting of the American Health League will be called in conjunction with Section I, and a symposium on "Public Health" will be held.

On Friday, January 1, there will be held a celebration of the one hundredth anniversary of the birth of Charles Darwin and of the fiftieth anniversary of the publication of the "Origin of Species." This will consist of a morning and afternoon program of addresses by prominent naturalists, to be followed by a dinner at night at which further addresses will be made.

A railroad rate of one fare and three fifths for the round trip, on the certificate plan, has been granted by the Trunk Line Association, the New England Passenger Association (excepting via N. Y., Ont. and W. Ry., the Eastern Steamship Company and the Bangor and Aroostook R. R.), the Eastern Canadian Passenger Association and the Central Passenger Association. The Western Association has on sale revised one-way fares in effect to Chicago, Peoria and St. Louis, with the understanding that persons can repurchase from these points and take advantage of any reduced fares that may be authorized therefrom. The fares to Chicago, Peoria and St. Louis from a large part of the Western Passenger Association territory are now on the basis of two cents per mile; hence, with the reduced fares from the three cities named, the net rate amounts practically to a rate of a fare and three fifths for the round trip. A rate of a fare and three fifths has also been requested from the Southern and the Trans-Continental Passenger Associations, but decisions have not yet been received.

The Belvidere Hotel will be the hotel headquarters of the association. The Stafford and the Rennert and probably other hotels will be the headquarters for some of the affiliated societies.

There will be printed in Science next week a list of the societies that will meet during convocation week. In addition to those printed previously, the following notices in regard to these societies have been received:

AMERICAN SOCIETY OF ZOOLOGISTS

The annual meeting of the Eastern Branch of the American Society of Zoologists will be held at Baltimore, Md., December 29, 30 and 31, 1908. By constitutional provision of the American Society of Zoologists this is also the regular triennial meeting of the Eastern and Central Branches, and therefore, since the joint meeting falls this time in the territory of the Eastern Branch, that branch will act as host. Members of the society are urged to send the titles of their papers to the secretary of the Eastern Branch not later than December 5, so that a preliminary program may be issued about December 10. It will be necessary to place the papers received after that date at the end of the list. Nominations for membership, accompanied by full statements of the qualifications of the candidates must be in the hands of the secretaries before December 1, in order that the list may be submitted to the executive committee of each branch before the meeting. Nominations for membership in the Central Branch should be sent to Professor Thomas G. Lee, Acting Secretary, University of Minnesota, Minneapolis, Minn. Nominations for membership in the Eastern Branch should be sent to the undersigned.

Lorande Loss Woodruff,
Secretary, Eastern Branch
Yale University,
New Haven, Conn.

THE AMERICAN SOCIETY OF VERTEBRATE PALEONTOLOGISTS

The next meeting of the American Society of Vertebrate Paleontologists will be held at Baltimore, December 28 to 30. The winter meetings of the Geological Society of America and the American Association for the Advancement of Science will be held at the same time and place. The meeting in conjunction with these societies is especially important, as the question of the future affiliation or relationship of the vertebrate paleontologists will be brought before the society by the committee appointed last year, and decided at this meeting. In addition to other advantages, members of the American Society of Vertebrate Paleontologists will have convenient opportunity to visit Washington either before or after the meetings and to examine the great collections of the National Museum.

W. D. Matthew,
Secretary-Treasurer
American Museum of Natural History,
New York

GEOLOGICAL SOCIETY OF AMERICA

The twenty-first annual meeting of the Geological Society of America will be held in the rooms of the geological department of Johns Hopkins University, Baltimore, December 29–31, inclusive, in affiliation with the American Association for the Advancement of Science. The regular circular of information will be issued shortly. Fellows intending to offer papers for reading are urged to send to the secretary without delay for the regulation blanks for the entry of title. Arrangements have been made in conjunction with Section E of the association for a symposium on correlation which will add greatly to the interest and value of the meeting.

E. O. Hovey,
Secretary
American Museum of Natural History,
New York

AMERICAN PHYSIOLOGICAL SOCIETY

The American Physiological Society will hold its twenty-first annual meeting in Baltimore during convocation week, beginning December 29, 1908. Joint sessions will be held with the American Society of Biological Chemists and with Section K—Physiology and Experimental Medicine—of the American Association for the Advancement of Science. The place of meeting will be the Lecture Hall, second floor, of the Johns Hopkins Medical School Building (Washington and East Monument Streets).

Reid Hunt,
Secretary

25th and E Sts., N. W.,
Washington, D. C.

THE AMERICAN NATURE-STUDY SOCIETY

One session of the meeting at Baltimore will be devoted to a discussion of "The Relation of Nature-study and Elementary Agriculture in Rural Schools," and one session will be devoted to "Nature-study in its Relation to High School Biology." It is expected that a third session will be made up of general papers. The dates of these sessions will be arranged, as far as possible, to avoid conflict with other meetings.

THE HAYDEN MEMORIAL MEDAL

The Academy of Natural Sciences of Philadelphia has conferred the Hayden memorial gold medal for 1908 on John Mason Clarke, the state geologist of New York, in recognition of his distinguished services to geological science.

The academy accepted in 1888 from Mrs. Emma W. Hayden an endowment of a memorial to her husband, Dr. Ferdinand V. Hayden, who was for several years director of the Geological and Geographical Survey of the Territories, remaining one of the four principal geologists of the United States Geological Survey from its organization, in 1879, until his death. Provision was at first made to confer a bronze medal and the balance of interest on the fund annually as a recognition of the best publication, exploration, discovery or research in the sciences of geology and paleontology.

The bronze medal was awarded annually until 1899, when the deed of trust was modified so as to provide for the conferring of a gold medal once every three years.

The recipients of the award have been as follows:

1890. James Hall, state geologist of New York.
1891. Edward D. Cope, distinguished paleontologist.
1892. Edward Suess, of Vienna, author of "Das Antlitz der Erde."
1893. Thomas Huxley, the distinguished biologist and paleontologist.
1894. Gabriel Auguste Daubrée, of the Institute of France.
1895. Karl A. von Zittel, of Munich, author of the monumental "Handbuch der Paleontologie."
1896. Giovanni Capellini, of Bologna, president of the Royal Geological Survey of Italy.
1897. A. Karpinski, of St. Petersburg, director of the Geological Survey of Russia.
1898. Otto Martin Torell, chief of the Geological Survey of Sweden.
1899. Gilles J. G. Denalque, secretary of the Geological Society of Belgium.
1902. Archibald Geikie, director of the Geological Survey of Great Britain.
1905. Charles Doolittle Walcot, director of the United States Geological Survey, and now secretary of the Smithsonian Institution.

In the opinion of the committee on the award Mr. Clarke's contributions to geology, especially his "Early Devonic History of New York and Eastern North America," rank him with the others who have received the recognition.

SCIENTIFIC NOTES AND NEWS

Professor W. W. Campbell, director of the Lick Observatory, has been appointed lecturer for next year on the Silliman foundation at Yale University.

On the occasion of King Edward's birthday, the honor of knighthood was conferred on Dr. Jonathan Hutchinson, Hunterian professor at the Royal College of Surgeons; Dr. Thomas Oliver, professor of physiology at

Durham; and Dr. J. J. Thomson, Cavendish professor of experimental physics at Cambridge. The K.C.B. has been conferred on Dr. Donald Macalister, principal of Glasgow University, and formerly lecturer on medicine at the University of Cambridge. Dr. Alfred Russel Wallace has received the Order of Merit.

THE freedom of West Ham has been privately conferred upon Lord Lister at his house in the country, as he was prevented by his state of health from receiving the distinction in public. Lord Lister was born at Upton, Essex, in the borough of West Ham.

SIR DANIEL MORRIS has been elected an honorary life fellow of the Royal Horticultural Society, London.

PROFESSORS HENRY M. HOWE and William Campbell, of the department of metallurgy of the Schools of Mines, Engineering and Chemistry of Columbia University, have been appointed by the American Society for Testing Materials as their representatives on the international committee dealing with the problem of uniform nomenclature of iron and steel. Professor Howe is chairman of this committee.

PROFESSOR SOLON I. BAILEY, of the Harvard College Observatory, who has had charge of the Arequipa Observatory, in Peru, has gone to South Africa, where he has established an observing station about four hundred miles east of Cape Town.

DR. J. E. KIRKWOOD, formerly in charge of botany at Syracuse University and recently associated with Professor F. E. Lloyd in Guayule investigations at Mazapil, Mexico, has taken up his residence at Tucson, Arizona, where he will complete some investigations on desert problems at the Desert Botanical Laboratory, and where he may be addressed.

MR. ABBOTT H. THAYER, the American artist and naturalist, has been giving at the Zoological Gardens, London, demonstrations of the obliterative effect of the patterns where the coloration is supposed to be conspicuous.

DR. E. B. POULTON, Hope professor of zoology in Oxford University, will give the annual address before the Entomological Society of America at its Baltimore meeting, on Thursday evening of convocation week, December 31. The title of the address will be "Mimicry in the Butterflies of North America."

THE Founder's Day address at the twelfth anniversary of the Thomas S. Clarkson Memorial School of Technology will be delivered on December 1 by Dr. S. W. Stratton, director of the Bureau of Standards.

MR. ROBERT MOND, of London, lectured at the College of the City of New York, on Tuesday, November 10, on "The Mond Nickel Process and the Carbonyls of Iron and Cobalt."

PROFESSOR W. B. CANNON has been elected president, Dr. J. L. Bremer, secretary, and Professor F. B. Mallory, treasurer, of the Boston Society of Medical Sciences.

THE Academy of Natural Sciences of Philadelphia has appointed Dr. Arthur Erwin Brown as its delegate to the University of Cambridge Darwin memorial celebration. Although Darwin became a member of the Dresden Academy in 1857, before the publication of the "Origin of Species," it is probable that to the Philadelphia Academy belongs the honor of having been the first foreign society to accord his great work official recognition. He was elected a correspondent on March 27, 1860, upon the nomination of Isaac C. Lea and Joseph Leidy. To his election Darwin refers appreciatively in a letter to Lyell dated May 8 of that year.

AT the opening meeting of the Linnean Society, held on November 2 at Burlington House, the president, Dr. Dukinfield Scott, announced that the council had arranged to present a silver copy of the Darwin-Wallace medal to the British Museum. He handed the gift to Mr. H. A. Grueber, keeper of the coins and medals, who, on behalf of the trustees, acknowledged it. Professor Dendy, F.R.S., the zoological secretary, exhibited the memorial medal founded by the New Zealand Institute in honor of the late Captain Hutton, F.R.S., who did so much to promote the study of natural science in the dominion.

The memorial tablet unveiled to the late Major James Carroll at the University of Maryland on October 11 bears the following inscription:

JAMES CARROLL,
M.D., 1891, and LL.D., 1907.
Major and Surgeon, U. S. Army.
Born in Woolwich, England, June 5, 1854.
Died in Washington, D. C., Sept. 16, 1907.
As a member of the Army Commission, which succeeded in demonstrating the mode of conveyance of yellow fever, he became an eminent contributor to science by his investigation, and a heroic benefactor of his country and of mankind by voluntary submission to the bite of an infected mosquito, whereby he suffered from a severe attack of yellow fever produced for the first time by experiment.
Greater love hath no man than this, that a man lay down his life for his friends.
Erected by the regents of the University of Maryland.

A committee has been formed to erect a monument to Dr. Cornil, former professor of pathological anatomy at Paris. It will be placed in his birthplace, Cusset, near Vichy.

Dr. James Fletcher, of the Experimental Farm, Ottawa, Canada, well known for his important contributions to entomology, has died at the age of fifty-six years.

Mr. W. S. Harwood, the talented author and magazine writer, died at his home in Los Gatos, California, on November 3. Mr. Harwood was born in Charles City, Iowa, 51 years ago. Among his writings are "New Creations in Plant Life, or Life and Works of Luther Burbank," "The New Earth," and his latest work, "The Life and Letters of Austin Craig," now in the press of the Fleming H. Revell Company.

As the result of a surgical operation, performed too late to save his life, Alvah Augustus Eaton, well known to botanists as a faithful student of the genera *Isoetes* and *Equisetum*, and as a close observer of the ferns, died at his home in North Easton, Mass., on the twenty-ninth day of September, 1908. Mr. Eaton was a skillful plant collector and in three excursions to Florida in behalf of the Ames Botanical Laboratory made many interesting discoveries of importance to American botany. During the last five years of his life he was actively engaged in work on the Orchidaceæ. His herbarium of *Isoetes* is, at his request, to be deposited among the collections of the Missouri Botanical Garden at St. Louis, Mo.

M. Alfred Ditte, the distinguished French chemist, has died at the age of sixty-five years.

Mr. Andrew Graham, from 1864 to 1903, first assistant at the Cambridge Observatory, known especially for his work on the Cambridge star catalogue published in 1897, has died at the age of ninety-three years.

Sir Henry Alfred Pitman, registrar of the College of Physicians, London, from 1858 to 1880, and formerly physician at St. George's Hospital, died on November 6. He received his bachelor's degree at Cambridge University in 1831, and celebrated last July his hundredth birthday.

We regret also to record the deaths of Dr. John M. Thome, director of the Cordova Observatory since the retirement of Dr. Gould; of Dr. Cecil G. Dolmage, known for his writings on astronomy; and of Mr. Archibald J. Little, who did valuable geographical work in the interior of Asia.

It is announced that the cost of the new library building for the Medical and Chirurgical Faculty of Maryland will be $88,000, and of this about $63,000 has already been subscribed.

Mr. W. K. Davey has given the sum of £1,000 towards the initial expenses of the Australian Institute of Tropical Diseases shortly to be established at Townsville, North Queensland.

Plans for a new Norwegian polar expedition were described by Captain Amundsen at a large meeting of the Geographical Society held at Christiania on November 10, and attended by the King of Norway. Captain Amundsen's plan is to go with Dr. Nansen's old ship the *Fram* to Cape Barrow, the northernmost point of Alaska, and thence north. The ship will drift with the ice across the Polar ocean. The voyage is expected to last five years.

THE National Conservation Commission will hold its first full meeting at Washington on December 1. At that meeting the first steps will be taken toward putting into tangible shape the results of the six months' inventory of the country's waters, forests, lands and minerals. One week later, after the commission has gone over the inventory, it will hold a joint meeting in Washington with the governors of the states and territories, or their representatives. At this meeting the inventory will be further discussed and the report which the president has requested the commission to make to him by January 1, will be formulated.

ACCORDING to a press despatch, the International Institute of Agriculture, which was proposed by Mr. David Lubin, of San Francisco, to King Victor Emmanuel, inaugurated its labors in Rome, on November 16, by a meeting attended by delegates from forty-six of the countries that have signified their participation. A plan of organization has been prepared, and this, together with a budget, was submitted to a general meeting on November 26. The United States is represented by Ambassador Griscom, Mr. David Lubin, Dr. C. C. Clark, Mr. W. F. Hill, Mr. G. K. Holms and Mr. William Stuart. After the speech by the president, Senator Faina, Mr. Lubin delivered an address in which he outlined the constitution of the institute.

THE daily papers state that Dr. Alexander Graham Bell has completed the frame of his new aerodrome. The *Cygnet,* which made a successful ascent last year with the late Lieutenant Selfridge as aviator, was composed of 3,393 tetrahedrons, while the new aerodrome, constructed on practically the same lines, will have 5,000 tetrahedral cells. It is said to be the intention of Dr. Bell to make a trial flight the first week in December. It is planned to place the machine on a platform holding between two motor boats. They will run up into the outer Bras d'or Lake, and when a speed of eighteen knots has been attained, the aerodrome will be released. Mr. W. F. Baldwin, chief of laboratories for Dr. Bell, is reported to have said that the experimental bureau at Hammondsport, N. Y., is about to make experiments on Lake Keuka, where an airship will be propelled by its own motors over the surface of the water to get sufficient speed to expand its wings. The machine will be attached to light canoes, which will be carried by the airship as it leaves the water on its flight.

FOREIGN papers state that M. Barthou, the French minister of public works, announced in the senate on November 5 that the sum of £4,000 is to be devoted by his department to the encouragement of aerial locomotion. The International Sporting Club, of Monaco, has offered the sum of £4,000 to be competed for at an international aeronautical meeting to be held at Monaco from January 24 to March 24, 1909. The length of the course will be about six miles. The first prize will be £3,000. On November 6 an inaugural meeting of the new Aeroplane Club was held in London, when it was decided to form a club devoted to the development of aerial navigation by machines heavier than air.

PUBLIC lectures in the department of chemistry, College of the City of New York, have been arranged for the current session as follows:

November 20—Professor Bradley Stoughton.
December 4—Dr. Wm. McMurtrie.
December 11—Dr. A. von Isakovics.
January 8—Professor V. Coblentz.
January 15—Professor M. Loeb.
February 19—Dr. R. W. Moore.
February 26—Mr. M. Toch.
March 5—Dr. A. P. Hallock.
March 12—Professor A. B. Lamb.
March 19—Dr. Harvey W. Wiley.
March 26—Dr. H. S. Miner.
April 2—Dr. Wm. J. Schieffelin.
April 23—Dr. M. Wallerstein.

THE department of archeology, Phillips Academy, announces the following free lectures to be delivered in the lecture hall of the archeology building at 8 o'clock.

October 27—"Games of the American Indians," Warren K. Moorehead.

November 17—"Five American Nations; Conquerors of the Snow, Forest, Mist, Desert and Plains," Professor Harlan I. Smith.

December 8—"The White Races," Charles Peabody.

January 12—"The Metal Ages," Charles Peabody.

January 26—"Lewis and Clark Expedition to the Head of the Columbia," Warren K. Moorehead.

February 9—"Lewis and Clark Expedition to the Pacific," Warren K. Moorehead.

February 23—"Caves at Home and Abroad," Charles Peabody.

March 9—"Social Life of the American Indians," Warren K. Moorehead.

March 23—"Lake Dwellings and the Bronze and Iron Cultures," Charles Peabody.

April 13—"Origin, Accomplishments and Destiny of the American Indians," Warren K. Moorehead.

UNIVERSITY AND EDUCATIONAL NEWS

At the annual Michigan Union banquet at the University of Michigan Mr. Clarence W. Barbour, representing the Michigan alumni in New York, announced that plans had been perfected and funds subscribed for the erection of a $300,000 dormitory, with a large "commons."

The H. K. Cushing Laboratory of Experimental Medicine at Western Reserve University was dedicated on the afternoon of November 20, when Dr. H. W. Welch, of the Johns Hopkins Medical School, made the principal address. The building, complete in all its appointments, is of reinforced concrete, faced with brick. It is 55×40 feet, and consists of four floors. On the first floor is a large room for chemical work, and in connection with this is a balance room, the balances being arranged on a solid concrete pier. A workshop, a store room, a dark room for photographic purposes, and for the reception of a centrifugal, complete the accommodation on the first floor. On the second floor is the library, and one large and several small rooms for individual investigations. Also, a refrigerator room, a room for maintaining a constant temperature and a chemical store room. The third floor has several rooms for students, and the fourth rooms for the study of nutrition in animals under the influence of different diets, with a view to throwing light on the diseases of nutrition in man. The building is practically fireproof. The laboratory is named for Dr. H. K. Cushing, who was for many years associated with the Cleveland Medical College, which later became the medical department of Western Reserve University. Dr. George N. Stewart is professor of experimental medicine and director of the laboratory.

The Rev. Dr. W. A. Shanklin, president of Upper Iowa University, has been elected president of Wesleyan University.

Dr. Frederic E. Farrington, who spent last year in France, studying especially the secondary schools of that country, goes this year from the University of California to the department of education in the University of Texas. In the latter institution he occupies the newly-established chair of associate professor of education in charge of the observation and practise of teaching.

Dr. Stanley R. Benedict, formerly assistant in physiological chemistry at Yale University, has been appointed instructor at Syracuse University.

Howard Lane Blackwell, Ph.D., has been appointed fellow for research in physics at Harvard University.

DISCUSSION AND CORRESPONDENCE

SIDE ISSUES BEARING ON THE AGE OF NIAGARA FALLS

In a late issue of Science (July 31, 1908), a notice of my recent book upon Niagara Falls was published by Dr. G. K. Gilbert,[1] which is chiefly a discussion of three minor problems, the treatment of which could scarcely be considered a necessary digression from the main issue of my book. In his dealing with these, a doubt is left as to the correctness of my conclusions regarding the age of Niagara Falls; and a substitution is given in his own behalf, announcing, without the evidence, that their duration is more than four times that of my computation, which computation was based upon the most carefully measured details of the work accomplished during each stage of the physical changes of the river. This correspondence is cordially welcomed in that it renews the interest in the subject, for as Professor James Geikie has

[1] "Evolution of the Falls of Niagara," by J. W. Spencer, pp. i–xxxi, 1–490, Geological Survey of Canada, 1907.

somewhere said—when controversy ceases the interest passes away, and the truth generally lies between the extremes. The value of the points raised must be taken in their magnitude relative to what has already been established in the investigations of Niagara Falls; accordingly, a backward sketch of some of the results must be made.

Years ago Dr. Gilbert presented data, in mathematical form, demonstrating that the Falls were no more than 7,000 years old, with several modifications tending to lower even this estimate (page 372). Shortly afterwards, my discovery that the Huron discharge had formerly nothing whatever to do with Lake Erie, or the Niagara (page 294, also Chap. XXV., and Ap. VII.), changed the then new idea of the short age of Niagara Falls. This now universally accepted fact is further proved by new soundings (pp. 71, 73), within and without the end of the gorge, bringing to light a narrow deep inner channel that could carry only the Erie drainage. The same phenomena I also found in the expanded reaches of the St. Lawrence River (Chap. XXIX.). Furthermore, the drowned channels among the swamps of Lake St. Clair furnished additional proof of the original northward discharge of the Huron waters (Chap. XXVI.).

From the structure of the terraces at Foster's Flats (Chap. XIV.), and the excavated depth of the channel above them (p. 66), I have been able to establish the location of the falls when the discharge of the Upper Lakes was added to the early Niagara River. In soundings and borings, the nature of the gorge at the Whirlpool Rapids has at last been revealed (Chap. V. and XII.). My soundings under the falls, the only ones that have ever been made (p. 56) have brought to light the reduced depth of the basin beneath (p. 48). This was exceedingly important, as it revealed the recent damming of the channel, which raised the level of the river in the basin just below the great cataract, thereby shortening the otherwise calculated age of Niagara Falls, while they were receding the last three miles, by thirty per cent.

The ancient volume of the river has been computed on a sound basis at fifteen per cent. of the full discharge of the four Upper Lakes, an amount closely agreeing with that previously calculated for the Erie drainage by Mr. Thomas Russel (U. S. Lake Survey), his result being 16.7 per cent. (p. 252). These and other features, such as the origin of the Upper Rapids (p. 166 *et al.*), dependent upon preglacial phenomena, cover some of the most important changes in the complex history of the cataract, all of which show that the energy of the falls has increased tenfold, or 1,000 per cent. This increased power is not questioned, but established.

Per contra, my critic raises three points, the relative importance of which will be seen upon the examination of each. One of these is the relative "efficiency," or, in other words, what has been the loss of work during the changing energy of the cataract. He says: "To say that the rate of recession is proportional to the energy is equivalent to saying that the efficiency does not change with the variation of energy," but in my statement I added "provided other conditions remained constant" (p. 350), and my whole book is a differentiation and measurement of the changing conditions. To the paragraph, just quoted from the review, my attention was called by a layman. His omission of the word "relative" before efficiency left on the layman's mind an impression that the critic fallaciously supposed that I had made a fundamental error. As the word efficiency is repeated a score of times, 'the science of the falls demands investigation of the point raised. He urges a comparison of the relative efficiency of the changing energy of the falls with a man-made engine, and says that "the computed energy of the American Falls does not differ greatly from the computed energy of the main cataract during the longest division of its history." Let me say that the now measured discharge shows that during the earlier period the volume of the main cataract was three times that of the American Falls of recent origin.

If we are to seek analogies, let it be noted that the kind of man-made engine most nearly approaching a waterfall is a water-wheel or turbine, though it is not so stated. Rankine, whom he quotes, mentions that in numerous trials the efficiency of different wheels varied from 66 to 80 per cent. The loss actually questioned is the difference between these figures, which shows that the relative work performed by the worst machine is only 17.5 per cent. below that of the best. In the turbine wheel there is a loss from leakage as well as from friction, which does not occur in the natural falls, where, however, there is wind effect. As the American Falls represent 200,000 gross horse-power, which is very much greater than any turbine, the relative loss of power should be very small compared with even the best engine. In testing the relative loss of power in turbines, Kent[2] mentions that in diminishing the supply of water to half the flow, in one kind of turbine, the useful work fell six per cent. only. This is the best kind of illustration for comparing the efficiency of the changing volume of the cataract with a man-made engine. The loss of work to the extent of six per cent. in the American Falls over that of the Canadian, due to smaller volume, would cause only an increase in the computed age of Niagara Falls of less than 2,000 years (or a difference in efficiency of ten per cent., would add less than 4,000 years) in excess of the 39,000 years. This only possible increase, if not counteracted by other minor elements, is provided for in the anticipated variation of ten per cent. (p. 369). The smallness of the variation suggested is better appreciated when it is compared with the discoveries of increased energy (1,000 per cent.), which has raised the supposed age of the falls from less than 7,000 years (Gilbert, formerly) to 39,000 years (Spencer).

However, if any allowance should be made, as above set forth, there is another physical component of about equal importance, the effect of which would counterbalance any relatively inferior efficiency of the smaller falls. Both are small factors compared with the great changes of energy discovered.

The second point raised is a plea for measuring the age of the whole gorge on a basis of the recession of the American Falls. He says: "The American Fall does not differ greatly from the computed energy of the main cataract during the longest division of its history," and further states that if I had used these falls for the basis of my calculations (or a formerly provisional rate based upon incomplete data obtained from measurements made in 1868, since abandoned for complete ones), the age would have been nearer 20,000 than 39,000 years, but I may say that with the full treatment of the subject, from even the partial data published, any one would have found the computation to have reached 32,000 years. But no computations based on the American Falls were attempted by me. He also says with regard to the recession of the American Falls: "It may with confidence be said that 0.06 foot a year [in recession] is nearer the truth than 0.60, but no definite estimate is warranted." This latitude in comparison reaches 0.32 foot (thirty-two hundredths), which appears to be what he meant, because in his official bulletin,[3] page 22, he gives this figure as one of his conjectures, but in the controversy one would think that he meant little more than the lesser amount (0.06). Using his coefficient of 0.32 foot, the age of Niagara would be over 37,000 years (not 20,000 years).

In my Niagara book, I stated that the American Falls had receeded 0.60 foot between 1842 and 1890, which was true for that period. More recent surveys show that afterwards, down to 1906, no further important changes had occurred. Thus the measured rate is reduced to 0.47 foot a year. This must be further diminished to 0.35 foot in comparing the work with that of the Canadian Falls. The mean total longitudinal recession has been only 29 feet since the first measurements were made, while that of the greater cataract has been 265 feet, and the discharge measurements show that it carries 95 per cent. of the volume of the whole river.

The recession is intermittent; in the one case the amount is so small that we do not know whether the cycle has been completed during the period of observation or not. Here a small error from any cause would prevent

[2] Kent's "Engineering Pocket Book," p. 596.

[3] Bulletin U. S. Geological Survey, No. 306, 1907.

the estimated rate being of more than approximate value. In the case of the main cataract, there have been many cycles, so that an error in one is not fatal to the determination of a mean rate.

In his recent report upon the recession of Niagara Falls,[4] Dr. Gilbert devotes much space in trying to prove as erroneous Professor Hall's survey (1842), which shows a shelf since fallen away. Without discrediting Hall's work, it seems much more probable that a cycle of undercutting had commenced prior to his survey, though the floor of the river fell afterwards, so that his measured amount of recession belongs to a longer period. The protruding shelf shown by Hall is also indicated on the map of the International Boundary Survey of 1819. On this basis the mean rate would be reduced to 0.34 foot (or for comparative purposes to 0.26). It we were to estimate the rate of recession of the smaller cataract in terms of the greater, it would be 0.28 foot a year (or for comparison, 0.22 foot). On the basis of 0.34 foot, the age of the Falls of Niagara would be found to be 37,000 years, which nearly approaches that already stated in my book. If 0.28 be taken, the result would of course be the same as that based on the main cataract. Conclusive measurement could not be made during a lifetime, besides which the spoliation of the cataract for power purposes will destroy the natural conditions; yet additional data are obtainable, so that it will be possible to write a supplementary chapter on the recession of the American Falls, now that the collateral evidence is called for.

There are other factors in the physics of the falls of differential value, but they are all embraced in the actual work done by the two cataracts, the relative efficiencies of which do not greatly differ, as shown above, upon the problem being analyzed scientifically. This opportunity of confirming my previous calculations affords me great satisfaction.

As to the recession surveys of Niagara Falls, it may be stated that mine of 1904 was the fifth one of the main cataract ever made (Preliminary Report of the Geological Survey of Canada for 1905, published in the summer of 1906), preceding by a few months that of Mr. W. Carvell Hall. In using this last-mentioned survey, Gilbert computes his rate of recession from only that portion of the falls where the greatest depth of water occurs, although that portion is some hundreds of feet less than the diameter of the cataract which has been making the gorge of an equal width. In his calculation, he also uses the mean of ordinates unequally placed. Thus he gives a result of 5.3 feet a year, but on page 25 he adds that there is an uncertainty of one foot. This estimate of five feet a year affords no coefficient of recession throughout the gorge. If corrected for the full width, the rate would be found to approximate that of mine. He also says that the recession between 1875 and 1905 was greater than in the previous thirty-three years; but had he broken up the former period into two divisions of fifteen years each, he would have found a great reduction in the rate of recession during the latter fifteen years. In his application of the rate of five feet in determining the recession of the American Falls the result would give too short a time, had there not been a previous acceleration, due to the higher stage of the cataract during its earlier history (unknown until discovered by my soundings under the falls). These compensating omissions, however, give an approximately acceptable rate (0.32 foot).

Thirdly, my critic says:

> If the efficiency of Niagara in producing recession varies according to the law, as the efficiency of a river in transportation, Spencer's estimate of the age of the river should be multiplied by a factor larger than four.

Lake Erie is a settling basin, so that only after occasional severe storms does the lake send down its turbid waters into Niagara River, and then only for a short time, but this small quantity of detritus, even then, varies with the volume and velocity of the river and is lost in the general averages of the discharge measurements. The volume of detritus removed from the channel of the river since its birth is less than a thousandth part of the volume of water that flows down each year. Again, it requires 900 tons of water to loosen every pound of rock carried

[4] Bulletin cited before.

away from the gorge in the recession of the falls, which is occasioned by the undercutting in the soft strata, and not by the abrasion from an infinitesimal quantity of detritus. The capacity of streams for transportation varies as the sixth power of the velocity, while the erosion varies only as the square of the velocity. I do not understand the ground for comparing the clear-water Niagara with the experiments based upon transportation of muddy water of other streams. But we can get an inkling as to the relative abrasion at Niagara. Only since the falls have receded the last mile and a half have the Upper Rapids come into existence (1,500 years ago or less). In the meanwhile the river, with its dissolving waters, ice, detritus and currents, has not made any true channel next to the head of Goat Island, while at the foot, after the rapids have descended over fifty feet, all of these forces together have only cut in the rock to a depth of four feet—and this while the falls have been receding a mile and a half. If the recession were proportional to the detritus, which he assumes as ground for quadrupling my computations, we should certainly have to raise his conjectural age into millions of years. The proposition of measuring the work of Niagara Falls by transportation of detritus is certainly irrelevant.

Concerning the soundings, it is further stated that my apparatus was of the Kelvin type. This statement requires correction. That used by me was invented and patented by Lieutenant Blish and Commander Tanner, officers of the U. S. Navy. It is entirely a different and better device for recording the depths than that of Kelvin, whose instrument could not have been used in fresh water. Commander Tanner kindly lent me some of the apparatus.

Dr. Gilbert says:

> But while the discovery of the real law of efficiency would be a notable contribution to the problem, it would not remove every difficulty. In its proper application there would be need to take account of various qualifying conditions, not all of which are easily evaluated.

He then specifically mentions five. Here indeed I not only accept his conditions, but I did anticipate them, giving the most detailed measurements of them, with many sections drawn to scale, and other illustrations. These I shall take up consecutively.

(1) "Width of gorge as affecting quantity of erosion," and I may add depth. These subjects are fully discussed, with numerous sections determined instrumentally, in chapters V. to X. and parts of XII. and XIV. (2) "Depth of the gorge from the crest of falls to bottom of pool." This has been measured for the first time, by me, and described in a headed page (56), figured section (p. 48), further explained (p. 86), and applied in calculations (p. 367). (3) "Concentration of flow as affecting efficiency." This is discussed, in relation to points raised, in chapters IX., XII. and XIV. (and p. 368). (4) "Thickness of the capping limestones as affecting efficiency." This is shown in tabular form at many points (p. 90), in many figured sections (Chap. VIII. and pp. 50, 343), and in other references and with a time allowance (p. 369). (5) "The relation of the Medina sandrock to efficiency." A table is shown to illustrate this (p. 90), also many figured cross-sections (Chap. VIII.) and longitudinal ones (pp. 50 and 343). These show that the Medina sandrock had no relationship whatever to the uppermost cataract upon which was based the recession during the first 35,000 years, and in the last 3,500 years, to only an infinitesimal amount. These features may be redescribed by others, but any student will find all of them described in my book as nowhere else, many for the first time, which will furnish him with data for working out specific problems that I may have deemed immaterial. Finally he says that "Spencer's computations do not include data bearing upon these variables." I am surprised that any one should have read my book and failed to take account of the distinct and articulate chapters, headed paragraphs and illustrations, covering all of these points. He also mentions my discussion of the present stability "of the land in the Great Lakes region, with the conclusion that no earth movements have occurred in modern times," without further comment, as

if concurring with me, when here I should have expected dissent, as the results are at variance with his former opinion.

In my book upon the Falls of Niagara, I have set forth the data found in my researches, by which their changing history has been discovered. The age of the falls is a very interesting, though secondary, problem. My observations may be repeated by others, with variations in treatment. The leading points raised by Gilbert are variations in treatment, of magnitude relatively small; and a third (that upon which he indicates his belief in their great antiquity) rests upon inadmissible analogies. All of these points, though tending to divert attention from the main issues, in reality confirm my conclusions. I have no theory as to the length of time to defend, except that which is suggested by the changing physical conditions, as measured by the falls, in the gorge and in the volume and height of the cataract, and as I have said in my book, a matter of a few thousand years does not make an important variation in the value of my pioneering work "in the correct line of investigating the problems presented by this remarkable region." I am pleased that my critic thinks that the determination of the age of Niagara lies within the scope of observation, and is of so much popular and scientific interest.

J. W. Spencer

Washington, D. C.,
November 1, 1908.

THE QUESTION OF PROFESSORS' SALARIES

The statement is sometimes made, that a general increase in the salaries of college and university professors would be of no service to the institutions concerned, in improving the character of the men available for professorships. I believe this view to be incorrect, especially as concerns our colleges; and I venture to present the following suggestions for the consideration of those who hold it.

A general survey of the institutions of learning, large and small, throughout the land, leads to the painful conclusion that our faculties no longer, as they once did, represent groups of cultivated men. The word "culture" has of course fallen into disrepute in our day; but the cultivated man, while we no longer aim to produce him, demands and receives our respect and admiration wherever he is found. It would not be difficult to cite a few notable survivals of the type here and there. The rarity of teachers of this kind in our college and university faculties to-day will be readily admitted by all who have any intimate knowledge of the matter. Yet the desirability of having such men as instructors of undergraduate students is keenly felt by those who have to choose a college for their sons. The function of the undergraduate course is precisely to give the student what he will not get when as a graduate he enters the special field of his life work; therefore the undergraduate course should give the student a general enrichment of life; which is exactly what we mean by cultivation.

But we are content at present that the highest product of our educational system should be the specialist; a man usually thoroughly conversant with one small branch of learning, and fairly well acquainted with some allied subjects, but often ignorant in every other field of human interest, without ideas of his own in any field but his own, and dead to everything that can be classed as the amenities of life—the arts, literature, human society.

I venture to suggest that our specialist is a man of this kind because he comes from a home which lacks those things of which we now deplore the absence in him. Then why do our institutions of learning draw from such a class of material? They have no choice; and for this reason: the youth who decides on the teaching profession as his career must of necessity abandon the idea of accumulating money; that surely no one will dispute; and there are many who are willing to accept this as a condition of their existence. But very few are willing to abandon the ambition for wealth as an aim in the future, and at the same time to accept a present and permanent reduction in their scale of living. For the ambition not to be rich makes for happiness about as well as the ambition to be rich; but it does not make for happiness to have to get along in life without comforts and reasonable pleasures that have hitherto been within our reach. A cutting down of the scale of living is one of the sources of real suffering.

Hence if we take, say, $2,000 as the average salary of our college professors, we may say that on the average our professors will be drawn from homes where the scale of living is adjusted to the same figure, or a little more. But the children in such homes have, in our day, few of the advantages of life—few books, little or no travel, perhaps one may say without offense, little social experience. That was not so a generation ago, when salaries were about the same, but the scale of living totally different. Nowadays the college professorship offers no material inducements except to those who have been brought up in a pretty severe economy, and who can get from it all the comforts to which they have been used, and perhaps something more, with often an added pleasure in a certain prestige, which is attractive. Many will say that the self-made man is the grandest type of manhood we can put before our young men, etc. But the self-made man, admirable and effective though he often is, is rarely a cultivated man, and therefore can not give us all of what we want in the college teacher. And then, the self-made men on our faculties have so rarely finished the job.

Now a general rise in salaries would, I think, make it possible for our undergraduates to have for their intellectual guides not men who merely know immeasurably more of Latin or of botany than do the students themselves, but men who bring with them fine traditions of cultivated living and of "high thinking," a wide experience of life and humanity. It should, therefore, be the aim of the college to pay such salaries to its professors as would enable them to give to their own children what the college would regard as a perfect preparation for professorial work. Only in this way can it draw its teachers from a class in which such preparation is possible.

The graduate student has totally different needs, and in the university there should be found room for both types of teachers, the man of cultivation and the man of knowledge. Of these two the latter is more necessary to the advanced student than the former. I believe it is equally true that for the younger student, the man of cultivation is more necessary than the man of knowledge.

Everything depends, however, on the point of view, and no one can recognize more clearly than the writer that his own is hopelessly old-fashioned; though in a time that we regret and admire it was almost universal.

S.

SCIENTIFIC BOOKS

Life and Letters of Herbert Spencer. By David Duncan, LL.D. 2 vols. 8vo, pp. xiii + 414; vii + 444. New York, D. Appleton and Company. 1908.

Obviously enough, it is impossible at this early date to offer a just estimate either of Spencer the man, or of his "synthetic philosophy." "The Autobiography," covering sixty-two years of its author's life, and the volumes now before us must always serve, nevertheless, as primary sources for that more objective appreciation to be undertaken, doubtless, after the lapse of years. In these circumstances, and in this journal, I shall confine myself to certain points suggested by the "Biography," and eschew excursions farther afield.

The contents of Dr. Duncan's work are as follows: (1) Twenty-eight chapters of strict biography, filling the whole of Volume I., and 245 pages of Volume II. The method employed is to rely largely upon Spencer's correspondence, and to connect the scattered parts by apposite comments which serve also to fill out lapsed details. I am much struck by Dr. Duncan's admirable restraint in subordinating his own personality, and permitting the events to tell their own tale. (2) Two chapters, entitled, respectively, Characteristics and Personal Reminiscences, and Spencer's Place in the History of Thought; in these the biographer speaks for himself, and, especially in the former, introduces appreciations furnished by intimate friends and familiar acquaintances. (3) Five Appendices, whil fall into two distinct groups. (*a*) Contributions from

Spencer's own pen. Of these the *first* deals with his Physical Traits and some Sequences (written in 1902); the *second* with his intellectual history, under the title, The Filiation of Ideas (written in 1889). In a prefatory note Spencer points out that they really belong to the "Autobiography," but that this book was stereotyped ten years before the first of them was written. The *third* is a three-page unpublished letter on The Nebular Hypothesis (written in 1900). (*b*) *First*, a List of Herbert Spencer's Writings. *Second*, a list of Academic and other Honors offered to Herbert Spencer. I ought to add that I have found Dr. Duncan's volumes much more interesting than the "Autobiography." In fact, they present a complex, in some ways contradictory, personality. Perusal of them can not fail to dispel many current misconceptions; they will also enable the reader to orient himself more readily towards this latest "runner" in the wonderful race of British empirical "torch-bearers." Their wealth of incident will, of course, elicit varying reactions from different minds, and I can only indicate one or two of my own.

Spencer was wont to pride himself upon the non-conformity of his ancestors. Exiles for conscience sake from their old homes on the continent of Europe, they appear to have remained "agin' the government" in the land of their adoption. However this may be, it is of more vital interest by far for us to note that Spencer's own nonconformity can not but have been influenced deeply by the life upon which he looked out. A Saul among the prophets of the dissidence of dissent in religion, in politics and in society, he felt himself commissioned as a kind of supreme critic. His lack of school and university experience left "all his angles acute," while his career, after 1878, *dans le mouvement* at London, seems to have been too belated to work radical alteration. Had the Royal Society elected him in 1853, when Huxley introduced him to Tyndall for the first time in its rooms, he would doubtless have welcomed the recognition gladly. But, as he thought afterwards, in 1874, the courtesy arrived over-tardily. I incline to believe that much of his contrariness must be sought deep down in the nature of the English environment during his active days. The movement, so marked since, whereby eminent representatives of science pass readily from their middle-class origins to terms of equality with the "upper ten thousand," had not eventuated. The standards of judgment, inherited from medievalism, that wrote a man down a scoundrel for his matured opinions, still prevailed widely. In a word, the great period of transition from renascence to modern thought was on, and Spencer had the fortune, or misfortune, to be a main instrument in a profound transformation, one by no means over yet, especially in English-speaking lands. Of this he exhibits slight awareness, and the continuous friction serves to confirm incipient idiosyncrasies. His influence upon the philosophical trend in Britain after J. S. Mill's death, say, has remained slight; his public in the United States was constituted sooner, and has always been larger. These straws show how the wind blew; and he felt the chill keenly, even if he never perceived the causes. Or, to put it otherwise, his career must be read in the light of the contemporary religious, social and philosophical situation in England. He tended naturally to dissent, and regnant moods of his contemporaries served to intensify this leaning. Remembrance of this will help to explain not a little. For, as he records himself, he was at odds with his countrymen.

A further indication of the unstable condition of the intellectual world may be traced in Spencer's morbid fear lest he should be accused of elaborating any ideas save his very own. I have noted no less than fourteen references in point (I., 128, 147, 185, 188, 197, 207, 253, 268, 315, 327, 342; II., 90, 168 f., 212). Be it Comte or Darwin, Rousseau or Tylor, he will acknowledge no obligation; nor does he relish that Maudsley, or Clifford, or Lockyer should, as he supposes in evident good faith, trade upon his ideas, and amass reputation while he goes supperless to bed. His unhumorous punctilio in these and other matters almost renders Gilbert's whimsies fit commentary;

For he himself has said it,
And it's greatly to his credit,
That he is an Englishman!
But in spite of all temptations
To belong to other nations,
He remains "*the*" Englishman.

The immense transvaluation that occurred during Spencer's life has, I feel sure, as much to do with these curious, unpleasing, and puzzling traits as any mere heritable quality. This appears further in the dogmatic judgments he offers so serenely upon other men. As might be expected, Goethe and Carlyle, Ruskin and Watts and Stevenson, to say nothing of Kant, fare badly; so do Owen and Kelvin, Laveleye and Tylor and Weismann; but even Comte, J. S. Mill and Bain fail to escape the "predestinate scratched face." Justly enough, Calderwood is convicted of "a piece of poor fumbling," and Princetonians will be charmed to know that McCosh's *soubriquet* in his native country (McBosh) is recalled with glee. George Eliot and Victor Carus come through the ordeal unscathed; while of Alexander Smith it is said, "I am strongly inclined to rank him as the greatest poet since Shakespeare"! Neither Tennyson nor Browning, let alone Arnold, merits similar commendation. Plainly, the conflict of the age has determined these curious phenomena quite as much as personal bias.

No less interesting and symptomatic is Spencer's relation to *Facharbeit*. The enemy has affirmed in many shapes, "scratch Spencer and you find ignorance." It were superfluous to comment upon this cynicism. But it so happens that certain facts, full of intimation, do make their appearance, and serve to cast light upon not a few matters. As concerns what we mean by the *English* term "science," Spencer took care to consult with authorities. Consequently, even Darwin is able to write, "I was fairly astonished at the prodigality of your original views." He sought counsel constantly with Huxley and Tyndall; when he dealt with individual ethics, he "solicited the criticisms of married lady friends on whose judgment he could rely"; when preparing for a new edition of the "Principles of Biology," in 1895, he "ordered copies to be interleaved and sent to young biologists, recommended as being familiar with the recent developments of the science"; on questions of physics and geology he referred to Clerk Maxwell, Kelvin, Judd and numerous other experts; when he desired information *re* statistics, he applied to Sir R. Giffen, and so on. But, then, he aimed to rank as a philosopher, not as a scientific leader. What of philosophy, and philosophers, we therefore ask? *Mirabile dictu,* he knew little of Plato, nothing of Aristotle; of Bacon, the "Essays" alone; of Hobbes, not much; of Locke, nothing; of Bentham and Paley, only their most general doctrines, noised abroad by the man in the street; of Kant, nothing; of Mill he read the "Logic," but recorded no more than an attack upon one of its doctrines; Hamilton and Mansel aside, he seems to have been blind or indifferent to the whole movement since Kant; for instance, his single communication to its leading English exponent is a letter on a burning question of party politics! He repudiated expressly all knowledge of Indian philosophy; and, although he was an authority on the philosophy of education, he avers that he never read "Emile." Further, he seems rather proud that he possessed slight philosophical equipment; and yet, he does not protest when friends baptize him "the greatest living philosopher," indeed, one can only infer that he took them *au pied de la lettre*. These extraordinary contradictions are explicable in one way, so far as I am capable of seeing. Spencer was a *Verstandsmensch* and did not know it. It is amusing to find him cling again and again to the outworn eighteenth century standpoint (*e. g.*, I., 232, 235 f., 287, 301, 304; II., 3, 79, 191, 201) and, at the same time, characterize modern idealism as "old-world nonsense." The old-world nonsense nestled between his own covers, despite his evolutionism. As Ferri pointed out, he did not draw the conclusions which evolution warrants, and thus in philosophy, as in other things, he stood rather aside from the main current of his time. Epistemology and logic failed to touch him, and he never attempted the deeps of constructive metaphysics. His constitutional aversion to criticism, and even to discussion, emphasized all this. So, here too, transition is written large over much of his work. This, more than aught else, explains the defense outlined by the Dean of Westminster, when he refused to entertain the proposal for a Spencer monument in the Abbey. And, as Dr. Duncan does not see (II., 244 f.), Hegel would have concurred, would have trimmed, possibly, upon his famous foot-note about the philosophy of hairdressing. Philosophically, Spencer was fated to be a mighty *Bahnbrecher;* such an one stood in need; and he accomplished the full tale of bricks. Accordingly, it is nowise astonishing that his appeal to philosophers *von Fach* has not been very fundamental. How could it be in the circumstances? Try the case from the scientific side. What would scientific men think of a colleague who comported himself in like manner, and then permitted acclaim as the sole high-priest? Notwithstanding, no one can deprive him of his rightful place as advance agent of evolutionary phenomenology; yet, for this very reason, our generation hesitates to enroll him in the apostolic succession of constructive thought. Further, the same facts indicate why, to this good hour, he has not received more than a modicum of the recognition that he earned so richly. They also account for some of his life-long asperities.

Pleasing glimpses are given of Spencer's relations with his friends, which dispel the wide-spread belief that he was a surly curmudgeon, "all intellect and no heart." Among these, one of the most interesting to Americans can not but be his unclouded friendship with Youmans, the founder of the *Popular Science Monthly.* But, beyond question, the most impressive factor in the personality was the indomitable will whereby, taking up arms against a sea of trouble, the man conquered, and all for the purest of ideal interests. To this battle the history of the race presents few parallels, and it bears a heartening message of encouragement to every worker for the spiritually indispensable, as Carlyle called it finely.

Finally, for the benefit of American readers, a word should be added concerning Dr. Duncan. He is an Edinburgh philosopher, who acted as Spencer's secretary for several years in the late sixties. In 1870, he proceeded to India as professor of philosophy in the Presidency College, Madras. After fourteen years' service, he became principal of this institution. From 1892 till 1899, when he retired, he occupied the important administrative office of Director of Public Instruction for the Madras Presidency. He is known as one of Spencer's oldest collaborators in the "Descriptive Sociology." He seems to me to have performed a task of infinite difficulty, due partly to the reasons outlined above, with admirable spirit and skill. The extreme care with which the book has been produced—I have noted but three trifling misprints—and the thorough, workman-like index, are among our least obligations to his *pietas.*

R. M. Wenley
University of Michigan

Notes on the Development of a Child, Parts 1–4, Vol. I., 1893–1899. The Development of the Senses in the First Three Years of Childhood, Vol. II., July 25, 1908. University of California Publications in Education, Vols. 1 and 4. By Millicent Washburn Shinn. Berkeley, The University Press. Pp. (Vol. I.) 424. $2.25. Vol. II., pp. 258. $2.50.

Dr. Shinn's first contribution to our knowledge of "the ontogenic evolution of the faculties of the human mind," which Professor Le Conte, in an introductory note to Volume I., describes as the "most important of all possible subjects," was published fifteen years ago as Part I. of the "Notes." (Pp. 88.) This part, after a page of biographical notes and two pages giving measurements of growth in height and weight, consists of data relating to the development of sight in infancy, chiefly during the first two years, and classified under such headings as: sensibility to light, movements of the eyelids and eyeballs, fixation, direction of look, sensibility to colors, color preferences, discrimination of forms geometrical and other, understanding pictures and other representations.

Part II. of Volume I., pp. 89–178, appeared in 1894. The first fifteen pages of this part continue the notes on the development of sight to the end of the third year. Then follow notes on the development of hearing (sensibility to sound, locating the direction of sounds, recognition and discrimination of sounds, interest in music); the dermal senses (contact, pain, temperature); taste and smell. Parts 3 and 4 of Vol. I., pp. 179–424, appeared in 1899. Pages 179–298 report the author's observations on sensations of muscular activity, motion and position; organic sensations, and general sensation. The remaining pages of parts 3 and 4 are given to reports on various sorts of movements—spontaneous, reflex, instinctive; equilibrium and motion (which is full of data on sitting alone, creeping, standing, walking and running); instincts connected with food-taking, learning to grasp with the hands, and so on. The volume may be described as a rich storehouse of accurate, minute observations relating to the sensory and motor development during the period of infancy.

With respect to the sources, method and purpose of Volume II., the author writes:

> My original data for the following study have come almost entirely from a journal of the development of a single child [the author's niece]. . . . But in the later examination of the data, I have supplemented them with the observations of others. My record was but little guided by any previously formulated theory, or by the effort to solve any previously formulated problem. . . . In the main I aimed only at a scrupulously objective record of the facts of development, as they appeared quite spontaneously.

The data thus collected were classified and published as Volume I. of the "Notes," as indicated above.

The purpose of Volume II. is to summarize and interpret the previously published observations relating to the development of the senses. By "interpretation" the author means tracing "the development of the senses from stage to stage, with reference to the genetic relationship of these stages, and the process by which each unfolds from the preceding"; the search for a general law of this unfolding; the consideration of "the bearing of any results thus reached on current problems of psychology"; and, finally, the author formulates, as corollaries, the pedagogical suggestions of the study.

Of the two methods which have been employed in the study of infancy—the comparative and the biographical—Dr. Shinn regards the latter "thoroughly checked and corrected by comparison" as "the true one for the study of children of the earliest period." Experimental investigation, no doubt, is sometimes necessary, but it is just as well, in the author's opinion, that the study of infaucy "should wait a while for any considerable experimental investigation, and should depend for the present on pure observation." The next step is quite easy and natural; namely, to banish from the field of child-study all mere scientists—psychologists and physiologists—and declare child-study to be a new and independent science. And this, in a sense, the author does. She observes that "a deep knowledge of adult psychology," has not been particularly helpful in the study of infancy, and expresses the opinion that the most solid and valuable contributions to our knowledge of babies, so far, have come not from psychologists, but from physiologists." Leaving aside the differences of opinion which may exist as to the relative importance of the contributions of psychologists and physiologists to child-study, it may be said that the *reason* assigned for the statement of the text—that in genetic psychology "the genetic element outweighs the psychologic" (Vol. II., p. 7)—seems to rest upon a curious misapprehension of the province and scope of modern psychology in general, and of the problems and methods of genetic psychology in particular. But, on the other hand, the physiologist, Dr. Shinn believes, can not guide the future of child-study, for he "stops short of the real point of interest in child development, the germination of the higher psychic activities." With the psychologists and physiologists both repelled from this new territory, and no invasions being threatened from other quarters, child-study may be free to develop "in the main its own theoretic basis," (1) by gathering a large mass of data by observation and limited experiment, and (2) by classifying, comparing and drawing inductions from these facts.

Continuing, the author advances the usual arguments for prefering the inductive method to the method of proceeding, theories in hand, in scientific research. In this connection, Professor Baldwin's well-known "Mental Development in the Child and the Race" is cited as a horrible example of what is likely to happen when an investigation is dominated by preconceived theories. That work, Dr. Shinn says, has failed to supply the theoretic basis for future observations in child-study, "because it has, after all, no close practical relation to that study." However highly the author may value that work on other grounds, evidently she does not hold it in very high esteem as a contribution to child-study.

The author next considers the difficulty of finding a satisfactory principle of classification for the data of child development. The analytic headings "dismember every incident we would report, for the actual development we are tracing is essentially synthetic, yet we must needs analyze, in order to interpret." All in all, a modification of the Spencerian formula for the process of evolution supplies a satisfactory guiding principle—viz., child development is "a progressive movement consisting of the integration of simpler activities into more complex, and the differentiation of specialized ones, out of generalized." The validity of this principle is not discussed, "because the most important part of the following thesis is a contribution to that very discussion."

Leaving the introduction and passing to the body of Volume II., we have the following divisions and sub-divisions: Part I., Sensibility of the new-born (visual, auditory, dermal, etc., sensibility). Part I. may be described as a condensation of the data reported in Volume I. relating to the sensibility of the new-born, together with numerous quotations from other students of infancy—Tiedemann, Kussmaul, Sigismund, Champneys, Preyer, Mrs. Moore, Mrs. Hall—and from the anatomical studies of Professor Flechsig in explanation and confirmation of the views expressed in the text. The principal conclusions of Part I. are:

> The child is at birth capable of receiving impressions in every department of sense (unless for a short delay in the case of hearing). . . . The sensations of the new-born are very limited and feeble, and seem to be simple and detached experiences, . . . are justly to be regarded as *pure sensations* in which there is no consciousness of space, of externality or internality, of surrounding objects, or of self (pp. 12, 47).

Part II., The Synthesis of Sense-Experience (the visual-motor association series, the tactile-motor association series, synthesis of the visual-motor and tactile-motor associations, auditory associations, associations of the minor special senses, feeling of a bodily self). This part (the nature of which is sufficiently well indicated by the heading and sub-headings) contains, in the writer's judgment, the best treatment of the topic heading the chapter which has thus far appeared.

The author's principle of classification is used with great effectiveness in this part in organizing and interpreting the wealth of detailed observations which she had previously reported.

It is amusing to note in passing that the author completely pulverizes, in the crucible of over-literalness one may think, Professor James's oft-quoted, "big, blooming, buzzing confusion" as a description of the mental state of early infancy. Her way is better: it is more scientific, and it is more euphonious, more poetic. She writes:

> Rather does the babe drift softly in among phenomena, wrapped away from their impact in a dim cloud of unconsciousness, through which but the simplest and faintest gleams and echoes make their way to him. . . . (Vol. II., pp. 144 f.).

Part III. traces the Development in Discrimination and Interpretation in the different sense-departments—sight, hearing, touch, etc. The treatment of sight, particularly the section on "color vision," is worthy of special mention.

Two general conclusions of the entire work remain to be noted: (1) The development of the senses does not follow the phylogenetic parallel—though some specific phases of the development show such correspondence, (2) the psychic life of the child centers from the first about the higher senses, especially sight, not the lower.

The Pedagogical Conclusions, Part IV., are all interesting, most of them are well-grounded, some of them are novelties or at variance with current practise and doctrine. But Dr. Shinn does not prescribe with undue confidence; pedagogy is still too much a matter of individual opinion, of more or less, of the true or false, practical or impractical, according to circumstances, to warrant laying down iron-clad rules for the management of infants. She does, however, offer a few general principles and a few special suggestions: (1) Nature herself will, in the main, attend to sense education. (2) Nothing in the infant's environment educates it as does the human presence. . . . The baby who is left lying on the bed alone a great deal, does not develop as brightly, and learn to use his senses happily as soon, as the baby that is cooed over and played with. (3) The secret of happy and wholesome development in the early years seems to be mainly in giving the largest possibility of free action. (4) When the child reaches the stage of instruction "tasks must be set, and efforts must be made." (5) The superficial recapitulation theory that a child is "only a little animal," and in no need of human education, often leads to harmful neglect of the early years. (6) The child can and probably should be taught before the end of the second year the names of all the simple plane figures, the alphabet, the Arabic figures, and to discriminate and name the principal colors.

It may safely be said that the 682 octavo pages of the two volumes before us, together with the volume on "The Biography of a Baby," published in 1900, and a number of magazine articles, entitle Dr. Shinn to the distinction of having made the largest, and, in certain respects, the most important contribution to our knowledge of the mental life of babies; and, somewhat incidentally, she has given us data and interpretations of no slight value in the treatment of the problems of functional and analytic psychology. It is clear that Dr. Shinn has not exhausted her store of data. Students of infancy and childhood will welcome forthcoming volumes, if such there be, in the assurance that they will contain valuable material presented in a readable form.

To be sure, no one will take up volumes which trace the physical and mental development of infants and expect light, summer afternoon reading. As literature, books on child psychology rank a little higher, but not much, than laboratory guides in chemistry; and for the present they are not likely to be interesting except to persons who have babies near at hand whom they wish to study and to the specialists in psychology.

Finally, the writer may be permitted a few general observations in the way of suggestions for future editions: (1) The work should take account of the recent studies in this field, (2) the number of repetitious passages might be considerably reduced, (3) many of the footnotes should be incorporated in the text, (4) a full table of contents for each volume would add to the value of the work.

David R. Major
Ohio State University

Nautical Charts. By G. R. Putnam, Mem. Am. Soc. C. E. Pp. viii + 162 (including 35 pages of illustrations). New York, John Wiley and Sons. 1908.

The author of this book has had long experience in the coast and geodetic survey. During the years 1900–1906 he was the director of coast surveys, Philippine Islands, in general charge of extensive surveys made for the production of nautical charts. He is now in charge of the drawing and engraving division at the Coast and Geodetic Survey Office, Washington.

The book is written in non-technical language to as great an extent as is feasible. The general reader will find it clear and concise.

A carefully selected two-page list of the more important books or papers bearing on nautical charts and related subjects is given.

A chapter (30 pages) entitled, Charts and Maps, gives a short historical statement of the development of the chart from the earliest known map to the present time, indicates the purpose and character of the one million nautical charts now published each year, and shows the present state of advancement of surveys for charting purposes. A double page reproduction of the earliest extant chart showing America is to be found in this chapter.

The collection of information for charts is treated in 34 pages. An excellent statement, fully illustrated by photographs and drawings, is made of the methods of surveying employed. The essential difficulty of making certain, even in a closely surveyed region, that no isolated pinnacle rock reaches up so near to the surface as to be a danger to navigation, is clearly indicated by text and illustration. An example is given of the recent discovery, in Blue Hill Bay, Maine, by the use of a wire drag, a special device for that purpose, of a pinnacle rock only six feet in diameter at its top. The rock has but seven feet of water upon it, although it is surrounded by depths of 78 feet, from which it rises nearly perpendicularly. The caution necessary in sifting evidence in regard to reported dangers to navigation and in making examinations for such reported dangers is illustrated by numerous concrete examples. It is important that chart users should have some knowledge of these matters in order that they may know what reliance they should place upon charts, upon the one hand, and what reliance to place upon hasty criticisms of charts, upon the other hand.

In the chapter of 19 pages, entitled, Preparation of Information for Charts, descriptions are given of the mercator projection, the polyconic projection and the gnomonic projection, and the special advantages of each are stated. The necessary limitations of each are also indicated. These are the three projections which one must understand to use charts intelligently.

Thirteen pages on the Publication of Charts are devoted mainly to a short enumeration of the various processes involved in passing from the drawings to the printed charts, such as engraving on copper, copperplate printing, printing from stone, photolithography, etching, etc., and of the advantages and disadvantages of each process or combination of processes now in use.

The imperative need for frequent correction of charts is treated in 15 pages. The average loaded draft of the twenty largest steamships was 24 feet in 1872 and 32 feet in 1903. Channels and harbors are dredged and otherwise improved and changed. Great natural changes take place. An island of sand has moved northwesterly for two miles directly across the mouth of the Columbia River in Oregon during the years 1851–1905 and has closed up the former channel. An average of 400 new rocks and shoals, dangerous to navigation and not previously shown on charts, are reported each year, according to British reports. Of the 367 reported in 1906 only 11 were discovered by vessels striking them.

In the last three chapters of the book (48 pages) there is brought together in convenient form for reference much information of value to the navigator who has the charts before him and desires to understand and use them. He will there find the charts explained; will find clear general directions given for plotting upon the charts, for locating a vessel from the results of astronomic observations, as well as by dead reckoning, by compass bearings, by sextant angles, and by sounding; and will find certain precautions which are advisable in the use of charts stated with the reasons for them. The book closes with six pages in regard to the various publications in book and chart form which are necessary or convenient for use in connection with nautical charts.

For any one having to do with charts, this book contains much useful information, set forth in the form of a handbook rather than of a technical treatise. For mariners, yachtsmen, surveyors and shippers it is of special interest. The expert in the lines treated will find it valuable in furnishing a good general view of the subject by an expert. The book is up to date, is written in an interesting manner, and yet is especially to be commended for laying emphasis upon matters which are really important to the users of charts, rather than the matters which are merely interesting.

J. F. H.

West Virginia Geological Survey. Vol. IIA. Supplementary coal report. I. C. White. Pp. xiv + 720 and map. 1908.

It is now five years since the publication of Dr. White's first volume on the coals of West Virginia. That was prepared from notes made by its author during many years of examination prior to organization of the state geological survey; so that, while giving matter of the utmost importance, it was more or less fragmentary and gaps remained in critical areas, where was to be sought the solution of some difficult problems in correlation.

More than two thirds of this supplementary volume is devoted to the Pottsville series, which occupies the southern part of the state on and beyond the New and Kanawha Rivers. Five years ago, positive correlation of beds had been determined in only a small part of this area and identifications elsewhere were little better than tentative. But during the interval many bore holes have been drilled and the cores have been measured with care; these measurements, and those of numerous exposed sections have made possible reconstruction of the general section and correction of errors found in earlier publications. It is unnecessary to mention these errors here, for though some of them were serious from the stratigrapher's point of view they are no longer, except in a very few instances, important from the economic standpoint, as the corrections have come in time. They reflect no discredit on the earlier students, as the deposits are so variable that the exact conditions could be ascertained in the semi-wilderness region only by the aid of diamond drill borings.

The Pocono anthracite, just west from the Great Valley, receives proper attention. Now that official condemnation of the coals is available, it may be hoped that the Dora coal fields will no longer prove a source of profit to coal experts and of loss to would-be investors. Dr. White calls attention to the fact that, while the Pocono coal beds are found only along the easterly border of the Appalachian coal field, the same great formation is rich in petroleum and natural gas within the central and western parts of the field. He suggests that, in the deeper portions of the area where land plants could not flourish, there was a growth of marine plants and animals whose remains were changed into those hydrocarbons.

Dr. White divides the Pottsville series into Beaver, New River and Pocahontas, a much better grouping than that offered by Stevenson, as it recognizes the early work of Fontaine on New River and that of David White in the Pocahontas and southern Anthracite field; the individuality of the lower divisions is as distinct as is that of the Beaver. The area of the Pocahontas and New River coals is not far from 2,600 square miles and the amount of available coal is estimated at 10,000 millions of tons. The coals are of remarkable excellence, very low in ash and sulphur; those of the Pocahontas have usually less than 18 per cent. of volatile matter, so that they are practically smokeless when properly stoked and are the typical steam coals. The New River coals are richer in volatile, 17 to 26 per cent., but are as low as the others in ash and sulphur. These coals thin away from the southwestern outcrop and disappear toward the northerly and northwestwardly border of the basin in which the lower and middle Pottsville were deposited, each important member of the column overlapping its predecessor toward the west.

The new borings and sections have made clear the relations of the Kanawha or Beaver coal beds. The imperfect sections of five years ago in counties immediately north from the Kanawha have been replaced with numerous excellent measurements, which show that Stevenson's identification of the great Roaring-creek coal bed with the Stockton bed of the Kanawha is an error, the former being about 50 to 75 feet above the latter. The Kanawha black flint, overlying the Stockton, has been discovered below the Roaring Creek sandstone (equivalent to the Homestead of Pennsylvania) so that it can not be the Putnam Hill limestone of Ohio and is most probably at a Mercer horizon, 70 or 80 feet lower.

The Roaring Creek coal bed is taken by Dr. White to be the Lower Kittanning, the next bed above the Brookville, to which Stevenson referred it. This difference in opinion is unimportant, as this is the lowest bed of the Allegheny in the region and is at only 10 to 30 feet above the sandstone which forms the top of the Pottsville.

This supplementary report is merely synoptical and it will be supplemented in turn by county reports giving the structure in detail. The plan and execution of the survey work are admirable; the measurements are very numerous and the correlations have been made with patient study; the analyses are in great part both proximate and ultimate and the number of them is unusually large. The new material, bearing on the origin of coal and the accumulation of coal beds is perplexingly important; if much more of this sort be presented, reconstruction of many familiar hypotheses will be necessary and much fine writing, of which the authors were justly proud, will become merely historical lumber.

John J. Stevenson

SCIENTIFIC JOURNALS AND ARTICLES

The Museums Journal of Great Britain for October, under the title "Board of Education: Circulation Department," states that the Victoria and Albert Museum contemplates extending the operations of its circulation department which is concerned with the loan of collections to provincial museums. In "Notes on an Eighteenth Century Museum" Thomas Southwell gives much information about the *Museum Boulterianum* a typical institution of its period. This contained many objects brought home by Capt. Cook, including specimens of *Hemignathus obscurus* and *Vestiaria coccinea*. The article on "The Lund Museum for the History of Culture" contains a brief discussion of the extent and character of restorations of art objects.

The American Museum Journal for November contains a brief account of "Cuthbert Rookery," the last of any size left in the state, and information as to "The Stefansson-Anderson Arctic Expedition" which is at work on the northeast coast, while Harlan I. Smith presents some of the results of "The Archeological Reconnaissance of Wyoming." It is noted that the Tuberculosis Exhibit will be opened the latter part of November. The number contains the lecture programs of various courses.

The Bulletin of the Charleston Museum for October notes the installation of the Museum Library in the new building and calls attention to the fact that it is the first free public reading-room in the city. The offices and workrooms are also in the new building and the re-arrangement of the collections is proceeding as fast as is possible.

The Zoological Society Bulletin for October contains an illustrated account of the elephant house soon to be opened to the public, and probably the most complete structure of its kind extant. In a note on "A Large Sea Turtle" (*Dermochelys*) it is stated that "It is not likely that any species of sea turtle exceeds 1,000 pounds in weight." This is probably true; it is surprising how animals shrink before tape line or scales and so far as we know the 840 pounds of this turtle is the maximum actually recorded. Mr. Beebe presents Part I. of an illustrated article on the "New World Vultures." He remarks that they apparently lack the sense of smell, but *per contra* it is to be noted that the olfactory lobes of *Cathartes* are well developed, being much larger than those of other birds. And what are olfactory lobes for but to record smells? Attention is called to the necessity for raising a fund for the purchase of bison for the Montana herd for which the government has provided a range.

The tenth volume of the *Transactions* of the Texas Academy of Science, including the proceedings for 1907, has just been published. Its contents includes the following papers: "The Resistive Powers of the Animal Organism," the annual address by the president, Dr. James E. Thompson, professor of surgery in the medical department of the University of Texas, Galveston; "A Theory of Ferments and their Action," by Dr. James W. McLaughlin, Austin; "Soil Fertility and Phosphoric Acid," Dr. George S. Frapps, state chemist, College Station; "Lord Monboddo—

A Precursor of the Darwins," by May M. Jarvis, M.A., University of Texas, Austin; "Fossil Tracks in the Del Rio Shale," by Professor J. A. Udden, Augustana College, Rock Island, Ill.; "Some Figures on the Cost of Train Service," by R. A. Thompson, C.E., chief engineer of the Texas Railroad Commission; "The Law of the Fall of Rivers and the Value of the Deduced Curve in River Improvements," by F. Oppikofer, C.E., Tarpon, Texas.

BOTANICAL NOTES

ANOTHER ELEMENTARY BIOLOGY

The recently published (Macmillan) "First Course in Biology" prepared by Bailey and Coleman is disappointing in that the presentation of the two sides of the subject is very unequal, that relating to plants being much inferior in every way to that relating to animals. Pedagogically, practically, and still more, scientifically the treatment of "Plant Biology" falls far below what we had a right to expect from the author. In the two hundred pages given to this subject there are brought out a great many interesting and useful facts, charmingly told, but they are presented in an unorganized form. There appears to be no orderly sequence in the presentation of the matter contained in the chapters. Thus the pupil is told in the first chapter that "no two plants are alike," which may or may not be important for him at this stage of his education; then next he is asked to consider plant adaptation, followed by two pages devoted to "the survival of the fit." The fourth chapter deals with "plant societies," the fifth with "the plant body," the sixth with "seeds and germination," the seventh and eighth with the root, etc. The twenty-third chapter includes six pages, devoted to "phenogams and cryptogams," a careful study of which must leave the pupil in a good deal of confusion as to the differences between spore-bearing and other plants, and the nature and significance of alternation of generations. The closing chapter consists of "more extended excursions into the cryptogamous orders." The author's unfamiliarity with this portion of the plant kingdom is evident. Witness this description of lichens (p. 195)—"they are thin, gray, ragged objects, apparently lifeless," and "they are now known to be green cells of various species of algæ overgrown and held together (imprisoned) by the mycelium of various kinds of fungi." What idea could a high-school pupil get from such statements? In the preface to the book the author refers approvingly to the "revolt against the laboratory method" and decries the study of botany "without really knowing plants"—but certainly this book in its present form is not likely to remedy these educational abuses. It must be remembered that even though one may intend to be very "practical," and have the gift of entertaining and attractive writing, it is still necessary to be strictly accurate in the statement of facts, and to carefully arrange the sequence in which these statements are presented. It is clear that the botanical part of this book should be revised, rewritten and rearranged before a second edition is issued.

CANADIAN ROCKY MOUNTAIN BOTANY

Some time last year Mr. Stewardson Brown, the curator of the herbarium of the Academy of Natural Sciences of Philadelphia, brought out a pretty book on the "Alpine Flora of the Canadian Rocky Mountains" (Putnams). The author says it "is meant only as a guide to the rich and interesting flora of the Canadian Rockies and Selkirks, or those portions traversed by the Canadian Pacific Railway between Banff and Glacier." It is thus a tourist's book, but its treatment is such that it becomes a useful book for the botanist, also.

It opens with a glossary of such terms as might puzzle the non-botanical amateur, and following this is a good key to the families. In the text the characterization of the families is brief and non-technical, as are also the descriptions of species. The genera are not characterized further than is done in the keys to the genera given at the beginning of each family. It should be stated that the nomenclature is of the modern kind. At frequent intervals are plates, either half-tones of photographs, or colored reproductions of water-color drawings. A good index closes this volume, which must prove very useful to tourist or botanist in the Canadian Rocky Mountains.

ORCUTT'S AMERICAN PLANTS

Few eastern botanists can realize the difficulties of the student of systematic botany in the far west, where there are no handy manuals containing the descriptions of all the flowering plants and ferns and in some cases plants of lower groups also. For some years Mr. C. R. Orcutt, of San Diego, California, has attempted to remedy this condition by bringing together the descriptions of genera and species of south Californian plants. We have often wished that his type and paper were better, but work of this kind is a labor of love, and in the absence of an endowment must be brought out at the least possible expense. It is greatly to Mr. Orcutt's credit that he has been able to bring out this book of nearly two hundred pages of descriptions, many of which occur in widely scattered publications. From the title-page we learn that the volume contains "descriptions of over 200 genera, more than 1,200 species and many varieties." A second volume is in preparation, at the close of which we are promised an index to the two volumes. This will make the work much more useful, for with no index it is well-nigh impossible to find any particular description without the expenditure of much time. When these descriptions are all brought out, they should be put together in the form of a systematic manual of the plants of southern California.

A HIGH-SCHOOL BOTANY

Notice should be made here of Coulter's text-book of botany for secondary schools recently brought out by the Appletons in the excellent type, paper and presswork which is characteristic of their publications. The plan of the book is that which has been generally followed in recent years. There is first a general part (less than one hundred pages) in which gross and microscopical anatomy are taken up by the pupil, and this is followed by chapters on algae, fungi, liverworts, mosses, ferns, horsetails and club-mosses, gymnosperms and angiosperms, nearly one hundred and fifty pages being given to an admirable treatment of the morphology and general classification of the plants of these groups. Then follow two chapters (20 pages) on flowers and insects, and seed dispersal, and then 61 pages on the structure and classification of monocotyledons and dicotyledons. The remainder of the book (about 40 pages) is given to little snatches of discussions of plant breeding, forestry, plant associations, hydrophytes, xerophytes and mesophytes. Some of these closing chapters could well be omitted, since the necessarily brief treatment is wholly inadequate. However, taken as a whole the book is one of the best of those adapted to use in the high schools.

Charles E. Bessey
The University of Nebraska

SPECIAL ARTICLES

MENDELIAN HEREDITY

One might suppose, at first thought, that, in cases of Mendelian heredity, the dominant form would be capable of gaining over the recessive in the course of evolution, merely from the nature of the dominance. The falsity of this view was well shown by Shull (1907) and more recently by Hardy (1908). The successful increase of a mutation depends upon aid from determinate evolution or natural selection. Here we are only concerned with the work of the latter.

Shull maintains that the view that recessiveness is a handicap is quite erroneous; "not only has the dominant form no advantage in the competition which the newly arisen elementary species must encounter, but it can be shown that under certain conditions the reverse is true." He then clearly shows that, where the new characteristic has less favorable chances of survival at the time, recessiveness is an advantage, for it may be shielded from extermination by being carried without somatic expression.

But if we assume the opposite condition, namely, that the new characteristic is more favored than the parent species, then dominance gives an advantage because the characteristic will be present in each generation, thus permitting the work of natural selection in increasing the numbers to work without interruption.

The recessive character, on the other hand, only occasionally manifests itself, so that natural selection seldom has an opportunity to aid it. This advantage that dominance wins for the characteristic is especially important, because the early generations are the critical period for every new characteristic. Even a favored characteristic may succumb during the early days, when all the eggs are in one basket, so to speak, so numerous are the chance deaths.

Trimorphic heredity, where the heterozygotes constitute a third form different from the parents, also affects the action of natural selection. In this case the *utility of the new characteristic is less important than the utility of the heterozygous characteristic* in the determination of the fate of the characteristic in question. In some cases, the heterozygous characteristic is so different, as in the Andalusian fowl, that it is quite conceivable that the selective value of the heterozygous characteristic might be even opposed to that of the original characteristic. More frequently it would have a decreased value, whether it be negative or positive, which may reduce it to no selective value. A characteristic might have a high utility, but if its heterozygotous condition lacked it, it would probably fail unless some other factor, such as assortative mating or determinate evolution, should come to its rescue. There is a possibility that the heterozygote might be favored by a selective value with the extracted characteristic neutral. It might then be successfully established by natural selection in spite of its own lack of selective value. Again the heterozygous characteristic may be favored and the extracted characteristic opposed. In that case the success of the heterozygote would be jeopardized. Rescue might come for it in the shape of a fixed heterozygous condition, such as that of the Barred Rock poultry.

The method of inheritance plays, then, a large rôle in the action of natural selection.

Roswell H. Johnson

October 11, 1908

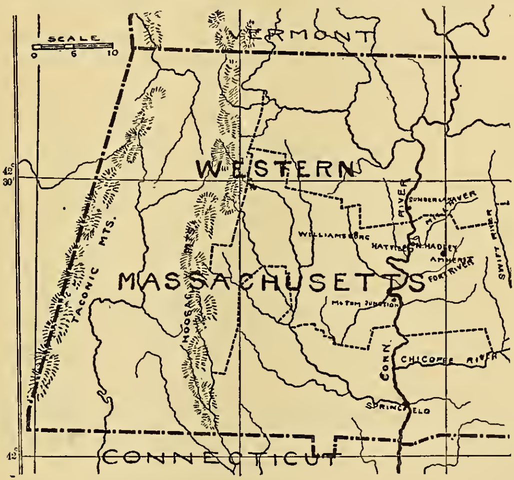
THE OTTER IN MASSACHUSETTS

It is not commonly known that the North American otter (*Lutra canadensis*) is nowadays anywhere in Massachusetts a frequent victim of the trap or the gun of the hunter. It appears, however, that the otter has escaped extermination in spite of its valuable fur, and in certain sections of the state has apparently gained in numbers. The solitary habits of the animal and its shyness may have conduced to its preservation. It has, nevertheless, always been eagerly sought wherever its presence has become known, on account of the beautiful pelt, which to-day has a substantial market value.

The persecution of these valuable fur-bearing mammals, it would seem, would have led to their extinction. While their shyness and general recluse habits are in their favor, their size and certain other instinctive habits are against them. The otter seems to be a playful creature and apparently enjoys a frolic with a companion or alone. During the rutting season, perhaps at other times as well, it is known to enter into the pastime of sliding on the snow or a muddy river bank into the water of a stream or pond, and to repeat this performance many times. These otter slides are the trappers' "signs." Apparently, too, the creature may have a sort of "playground" or place where it more or less regularly leaves the water for a roll in the snow or mud.

The great traveling capability of the otter is attested by its wide distribution. It is said to be generally distributed over North America, apparently in no great abundance at any one place, but likely to be met with in localities adapted to its habits. The roaming habit, of course, in a way stands between it and destruction. In its new haunts it may live and breed for some time, undiscovered. In the old it would probably have been hunted so relentlessly that it would have been extirpated.

It is to me a matter to occasion some surprise that the otter is as abundant as records seem to show, in certain parts of this state. The otter has always been included in a list of the mammalian fauna of the state. It appears at no time to have become so decimated in numbers as to have been excluded from such a list. In 1835[1] E. Hitchcock included it in his list of Massachusetts mammals, without any reservations, from which fact we may infer that if not abundant it was yet fairly common. In 1840[2] E. Emmons wrote: "The otter is still an inhabitant of our waters, but, from its shyness, watchfulness and aquatic habits, is rarely seen and still more rarely captured." In 1861,[3] however, E. A. Samuels referred to the otter as "once



quite common," but "now nearly exterminated, one in two or three years being about the greatest number captured." He reported a specimen killed that season near Marlborough, Middlesex County, and another at Palmer, Hampden County. Eight years later[4] J. A. Allen wrote of the otter as "not rare; still not often captured," and stated that during the ten preceding years some half dozen had been taken near Springfield.

Records are not at hand for later years up to the winter of 1905–6. During that season a party fishing through the ice at an ox-bow of the Connecticut River one half mile north of Hatfield caught an otter. In the confusion following this unexpected catch the creature escaped. In the succeeding autumn another fine specimen, a male, was taken in the town of North Hadley, just across the river from Hatfield, from a mill pond in a creek known locally as "Mill River." A few months later still another specimen, an old male, was taken from this pond. The skeleton and mounted skin of this animal are now in the Massachusetts mammal collection at the Agricultural College. Shortly afterwards a third male was caught from this pond. The trap had been set at the "playground" of the animals. Tracks have frequently been seen near "Fort River," a few miles south of "Mill River," and in a mill pond of this stream, another was trapped in the winter of

[1] Report on Geology, Mineralogy, Botany and Zoology of Massachusetts, 1835, p. 526.

[2] Report on Quadrupeds of Massachusetts, 1840, p. 48.

[3] Agriculture of Massachusetts, 1861, Part I., p. 160.

[4] "Catalogue of the Mammals of Massachusetts, with a Critical Revision of the Species," *Bull. Mus. Comp. Zool.*, Cambridge, 1869, p. 178.

1907–8. In the early spring of 1908 a pair of otters were shot in the "old bed," a large ox-bow of the Connecticut near Mt. Tom Junction. In the preceding winter months a boy shot another on a cake of ice in the Connecticut River near Hatfield. At Sunderland, north of Amherst, in the same season, another specimen was shot in a brook, tributary to the river. In Swift River, a few miles east of the Connecticut, two others were caught in a trap within the last two or three years. Traditions of the presence of the otter, a dozen, twenty and more years ago are common among the residents of the river towns in this neighborhood, but it is generally conceded that these animals appear more abundant at the present time than for many years preceding.

A few weeks ago while searching for microscopic forms near "Mill River" I came upon a large otter feeding in a stagnant pool near the creek. My approach had been along the road. The dust was very deep and muffled every sound. The creature remained feeding—apparently on vegetable matter, possibly frogs—or paddling about for several minutes at a distance of less than one hundred feet from my standing place. At last it evidently saw or scented me and mounted the bank and was lost in the brush. It soon emerged at the bank of the stream a hundred yards away and swam around a bend out of sight.

The surprising abundance of these animals in the Connecticut Valley is thus shown and seems to be a matter deserving of record. The extent of their presence elsewhere in the state can not be stated with any accuracy. Dr. Glover M. Allen[5] reports that they are occasionally seen about the Charles River in the eastern part of the state, he having found unmistakable tracks of the otter near Dedham, Norfolk County, two winters ago.

It is, of course, possible to postulate the persistence of these animals in this state as a logical consequence of their shy habits and tendencies to roam about. At times they might appear to decrease in numbers when eagerly sought for their fur. When the relentlessness of the hunter abated they would multiply and attract attention once more, the streams or ponds where the creatures had been driven serving as centers of dispersion. The younger animals, not having the experience of the older ones, would be less wary and timid; might, indeed, if unmolested for some time, become comparatively bold. The comparatively large size of these animals and their habits, however, would reveal their presence. Even their roaming habit is in a measure against them, as they are essentially stream-loving animals, and in the winter months when searching for the rapids and falls of the streams for open water would leave their tracks in the snow. The otter is a good land traveler and does not always follow the winding courses of the waterway. Their comparative scarcity in the eastern part of the state is noteworthy.

The abundance of these animals in the Connecticut River valley has suggested to me that they have come along this waterway from the north outside the limits of the state to the smaller tributaries of the river in the lowland of the valley. They may have traveled eastward through the valleys of the Ware, the Assabet, and the Blackstone to the seaboard. But one must not overlook the possibility of their having come along another waterway from the north—the Merrimac, along the tributaries of which—the Concord and the Nashua—they might have easily made their way southward.

The emigration from Vermont of terrestrial mammals is a matter of common knowledge. This emigration is along the Hoosac and Taconic ranges in the western part of the state. Early reports record many wild mammals in these districts, but their numbers are fewer, apparently, at present. In the fall of 1907, however, a black bear (*Ursus americanus*), variety not known, was shot near Williamsburg in the eastern foothills of the Berkshires. Some indication of the number of wild cats is had from the treasurer's records in Berkshire County. By the enactment of our general court (Chap. 344, Acts of 1903) provision is made for the payment of a bounty of $5.00 for every wild cat (either

[5] Personal letter.

Lynx rufus or *L. canadensis*) killed in the state. The following bounties have been paid in Berkshire County under the provisions of this act: 1903, $100; 1904, $110; 1905, $115; 1906, $100; 1907, $60.[6] The records are not sufficiently explicit as to the species of *Lynx*, but the loupcervier seems far less common, as in only a few cases was the distinction made on the certificate. These animals (*L. rufus*) are sporadically reported from other sections of the state, but often from localities that lead to the suspicion that they may have immigrated from the western hilly or mountainous parts.

C. E. Gordon
Massachusetts Agricultural College

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 652d meeting was held on October 10, 1908, President Bauer presiding. The following papers were presented:

Vertical Temperature Gradients of the Upper Atmosphere: Mr. W. J. Humphreys.

The extensive work that has been done during the past ten years in exploring the air with sounding balloons was reviewed and illustrated with typical curves.

The records obtained with these balloons show that for about 3,000 meters above the surface of the earth the winds are turbulent and the temperature gradient irregular. Above this for some distance the temperature decreases nearly uniformly to a minimum at an altitude of from nine to fifteen kilometers usually. This height and the temperature both are functions of season, of latitude and of type of weather; and the temperature gradient is similarly affected.

Above the minimum the temperature gradient usually changes abruptly and from that point up as far as soundings have been made slowly increases.

All these phenomena were separately discussed and explained as mainly due to the amount and distribution of water vapor in the atmosphere and the consequent location and temperature of the effective radiating surface of the earth.

The results are in accord with the best determinations of the solar constant and with the known laws of radiation and absorption.

[6] Personal letter, Mr. Henry Brewster, treasurer of Berkshire County.

The New Magnetic Survey Yacht "Carnegie": Mr. W. J. Peters.

A paper on the proposed new vessel designed for a continuation of the magnetic survey of the oceanic areas.

The paper first gave the reasons which made it desirable to purchase a vessel especially built for the requirements of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Then followed data concerning the size, sail area and expected performances.

A brief description of the living quarters, accompanied by slides, and also a statement of the methods of observation which are to be on the lines followed in the previous work on the *Galilee* in the Pacific Ocean.

There was also exhibited a graphic representation of the curves of expected maximum ship deviations. A more complete publication will appear elsewhere.

The 653d meeting was held October 24, 1908. The following papers were read:

The Results of Recent Observations in Atmospheric Electricity: Mr. P. H. Dike.

The paper gave a summary of some of the recent work in atmospheric electricity and showed the relationship of this work to that done along the same lines on board the Carnegie Institution Magnetic Survey Yacht *Galilee* during the cruise recently finished.

Continuous records made at various observatories of the course of the potential gradient show its extreme variability and slight apparent connection with other atmospheric phenomena. It is of interest as a factor in the determination of the earth-air current.

The discovery of the ionization of gases led to the study of the conductivity of the air, at first by faulty methods through the lack of appreciation of the errors due to saturation currents. J. J. Thomson cleared up the misunderstandings and led the way to more accurate work. For field work the Gerdien conductivity apparatus has been found most useful, and gives fairly consistent results. In conjunction with the record of the potential gradient it gives the earth-air current in absolute measure. Gerdien has found this current at Göttingen to be about 2.5×10^{-16} amperes, with a conductivity for positive electricity of 1.16×10^{-4} electrostatic units and for negative of 1.12×10^{-4} electrostatic units.

The speaker had made use of the same type of instrument on board the *Galilee*, making observations at sea from latitude 55° 41′ north to 45° .07′ south, but was unable to measure the potential gradient. The conductivities found gave as means $\lambda p = 1.60 \times 10^{-4}$ and $\lambda n = 1.433 \times 10^{-4}$ electrostatic units, somewhat greater than Gerdien found on land. A description of the method of observation at sea was given and the difficulties mentioned. Calibrations of the electroscope in New Zealand and at the Bureau of Standards in Washington showed its sensitiveness to be nearly constant, but gradually increasing.

C. T. R. Wilson's method of measuring the earth-air current was described. He uses a test plate maintained at zero potential while insulated from the earth, and arrives at a value for the current almost identical with that of Gerdien, namely, 2.2×10^{-16} amperes. Mention was made of Schering's work in Göttingen on the continuous registration of the conductivity of the atmosphere, and his apparatus described. He avoids saturation currents by removing the charged body to a sufficient distance from earthed conductors, and obtained a trace showing the course of the conductivity by means of an electrometer connected with the charged body.

Satterly at the Cavendish Laboratory, Cambridge, Eve at Montreal and Ashman at the University of Chicago, have all made independent determinations of the quantity of radio-active emanation in the atmosphere in terms of the mass of radium per cubic meter required to maintain in equilibrium the observed amount of emanation. Ashman condensed the emanation by cooling with liquid air, Eve absorbed it with cocoanut charcoal and Satterly used both methods. The results give as the radium equivalent per cubic meter according to Ashman 97×10^{-12} gram, Eve 60×10^{-12} gram, from results extending over a year, and with a ratio of maximum to minimum of 7 to 1, and Satterly, 88×10^{-12} gram for the charcoal method and over 100×10^{-12} for the liquid-air method.

On board the *Galilee* practically no radio-active deposit could be collected, yet the ionization was as great as on land, tending to disprove the theory that the ionization of the air is due to the radioactive content.

Attention was called to the need for a well-equipped observatory for research along these lines in this country, where the subject has been almost entirely neglected.

Thermometric Lag in Calorimetry: Mr. W. P. White.

Of late, in calorimetry by the method of mixtures, several attempts have been made to avoid an error due to the lag of the thermometer to which considerable importance has been attached.

This error, however, does not exist at all, which may be shown as follows: In a calorimetric run by the method of mixtures, all the temperature data lie upon a temperature-time curve whose form determines both the cooling correction and the main temperature interval. The exact instant at which temperatures on this curve are read is unimportant, so long as the temperature *intervals* are preserved. If now, all temperatures are plotted the same number of seconds wrong, as they would be when the same lagging thermometer is used throughout, no appreciable error can result. The importance of lag in calorimetric thermometers has, therefore, been greatly overestimated.

R. L. Faris,
Secretary

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA

The 179th meeting of the society was held in Chemistry Hall on Tuesday, October 13, 1908, 7:30 p.m. The program was as follows:

"Results of the Microscopic Study of the Slate near Chapel Hill," Mr. H. N. Eaton.

"Chemical Energy," Professor J. E. Mills.

"A Further Contribution on the Regenerative Power of Sponges," Professor H. V. Wilson.

Alvin S. Wheeler,
Recording Secretary

SECTION OF BIOLOGY, PITTSBURGH ACADEMY OF SCIENCE AND ART

The first meeting of the year was held at the Carnegie Institute on Tuesday evening, November 10. At the invitation of the section about twenty-five geologists attended the meeting, and it was decided that there was sufficient interest manifested to warrant the formation of a Geological Section in Pittsburgh. As the Biological Section had already prepared a program which embraced a large number of topics of interest to geologists, it was thought best to combine the two sections for the present year at least. The meeting was addressed by Director W. J. Holland, Dean M. E. Wadsworth, Mr. R. R. Hice, Mr. F. Hewett, Mr. F. Z. Schellenberg, Mr. E. Andrews, Mr. F. S. Webster, Professor J. G. Ogden, Dr. A. E. Ortmann and the secretary of the section.

Percy E. Raymond,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 4, 1908

CONTENTS

WILLIAM KEITH BROOKS

AT sunrise November the twelfth there passed peacefully away, at his home "Brightside," on the shores of Lake Roland, one of the foremost of the few greatest of American zoologists.

William Keith Brooks owed his early education in part to the excellent public school teachers of Cleveland, Ohio, and in part to such elements of his boyhood's environment as his native bent led him to pick out and assimilate. Among such influences were collections of fossils, stored in a neighbor's barn and the wonder of the flocks of carrier pigeons that still came over the lake to be destroyed by clubs and guns on the bluffs, darkening the air till school could no longer "keep."

More significant yet were the self-made aquaria, and the back-yard pond that was sometimes visited by a migrating carrier pigeon and more often the source of rare delight in the study of the habits of aquatic insects. And it was there that was learned an indelible lesson of the power of reflexes and mechanisms, by the observation of a dragonfly that had lost most of its machinery except that of the head, yet continued to chew and swallow food, which, like the water drunk by Munchausen's bisected horse, passed steadily out into the open void.

He was not given to athletic sports, though winning a prize for excellence in calisthenics. Contemplative and studious, he desired to enter college, but his mother did not approve and he began life in his father's counting house. Here he exhibited characteristic interest in the solution of problems and distaste for such mechanical drudgery as had only practical and not theoretical ends in view by the invention of a calculating machine to lessen the amount of unprofitable manual work.

To get the higher education despite lack of financial support he became a teacher at Hobart College and there entered upon a second marked period in necessary preparation for his life-work. He learned the boy mind and the simple way to teach by arousing interest in the truths of nature. Some others profited by this much later when he was induced to give private lessons in natural history to boys in Newport and the same bent always made his university lectures the opposite of that ill-digested verbiage that is sometimes heard. At Hobart two great opportunities were utilized: communion with nature as presented along the rapids below the falls of Niagara and communion with the thought of philosophers he met in his readings in the library. It was then that he became so strongly impressed by the writings of Bishop Berkeley as never to be oblivious of the relation of observational science to the fundamental character of the ego. In the woods about Hobart, Brooks made those observations upon the habits of squirrels, that were probably his first publications and perhaps his last contributions in print to the study of mammals, for his life-work was largely in the field of the lower animals though the complex psychology of the mammal appealed to him strongly.

After two years he entered Williams College where a love of natural history was fostered by the society that sent out an expedition across South America. Receiving the A.B. degree he was drawn by the fame of Agassiz to his first experience with marine life at the famous experiment, the Penikese school, where he shared the discomforts and the delights of the beginnings of that hastily materialized ideal. Sailing to that island by fishing vessel the poetic strain in his composition long treasured the glimpse of his point of departure, the then picturesque hamlet of South Dartmouth, much later recognized, for its rare atmosphere, by the artist, Tyron.

At Harvard College, he received the degree of Ph.D. He had the stimulus of contact and friendship with Hyatt and McCrady and the environment of the museums of Agassiz and of the Boston Natural History Society. With Hyatt's aid he added to his own studies of the embryology of pond snails, such intimate knowledge of the large collections of gasteropod shells that he could distinguish and identify them in the dark. By McCrady he became inspired by the beauties of form and problems of life-history of the medusæ that McCrady's studies at Charleston, S. C., were revealing.

In 1875, he, with H. Tuttle and Theodore B. Comstock, opened a summer school at Cleveland, with some twenty-five, chiefly school teachers, in attendance, with lectures, excursions and laboratory study of both local and marine animals and plants.

With the opening of the Johns Hopkins University, Dr. Brooks saw an opportunity to devote himself to the study of zoology untrammelled by tradition and with the freedom to express the genius that was in him. Appointed fellow, he was at once made instructor, and having no administrative routine was enabled to give himself wholly to investigation—not that he was lacking in initiative and practical expedients. By personal representation he obtained from prominent citizens a nucleus of support for the founding of the Chesapeake Marine Laboratory, the first school for study of marine life to take the field opened by Agassiz's initial experiment. He also induced the civic authorities to open a public aquarium in Druid Hill

Park, though this was subsequently abandoned, since the city had not then grown sufficiently mature to feel the need of such mild expression of intellectual interest and means of instruction.

His summer schools in the Chesapeake, at Crisfield, at the old fort on the Rip Raps off Old Point Comfort, and at Hampton, at first provided instruction for elementary students and school teachers as well as opportunity for research by naturalists, but later this latter side was the one exclusively developed. His study of the fauna of the Chesapeake soon made it evident that the fundamental problems of marine biology could be more profitably attacked at some point on the ocean shore farther south and it revealed also the hitherto unknown fact that the practical problems here in pressing need of solution could be solved by common sense application of scientific principles.

Professor Brooks's discovery that the eggs of the American oyster could be fertilized outside the body suggested the development of an oyster industry along the lines in use by the fish hatching stations and led to the establishment of the Maryland Oyster Commission. As leading and working member of this body, Professor Brooks made an extensive survey of the oyster beds of Maryland and concluded that the state had there a vast means for development, which needed but the application of good business management to rescue it from its condition of neglect. From that date, 1882, Professor Brooks lived in the belief that the people of Maryland would utilize the great natural gifts of the Chesapeake by legislation that would remove the oyster industry from a mere hunt to the level of scientific agriculture. To this end he stimulated popular interest and sought to appeal to those of slow comprehension both by popular lectures and by his popular book, "The Oyster," which was issued in 1891 and reedited later. With characteristic persistence of purpose he was loath to let the truth be swamped by popular conservatism and ignorance and became so determined to see the state enter upon the enjoyment of the fruits of his labors that the oyster question and its ultimate solution played no small part in keeping Professor Brooks in Baltimore when alluring opportunities for enlarged activities were offered at a more northern university. However, he was temperamentally more at home in the non-nervous community of his adoption than in the bustle of the strenuous life of denser populations.

This interest in the practical value of zoological work was sustained by several of his students, who, following Professor Brooks's lead, made advances in the culture of the oyster, in New England, in New Jersey, in Oregon, in Louisiana, in the Carolinas and in Maryland itself. For at the eleventh hour a good beginning was made and Brooks's disciple, Professor Caswell Grave, the zoological member of the present Shell Fish Commission of Maryland, has utilized the new legislation for a most promising realization of Professor Brooks's dreams of scientific knowledge and control of the vast natural resources of the state.

But the philosophical problems of biology always took first place in Brooks's mind and it was at Beaufort, N. C., that he found marine life presenting the problems best suited to his patient and enthusiastic labor. The yearly work of his laboratory, established in the old Gibbs house (that boasted the distinction of being built of cypress and put together with copper nails), added much to the facts of marine embryology and to the number of now well-known investigators.

Upon that foundation was ultimately builded the present well-known marine station of the Bureau of Fisheries at Beaufort, embodying a dream that Professor Brooks could not himself realize as the university became no longer able to maintain the "Chesapeake Laboratory."

Financial embarrassments of the university led to the abandonment of steam launch and sloop and discontinuance of the university's summer school at Beaufort, but from year to year, when it was possible, temporary stations were established by Professor Brooks and his men; in the Bahamas, at Green Turtle Cay, at Nassau, at the Bimini Islands; and later in Jamaica at Port Henderson, and again at Port Antonio.

Meantime, as director of the United States Fish Commission Laboratory, at Woods Hole, in 1888, and while upon expeditions of the *Grampus* he had opportunity to renew his acquaintance with the fauna of the North Atlantic and to explore the Gulf Stream.

From this varied experience of marine life arose those contributions to the embryology and life histories of non-vertebrates that will long endure as a monument to the industry, keen observation and no little artistic skill of Professor Brooks. His chief observations were made upon the hydromedusæ and the mollusca and crustacea and notably upon those exceptional kin of the vertebrates, the pelagic tunicates, the salpas.

Among these contributions to the facts of marine life might be recalled his papers upon gasteropods and amellibranchs, beginning in 1875, with a communication to the American Association for the Advancement of Science, the papers on *Lingula*, on the development of the squid, on squilla and the other stomatopods, on lucifer with its exceptional cleavage, on the macrura: and a series of papers upon salpa, culminating in 1893, after a continued interest from the first publication upon this animal in 1875, in his great monograph upon salpa, a quarto volume of nearly four hundred pages and fifty-seven plates. From his trips to the Bahamas came also his monograph on the skulls of the Lucayan Indians.

While some of this work appeared in various journals, in the publications of the Philosophical Society, the National Academy, the *Philosophical Transactions* and in the results of the *Challenger* Expedition, much of his earlier work came first to light in "Studies of the Biological Laboratory," but later he assumed editorship of the work in his laboratory in a series of well illustrated quartos published by the university, as "Memoirs from the Biological Laboratory."

Professor Brooks made some contributions to systematic zoology, but his work was chiefly embryological and it is well represented by his monograph upon salpa. This is not merely an account of the embryology and organology of salpa, but creative, philosophical thought upon such problems as: the probable origin of salpa, the origin of the chordates, the origin of pelagic animals, and the discovery of the ocean bottom and its effects upon the evolution of animals.

As is well known Brooks's work was inspired throughout by his interest in the intellectual problems presented by animal life as well as by his love of their forms and activities. And it was this tendency to the philosophical application of zoological facts that was expressed in his later essays and lectures and finally in his book "The Foundations of Zoology." He was not a writer of text-books, yet his "Handbook of Invertebrate Zoology" shows his original and novel treatment of what was then an almost unexplored field in textbook writing, the study by the student at the seashore, of the life histories and eggs and larvæ of marine animals as a basis for the philosophic study of morphology. And with a more fortunate choice of publisher the book might have long continued to widen the sphere of his influence.

Dr. Brooks married, in 1877, Amelia Katherine Schultz, of Baltimore. His happy home life furnished the environment for the development of his very domestic social needs and the loving care of his devoted wife tided him through many difficult contests between his over-zeal for work and his physical restrictions.

But Mrs. Brooks, in the spring of 1901, after long years of suffering, lightened we hope for a time by the appreciation that came to Professor Brooks when his students requested him to sit for the portrait that they presented on his fiftieth birthday, and which came more for her comfort than for his, passed away from life, to be followed for us too soon by the man whose life we rejoice in, whose death we mourn.

To the students who were taken so freely into that home life a hope of attaining the best that life has to offer, despite financial restrictions, was held forth, and there are many who recall the delightful evenings of reading and talk when they met at his house on terms of equality and free intercourse. His two children he strove to educate with freedom from too much of the burden of inherited custom and regretted the unavoidable interference of some who knew but one orthodox way for the saving of souls. As an example of the thoroughness with which he sought to apply the best to the problem of education may be cited that he would have none but the best "Windsor and Newton" colors for the boy who was entering upon that period of color-love that all go into and most through, fearing lest the mind would be injured by muddy and overlapping tints, and not kept clear as he sought to hold his own. That his two children should have what he had so hardly won, the higher education, he freely spent himself.

His son, as student in mathematics, received the degree of Ph.D. at the Johns Hopkins University, and is now an actuary in Jersey City. His daughter graduated at Vassar and was able to comfort the last days of her father who had had clean-cut ideas as to the highest mission of the perfect woman.

Their inheritance is that education and the privilege of such parentage and nurture.

The condition of Professor Brooks's health was long a source of anxiety to his friends who knew of his heart trouble. As years passed the problem of continuing hard work with increasing bodily handicaps became very difficult. He felt that he ought not to take a period of rest and absence on account of the needs of his children, thinking to work to the end.

In 1908 difficulty in breathing added to his burdens and his machinery was most seriously out of order. He continued to come to his lectures and worked earnestly to complete a final paper on salpa, for which the drawings were finished and which he planned to write out in the summer. This, he said, would probably be his last piece of serious microscopic research, since trouble with his eyes made the employment of immersion lenses too difficult; and his mind was eager to digest the facts of his long experience and the recent work of others. But his strength was not equal to the task. Sudden attacks confined him to his home, but yet his will brought him back to his laboratory, till one last day, February 12. After preparatory rest, driven by his conscientiousness, he forced himself to attend an oral examination of a candidate for the degree of Ph.D. Then walking to the train that brought him home, he was there overcome by a serious collapse. He was persuaded to go to the hospital and, after most severe attacks there, rallied; but in nine long months that followed he scarcely left his wheel-chair.

When he returned to his home he got such comfort as might be from the advent of spring, the passing of summer and the long lingering of autumn, amidst scenes so familiar and dear. Despite his critical state he was deeply interested in such news as came to him from the university. His last official act was a strong, successful plea for another when his own interests might well have absorbed his attention. His was real friendship growing out of his own wide sympathies.

While having some strength to correct the proofs of papers in press he felt most keenly his inability to put his last work upon paper, and till this work was done he would not deem it right to retire or seek a pension.

The end was imminent, but could not be predicted. His mind was still interested in books and objects of nature, down to a week from the end. Back of the weakness of organs, which he deplored, lay indomitable will and soul, masked not absent. Finally came stuporous death.

After services in Trinity Church, his friends, the faculty and his students, followed the body to its resting place, on the bow of a hill overlooking a broad valley, in the cemetery of the county seat of Baltimore County.

In person, Professor Brooks was of short stature and with ruddy abundant flesh, but yet with small refined boning. Early photographs show him a strikingly thoughtful, quiet but resolute man, with the seeing eyes that remained to the last. Later, when first he came to Baltimore, Brooks was a noticeable, short man, with bushy beard and square, thoughtful brow, very slow of speech, lacking in all superficial conversational art, content with his own thoughts and the worship of his college companion and long most faithful friend, his great St. Bernard dog, "Tige."

To many he is known only from Corner's portrait, which recalls to his older students his characteristic, Buddha-like, quiet and peaceful absorption in thought, till some inner conclusion, or strong outer compulsion caused the peculiar rising glance of the eyes that saw so much and seemed to question so strangely one's inner self.

Born with a physical heart that failed to become completed as in the average man, he learned to conduct his life within the limits set by his peculiar physical organization and avoided all intense muscular efforts and sudden movements. Owing to these habits he was often misunderstood. Yet on right occasion he could exchange his slow rate of living for strong effort. With sympathy for all suffering he once lifted his great St. Bernard dog, "Jupiter," when too tired to longer follow the carriage, and thus he received a severe strain that cost him weeks of pain.

Knowing both the physical and the financial handicaps of his life's race we can appreciate his saying:

> The only necessary law of progress that I can discover is that it is necessary to fight pretty hard for everything worth the getting, and that it is no light or easy task to keep what has been won.[1]

Brooks was no friend of conventionalities, and at times might extend his absorption in the essentials of thought-life to some neglect of many superficialities that others highly prized. In the stress that comes, at times, to those who live in the country and journey daily, some factors of his dress, such as a necktie, might at times be forgotten, but if the loss were discovered, replaced by quick purchase through the faithful laboratory janitor, who honored, and, with good cause, loved

[1] Address Western Reserve University, 1899.

the man whose kindness expressed itself in deeds not made public.

Professor Brooks was very fond of good reading and familiar with the classics of English literature and though he was not able to acquire a library he did get and keep at hand his favorite authors—not for their bindings but for their thoughts and modes of expression. His enviable use of English came in part from his reading but was primarily a habit of mind.

For one of his dogs that chewed up Shakespeare and Tennyson, he had only praise, as exhibiting the tastes of a gentleman, but the other that destroyed cheap novels, was a worthless rascal. An even more characteristic judgment was expressed when one of his students told him that it required three generations to make a gentlemen, and he replied that he thought a gentleman was one who had consideration for the feelings of others.

In later years he developed a strong love of music, and when it became impossible to work through the evenings, as of old, he passed many an hour in the enjoyment of classical music that mechanical devices have made reproducible by one who has had no leisure for musical education. Beethoven's fifth symphony, the overture to Tannhäuser and some fugues of Bach were favorites of his.

His love of flowers led him to make what use he could of a city window and when fate brought him a residence outside the city, a great solace to him was the diminuive greenhouse he was finally able to indulge in. Denied the opportunities that Darwin had, he could not carry on the experiments upon the breeding and heredity of plants that he wished, but when, too late, he had some little space he did such work as circumstances allowed. But it was largely as a source of pleasure and relaxation that he reared his favorite flowers. His attitude of mind towards all forms of life was expressed in the following sentence:

> As for myself, I try to treat all living things, plants as well as animals, as if they may have some small part of a sensitive life like my own, although I know nothing about the presence or absence of sense in most living things; and am no more prepared to make a negative than a positive statement.[3]

Brooks was not an experimenter, but an observer of natural processes, from which he endeavored to interpret logically. He saw too many facts to be long satisfied with the sharp cut result that seemed to follow from experimentally severing some portion of the phenomena from the rest. He was a recorder of nature and a philosophic reasoner about the outside universe as it appeared to his consciousness.

While there was a grain of truth in the remark of an artist who said that Brooks owed his success to the hand drawings he was able to make so well, his long labors with the painfully slow methods of pen stippling contributed to success, not so much from artistic skill as from the leisure to think which this calm, sedentary occupation afforded.

If directness be one hundred per cent. of genius, Brooks also has this claim to be regarded as a genius, for laboratory paraphernalia were always means and not ends to him and while he enjoyed the perfection of a lens or a microtome, or a typewriting machine, or the brilliance of a selective staining fluid, technique was always reduced to its simplest terms in his work. With customary pertinacity he continued to use a simple friction tube when a larval student would have none but a bright complexity of screws, however ill made. However, when his work demanded it he would use all the refinements of Zeiss's apochromats and he wished that samples of all makes of instruments might be in the

[3] "Foundations of Zoology," 1899, p. 17.

laboratory in order that students might learn to use and select what was fitted to their work. From a spirit of patriotism he sought to aid American instrument makers at a period when their product was but the poor things that now lie wrecked from attempts to use them.

He was sure to surprise with unexpected thought. The canals of Mars, if really due to the work of organisms, were, he suggested, on the basis of what we know her, more likely, formed by social arthropods than by man-like beings, as they would be work carried on by great coordinate efforts through long periods.

His interest in the topics of the day was deep and real, but he was not a man to serve in public life. He contributed to the welfare of society by doing the best possible as a trained specialist.

In the question of the admission of women to universities made for men he took his stand upon the basic biological facts as he saw them, but, finally, with his usual effort to be fair thought that the experiment might be tried as one way of finding the proper solution.

Born a decade before the appearance of the "Origin of Species," Brooks's intellectual life unfolded during that remarkable period of an overwhelming acceptance of the doctrine of evolution by means of natural selection. Most of his hard-earned facts were brought to the support of evolution as revealed by embryology. Yet the defects in Darwinism were long considered by him and after ten years of thought upon the problems of heredity Brooks, in 1883, put forth in his first book, "Heredity," many ingenious thoughts that led him, then, to an attempt to reconcile the subsidiary hypothesis of Darwin, the pangenesis hypothesis, with the opposing facts of Galton. This attempt to make pangenesis acceptable as the basis of an understanding of heredity will always rank as an interesting contribution to the history of thought upon this subject, though, as Brooks expected, his special views have not been accepted. This book was put forth as a stimulus to research, "to incite and direct new experiments," he said. Its main interest lies in its revelation of the best that could then be done toward solution of problems that yet wait such experimental evidence as alone may make their solution possible.

The lectures and essays that grew into his book, "The Foundations of Zoology," published in 1899, and again in a revised edition, show Professor Brooks's breadth and depth of philosophical thought, and it is upon this work that his claim to a place amongst our immortals will largely rest.

But the estimate of Brooks as a leader of philosophical zoology can best be left to the perspective that time will bring and to the minds of another generation biased neither by love of Professor Brooks as a man nor, on the other hand, an absorption in the activities of our present transition period of zoological methods and ideals.

What we can most surely appraise at the present moment is the work of Brooks as friend and teacher, an inspiration and example. Men who have worked in close contact with Brooks now hold commanding positions in the intellectual life of the world: the influence of their living presence is exerted in Japan, and in England, in South Africa and in Canada, and through his native country from Maine to the gulf and from ocean to ocean. On March 25, 1898, sixty of these students and friends contributed with genuine feeling to celebrate his fiftieth birthday. It was truly an unique personality that had added to their rational enjoyment of life and helped in their own struggles for ideals.

These students of a pioneer in the field of American embryology have naturally followed his lead and their observations have been an extension and elaboration of his work, whether in the same field or in newer ones recently opened. His philosophical mind left its impress upon their ways of thought in whatever part of zoology they labored. The old problems of heredity are now attacked by new methods, but some of the foremost investigators are bound to Professor Brooks, more or less intimately, by nurture got when he was a stimulating if not also a formative part of their environment. Thus William Bateson, the present leader in studies of variation and heredity, coming to the Chesapeake laboratory to continue embryological studies on *Balanoglossus* and the origin of the vertebrates, first heard the problems of heredity, from Brooks, in long and intimate discussion and exposition.

Professor Brooks's religious *beliefs* remain unknown to me but the view-point of his intellect may be inferred from the following extracts from the "Foundations of Zoology":

If any believe they have evidence of a power outside nature to which both its origin and its maintenance from day to day are due, physical science tells them nothing inconsistent with this belief. If failure to find any sustaining virtue in matter and motion is evidence of an external sustaining power, physical science affords this evidence; but no one who admits this can hope to escape calumny; although it seems clear that the man of science is right, . . . for refusing to admit that he knows the laws of physical nature in any way except as observed order.

Many will, no doubt, receive with incredulity the assertion that the ultimate establishment of mechanical conceptions of life has no bearing, either positively or negatively, upon the validity of such beliefs as the doctrine of immortality, for example. The opinion that life may be deducible from the properties of protoplasm has, by almost universal consent, been held to involve the admission that the destruction of the living organism is, of *necessity*, the annihilation of life. Yet it seems clear that this deduction is utterly baseless and unscientific; . . . if it be admitted that we find in nature no reason why events should occur together except the fact that they do, is it not clear that we can give no reason why life and protoplasm should be associated except the fact that they are? And is it not equally clear that this is no reason why they may not exist separately?

Those who were with him during long periods of work continued despite illness know his control, those few who saw him seized with bitter pain know his fortitude.

Beneath his passive exterior much went on that rarely came to the surface and he had strong antipathies and emotions held in check by a strong will and philosophical balance. That he could take risks will be recalled by those whom he, as licensed pilot, brought safely into harbor, though the keel of the schooner scraped the bar in the trough of the heavy ground swell.

His stern sense of duty drove him to many tasks he neither liked nor felt he had the natural bent for. His conscientiousness and punctilious regard for justice and honesty brought him into antagonism with many customs and with persons of less sharply defined honesty.

In many excellencies he was a child to whom wisdom of experience had come; his spirit retained the simplicity of the child and a child's interest in the outer world as something apart from self, and did not readily acquire the conventional content with mere getting and eating.

Many have warm hearts for the clear teacher and wise friend who lived much on a higher plane of work and thought, above many petty considerations of immediate expediency. His faults but add to the charm of that large, luminous picture of virtues that the recollection of him calls up in our minds.

Who again will teach us, as Brooks did, that

The hardest of intellectual virtues is philosophic doubt, and the mental vice to which we are most prone is our tendency to assume that lack of evidence for an opinion is a reason for believing something else.[3]

May the Johns Hopkins University treasure as ever living the example of Brooks, the naturalist—one of the two members of her illustrious faculty of whom their great leader, Gilman, said they preeminently were "men born for lives of research." E. A. Andrews

November 26, 1908

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at the Johns Hopkins University, at Baltimore, during convocation week, beginning on December 28, 1908.

American Association for the Advancement of Science.—Retiring president, Professor E. L. Nichols, Cornell University; president-elect, Professor T. C. Chamberlin, University of Chicago; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. J. Paul Goode, University of Chicago.

Local Executive Committee.—William H. Welch, M.D., chairman local committee; Henry Barton Jacobs, M.D., chairman executive committee; William J. A. Bliss, secretary, Joseph S. Ames, William B. Clark, R. Brent Keyser, Eugene A. Noble, Ira Remsen, John E. Semmes, Francis A. Soper, Hugh H. Young.

Section A, Mathematics and Astronomy.—Vice-*president*, C. J. Keyser, Columbia University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Carl E. Guthe, State University of Iowa; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor Louis Kahlenberg, University of Wisconsin; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Geo. F. Swain, Massachusetts Institute of Technology; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

[3] "Science or Poetry," 1895.

Section E, Geology and Geography.—Vice-president, Bailey Willis, U. S. Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor C. Judson Herrick, University of Chicago; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor H. M. Richards, Columbia University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Professor R. S. Woodworth, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Professor G. Sumner, Yale University; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. H. Howell, Johns Hopkins University; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Professor John Dewey, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 31. President, Professor D. P. Penhallow, McGill University; secretary, Dr. H. McE. Knower, The Johns Hopkins Medical School, Baltimore, Md. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 30, 31. President, Professor H. S. White, Vassar College; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28, 29. President, H. W. Tyler, Boston, Mass.; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor E. L. Nichols, Cornell University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 29–January 1. President, Professor Marston T. Bogert, Columbia University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Professor Samuel Calvin, University of Iowa; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—January 1, 2. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor Richard Swan Lull, Yale University; secretary, Dr. W. D. Matthew, American Museum of Natural History, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor John J. Abel, The Johns Hopkins University; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 29–31. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 29–31. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–January 2. Vice-president, Professor H. L. Russell, University of Wisconsin; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 29–31. President, Professor William Morton Wheeler, Harvard University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn. *Central Branch*, December 28–30. President, Professor E. A. Birge, University of Wisconsin; acting secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The Entomological Society of America.—December 29, 30. President, Professor W. M. Wheeler, Harvard University; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor S. A. Forbes, University of Illinois; secretary, A. F. Burgess, Washington, D. C.

The Botanical Society of America.—December 29–31. President, Professor W. F. Ganong, Smith College, Northampton, Mass.; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—December 30, 31. President, Professor L. H. Bailey, Cornell University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Chapter.—President, Dr. T. C. Frye, Seattle, Wash.; secretary, Mr. N. L. T. Nelson, St. Louis, Mo. Address: Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor G. M. Stratton, University of California; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Philosophical Association.—December 29–31. President, Professor Hugo Münsterberg, Harvard University; secretary, Professor Frank Thilly, Cornell University, Ithaca, N. Y.

Southern Society for Philosophy and Psychology.—Convocation week. President, Professor J. MacBride Sterrett, The George Washington University; secretary, Professor Edward Franklin Buchner, The Johns Hopkins University, Baltimore, Md.

The American Anthropological Association.—December 28–January 2. President, Professor Franz Boas, Columbia University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 28. President, Professor Roland B. Dixon, Harvard University; secretary, Dr. Alfred M. Tozzer, Harvard University, Cambridge, Mass.

THE AMERICAN MINING CONGRESS

The eleventh annual session of the American Mining Congress meeting this week at Pittsburgh, Pa., has the following preliminary program:

Addresses of welcome and responses.

Report of Committee on Alaskan Mining Laws, Hon. James J. Godfrey, Seattle, Wash.

Report of Committee on Vertical Side Line Law, Dr. John A. Church, New York City.

Report of Committee on Prevention of Mine Accidents, Dr. H. Foster Bain, Urbana, Ill.

Report of Committee on Protection Against Mining Frauds, Mr. C. J. Downey, Denver, Colo.

Report of Committee on General Revision of

Mining Laws, Dr. W. R. Ingalls, New York City.

Report of Committee on Smelter Rates, Hon. E. A. Colburn, Denver, Colo.

Report of Committee on Investigation of the National Forest Service and its Effects upon the Mining Industry, Colonel A. G. Brownlee, Denver, Colo.

"The Mineral Resources of Arkansas," A. W. Estes, Yellville, Ark.

Annual address of the president, Hon. J. H. Richards.

Reception to delegates and members by the citizens of Pittsburgh.

"Conservation in the Coal Industry. Protection of Life and Prevention of Waste," John Mitchell, Indianapolis, Ind.; G. W. Traer, Chicago, Ill.; J. B. Zerbe, Cleveland, O.; J. V. Thompson, Uniontown, Pa.

"Formal Opening of the Government Stations for Investigation of Mine Explosions," Hon. James R. Garfield, Washington, D. C.; Hon. O. W. Underwood, Birmingham, Ala.

"Brief Statement concerning the Government Work for Greater Safety in Mining" (illustrated), Dr. J. A. Holmes, Washington, D. C.

"Work of the Government of the United States for the Mining Industry," Hon. James R. Garfield, Secretary of the Interior, Washington, D. C.

"Arbitration as a Factor in the Mining Industry," Mr. Thomas L. Lewis, Bridgeport, Ohio.

"The Federal and States Governments in their Relation to the Mining Industry," Senator Charles Dick, Akron, Ohio; Congressman George F. Huff, Uniontown, Pa.; Thos. L. Lewis, Bridgeport, Ohio; George H. Harrison, Columbus, Ohio.

"The Mining Industry as influenced by Transportation," E. H. Harriman, New York City; Dr. James Douglas, New York City; Wm. G. Mather, Cleveland, Ohio; Alexander Dempster, Pittsburgh, Pa.

"The Distribution of the Nation's Mineral Wealth" (illustrated with lantern slides), Dr. George Otis Smith, Director U. S. Geological Survey, Washington, D. C.

"Alaska and Its Mineral Resources," Dr. A. H. Brooks, Chief Alaska Division, U. S. Geological Survey, Washington, D. C.

"Nevada and Its Mining Industry."

"Utah's New Developments in Mining," Duncan MacVichie, Salt Lake City, Utah.

"Mining and the Mineral Resources of Arizona," Colonel Frank Cox.

"The New Mining Industry—The Rare Metals," Dr. Herman Fleck, Professor of Mining Engineering, Colorado School of Mines, Golden, Colorado.

"Secondary Mining Education," H. H. Stoek, editor *Mines and Minerals*, Scranton, Pa.

"The Iron and Steel Industry," Hon. Elbert H. Gary.

"The Mineral Resources of Virginia," E. A. Shubert, Roanoke, Va.

"A Tariff Duty on Zinc Ores," S. Duffield Mitchell, Carthage, Mo.

"The Barren Zone of the Appalachian Coal Field," Dr. I. C. White, State Geologist, Morgantown, W. Va.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

A meeting of the institute is to be held in Pittsburg, December 28 and 29, in the buildings of the Carnegie Technical Schools. Papers of general chemical engineering interest are to be presented; notable among these will be the first technical statement by the inventor, Mr. James Gayley, regarding the process for dehydrating air used in blast furnaces and other metallurgical apparatus. Other papers on the use of fuels and power production are to be presented. The measurement of high temperatures and dryer calculations and dryer designs are the subjects of two other important papers.

One feature of the Pittsburg meeting will be the exhibition by manufacturers of novel plants and machinery, partly by drawing and partly by the actual installation for tests in the presence of the institute. These exhibitions and tests are in no way official in that the institute does not undertake to pass official judgment upon any of the exhibits, and are no more sanctioned or indorsed by the institute than technical papers presented to it would be, but are offered by the manufacturers as a method of acquainting those in charge of manufacturing operations with the latest and best machinery in the various lines.

Such an exhibit, however, should be an increasing source of breadth and education to the members, and the tests and discussions which will inevitably result from the special installation of machinery for this purpose should do much to unify the judgment of chemical engineers on the question of certain classes of apparatus which have hitherto been largely matters of individual opinions.

This meeting will be the first annual meeting of the American Institute of Chemical Engineers, organized last spring in Philadelphia for the purpose of bringing together all those who are particularly interested in the combined application of chemistry and engineering to technical problems. The organizers of the institute, after considerable investigation as to the need of such a society, have made the qualifications for active membership extremely rigid, believing that a very important object of an organization of chemists and engineers (besides meeting for purely social purposes) should be the raising of professional standards among its members. To this end a careful and serious effort is being made to so limit membership that admission to the institute will be in itself an evidence of the standing of its members.

That there was need for some such movement is sufficiently evident by the extent to which fake processes have at times been offered in this particular field. Hitherto chemistry has by the very nature of the phenomena studied, the transformation of matter, presented that element of the mysterious which seems to be important to the successful exploitation of fraud. Numerous patents, which never worked and never could work, have been taken out and sold or made the basis of "Wildcat Companies." Numerous manufacturers have been victimized and it is hoped that in time the Institute of Chemical Engineers may be able to do for the chemical engineering profession what the Society of Civil Engineers has so ably accomplished in its field.

All communications from those desiring to attend the Pittsburg meeting, or from manufacturers who desire to exhibit, should be addressed to the secretary, Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

VOCATIONS OF YALE ALUMNI

THE *Yale Alumni Weekly* gives some statistics from the new quadrennial catalogue of living graduates. It shows that the law holds its own, or nearly so, in the ratio of alumni choosing it even if one goes back far into the expired century or even earlier. In 1797 there were 42 per cent. of Yale graduates in the law. This ratio fell to 33 per cent. in 1802; rose to 36 per cent. in 1813–14; fell to 31 per cent. in 1821–2–4; rose to 32 per cent. in 1831–3–4; and to 33 per cent. in 1841–5. During the last ten years in the academical department there were graduated 2,950 men, of whom 713 (or somewhat more than 24 per cent.) took the law. The choice of law varies much in particular classes. Thus in the class of 1898 it runs up to 31 per cent.; in the class of 1901 it runs down to about 21 per cent. But the average of 24 per cent. in the last ten classes is not strikingly divergent from the ratios of the first half of the nineteenth century.

As was to be expected, the ministry shows a big decrease. It took 39 per cent. of the Yale graduates in 1797; 30 per cent. in 1802; 25 per cent. in 1813–14; 34 per cent. in 1821–2–4; the same in 1831–3–4; and 27 per cent. in 1841–5. The last ten academic classes, with 2,950 men, return but ninety-five ordained or prospective clergymen, or somewhat more than 3 per cent. For the whole university there are but thirty-six more clergymen as compared with four years ago, although during that time the total of living graduates shows an increase of 2,141.

Medicine in 1797 took 8 per cent. of the college graduates; in 1802 the same; in 1813–14 it rose to 14 per cent.; in 1821–2–4 to 20 per cent.; in 1831–3–4 it fell to 15 per cent.; and in 1841–5 to 9 per cent. Among the 2,950 graduates of the last ten years it numbers 162, or about five and one half per cent. Here again appear striking disparities—eight out of 290 men in the class of 1906 taking that vocation, as compared with twenty out of the 305 men in the class of 1903.

Education in the vocations of the academic graduates comes out stronger than any occupation except the law and business. In 1797 it counted 3 per cent.; in 1802 it fell to 2 per cent.; in 1813–14 it rose to 5 per cent.; in 1821–2–4 it was the same; in 1831–3–4 it was up to 10 per cent. and in 1841–5 fell to 8 per cent. During the last ten years it has taken

343, or nearly 12 per cent. of the college graduates.

But it is in the drift to the business vocations that the change comes out most impressively, an index, in a sense, of the familiar materialistic character of the age. In 1797 there were in business 6 per cent.; in 1802 there were 17 per cent.; in 1813 it fell to 12 per cent., to 8 per cent. in 1821–2–4, to 4 per cent. in 1831–3–4, and rose to 12 per cent. in 1841–5. It seems only fair to include under the head of "business," manufacturing and banking (finance), as well as the mercantile occupations. In the last ten classes there are then 1,149 out of the 2,950 academic graduates, or about 40 per cent., in the "business" vocations. A larger number (413) went into "finance" than into mercantile vocations (368).

Out of 7,869 graduates of the academic department now living and including all classes since 1837, only 173 have gone into agriculture and only 112 into art; 890 into education; 231 into engineering; 927 into finance; only ninety-four into the government service; 2,288 into law; 291 into literature, including journalism; 716 into manufacturing; 575 into medicine; 769 into mercantile pursuits; 496 into the ministry; forty-four into specialized science as distinguished from education; 119 into transportation; and only 119 are unspecified.

THE CHARLES WILLIAM ELIOT FUND

A committee of nineteen influential Harvard alumni, including Mr. Alexander Agassiz and Dr. Simon Newcomb, has issued the following statement:

Charles William Eliot, after forty years of faithful and brilliant service, has resigned the presidency of Harvard University.

We think this event should be recognized by some suitable action on the part of the alumni.

With the cooperation of the Alumni Association we invite the graduates of Harvard University, and others who have been connected with it, to subscribe to a fund to be known as the Charles William Eliot Fund, the income of which shall be paid to President and Mrs. Eliot during their lives, and afterwards be used in such a manner as he may designate.

It is especially desired that this fund should be, so far as possible, the gift of all, and the smallest contributions will be as gratefully received as the largest.

Subscriptions, to which no publicity will be given, may be sent to F. L. Higginson, 50 State Street, Boston, Mass.

THE DARWIN CELEBRATION OF THE NEW YORK ACADEMY OF SCIENCES

The investigations and publications of Charles Darwin have had a profound influence upon the progress of science in America as well as in all other parts of the world, but no important memorial of this great naturalist exists in this country. The one hundredth anniversary of Darwin's birth and the fiftieth anniversary of the publication of the "Origin of Species" fall within the year 1909, and the council of the New York Academy of Sciences proposes that these events be suitably celebrated on Darwin's birthday, February 12, 1909, when addresses are to be delivered by members of the academy setting forth Darwin's achievements in different departments of science, and a bronze bust of Darwin is to be unveiled and presented to the American Museum of Natural History by the president of the academy and accepted by the president of the museum. It is also proposed to hold in connection with the celebration an exhibition at the museum of Darwiniana and objects illustrating Darwin's theory of evolution through natural selection and his work in botanical, zoological and geological research.

A Darwin memorial committee to make all arrangements has been appointed as follows: E. O. Hovey, *Chairman;* J. A. Allen, C. W. Beebe, C. L. Bristol, N. L. Britton, H. C. Bumpus, G. N. Calkins, J. McK. Cattell, F. M. Chapman, C. F. Cox, H. E. Crampton, C. B. Davenport, Bashford Dean, A. W. Grabau, W. T. Hornaday, M. A. Howe, J. F. Kemp, F. A. Lucas, W. D. Matthew, T. H. Morgan, H. F. Osborn, H. H. Rusby, W. B. Scott, J. J. Stevenson, C. H. Townsend, W. M. Wheeler, E. B. Wilson.

SCIENTIFIC NOTES AND NEWS

THE Bell Memorial Association at Brantford, Ont., announces that the former homestead of Professor Alexander Graham Bell will be acquired as a public park in addition to the erection of a memorial monument to cost $25,000. This monument will be unveiled in 1910.

DR. GEORGE W. HILL, of Nyack, N. Y., and Sir William Ramsay, professor of chemistry at University College, London, have been elected corresponding members of the Bavarian Academy of Sciences.

M. LOUIS-FÉLIX HENNEGUY, professor of comparative embryogeny in the Collège de France, has been elected a member of the Paris Academy of Sciences.

THE Senate of London University has awarded the Rogers prize of £100 for original research in medical science to be divided between Dr. David Forsyth, assistant physician to Charing Cross Hospital, and Mr. F. W. Twort, assistant bacteriologist to the London Hospital.

WE regret to learn that Dr. Andrew J. McCosh, professor of surgery in Columbia University, has met with a serious accident, having been thrown from his carriage on November 29.

THE Connecticut Academy of Arts and Sciences has appointed Professor Tracy Peck to act as its representative at the Cambridge commemoration of the one-hundredth anniversary of Charles Darwin's birth.

PROFESSOR THEODORE WHITTELSEY has resumed his duties in the department of chemistry of Northwestern University, after a year's leave of absence in Torreón, Mexico, where he has been conducting investigations for the Continental-Mexican Rubber Company on the chemistry of Guayule rubber and of the plant from which it is obtained.

DR. LUDWIG DIELS has been appointed first assistant in the Berlin Botanical Museum to succeed Dr. Robert Pilger, who has been called to Marburg.

AT the first meeting of the Cornell Chapter of Sigma Xi for the present year, held on November 12, President J. G. Schurman gave an informal address on "Research in Universities."

DR. JOSEPH PIRCHER has been appointed vice-director of the Vienna Bureau of Meteorology and Geodesy.

ON November 6, Dr. W. T. Hornaday lectured before the Stamford Scientific Society on "The Home of the Mountain Goat and Grizzly Bear."

THE eighty-third Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Professor William Stirling, M.D., D.Sc,. his subject being "The Wheel of Life." The course, which will be fully illustrated, will begin on Tuesday, December 29, and will be continued on December 31, January 2, 5, 7 and 9.

MR. AND MRS. WALDEMAR JOCHELSON, who were members of the Jesup North Pacific Expedition, were guests at the American Museum of Natural History during October, while making studies of some of the Alaskan material. Mr. and Mrs. Jochelson are on their way to the Aleutian Islands to prosecute ethnological studies under the auspices of the Russian Imperial Geographical Society of St. Petersburg.

DR. A. HRDLIČKA is leaving, in a few days, for a five months' trip to Egypt and Europe, in the interests of the division of physical anthropology of the U. S. National Museum.

THE Rev. T. A. Bendrat, M.S., of Constableville, N. Y., has undertaken an expedition to the Upper Orinoco, intending to penetrate, if possible, as far as its headwaters in order to explore geographically, geologically and biologically an almost unknown tract of country east of Esmeralda.

PRIVAT-DOCENT DR. WILHELM FALTA, assistant in the I Medical University Klinik, Vienna, has recently spent two months at the Nutrition Laboratory of the Carnegie Institution of Washington in Boston, Mass. Dr. Falta obtained a grant from the Royal Academy of Science in Vienna for the specific purpose of studying gas interchange in diabetes mellitus. He also obtained a grant from the minister of culture and education in Vienna for the specific purpose of studying the respiration calorimeter in the new Nutrition Laboratory, with a view to the possible construction and installation of a similar apparatus in the I Medical Klinik in Vienna. Since his arrival in this country, Dr. Falta's intimate knowledge of diabetes mellitus has resulted in his being called upon for a number of addresses before the medical and scientific societies, both in Boston and in New York. Just before leaving for Vienna, he gave one of the Harvey Society lectures in New York City.

In a letter to the Boston *Transcript* Mr. George N. Lovejoy says: "It is extremely difficult to realize the sad termination, in all probability, of the career of Professor Mark W. Harrington, formerly at the head of the astronomical department in Michigan University, and latterly chief of the United States Weather Bureau, Washington. One of the brightest intellects and most successful instructors, whose work as a teacher, not only in this country, but in China, years ago, brought him into prominence among scholars everywhere; whose career, though brief, at Washington was such as to redound to his credit and the honor of the government; a man of rare conversational gifts, an interesting personality, genial at all times, it is hard, indeed, to realize that such an one to-day—as for ten years past—has been an inmate (until recently his identity unknown) of an insane asylum, his mind a melancholy blank."

A Cleveland Memorial Association has been formed, its object being to erect in Princeton a suitable memorial of the late President Cleveland. By contributions throughout the state of New Jersey, a fund of $100,000 is to be collected for this purpose. A general committee of fifty prominent citizens will be in charge of the project, with smaller local committees in each county of the state. Just what form the memorial will take has not as yet been decided.

A marble bust of Hermann von Helmholtz by the sculptor Ernst Herter will be erected in the hall of the Wilhelm's Military Academy in Berlin, where he was student.

The death is announced of Mr. Oliver Weldon Barnes, of New York City, a civil engineer, who had been identified with railroad construction work in various parts of this country for the last sixty years.

Mr. Albert Craw, formerly entomologist under the California State Board of Horticulture, and since 1904 superintendent of entomology of the Hawaiian Board of Agriculture, has died at the age of fifty-eight years.

The foot and mouth disease prevails in twelve counties of the state of Pennsylvania, and has been discovered in the stock yards of east Buffalo. Stringent methods are being used to prevent the spread of the disease. Those whose stock is destroyed will be indemnified, the state making good one third of the loss and the federal government two thirds. The British Board of Agriculture has forbidden the importation of cattle, hay and straw from Pennsylvania, New York and New Jersey. So far as is known this is only the second time the disease has appeared in North America, the first outbreak having occurred in the New England States in 1892.

The International Tuberculosis Exhibit was opened on December 1 in the new northwest wing of the American Museum of Natural History, New York City. Robert W. De Forest, president, and Mayor McClellan delivered the principal addresses. Health Commissioner Darlington, Controller Metz, Professor Henry Fairfield Osborn and Dr. Alfred Meyer made addresses.

The annual meeting and dinner of the American Alpine Club will be held in Baltimore on January 2, 1909, at the time of the winter meeting of the American Association for the Advancement of Science. Members are requested to note the time and place and arrange, if possible, to be present. The Geological Society of America and the Association of American Geographers will also be meeting in Baltimore during convocation week. Interesting reports from members and addresses from distinguished guests will be made.

The subject for the general discussion at the American Philosophical Association meeting, to be held at Baltimore, December 29–31, will be "Realism and Idealism." The speakers will be Professors Royce, Woodbridge, Bakewell, Smith and Calkins.

The lectures to members of the American Museum of Natural History arranged for the present season are as follows:

November 12—William A. Bryan: "Kilauea in Action—A Visit to Hawaii's Famous Volcano." (Illustrated with moving pictures.)

November 19—Frank M. Chapman: "Florida Bird Life." (Illustrated with moving pictures.)

December 3—Henry E. Crampton: "Tahiti and the Society Islands."

December 10—Nathaniel L. Britton: "Some Native Trees, their Flowers and Fruits." (The members of the New York Botanical Garden will be the guests of the museum on this evening.)

December 17—Roy C. Andrews: "Whale Hunting with a Camera."

We learn from the *American Medical Association Journal* that the National Academy of Medicine at Rio de Janeiro celebrated on October 3 the hundredth anniversary of the founding of the medical departments in the universities of Rio de Janeiro and Bahia in Brazil. The session was open to the public, with the president of the academy, Professor A. Nascimento, in the chair. Five gold medals were awarded, one to the president of the republic and one to the minister of the interior, who were both present, the others being given to the deans of the medical faculty at Rio and Bahia. A souvenir volume edited by Dr. F. Figueira was also a feature of the celebration.

The *British Medical Journal* states that on November 14 the twenty-first expedition of the Liverpool School of Tropical Medicine left Bristol for Jamaica. It consists of Mr. R. Newstead, M.Sc., and Dr. W. T. Prout, C.M.G., late Principal Medical Officer of Sierra Leone. Later the expedition will be joined by Dr. A. H. Hanley, C.M.G., late Principal Medical Officer, Southern Nigeria. The objects of the expedition are twofold, as it is partly medical and partly entomological. Dr. Prout and Dr. Hanley will investigate: (1) The prevalence of filaria in Jamaica. (2) The prevalence of malaria in especially malarious districts of the island. (3) Measures for prevention of mosquito-borne diseases where feasible. (4) Preliminary investigation into the so-called "vomiting sickness" amongst children. Mr. Newstead's scheme of work is as follows: (1) To study the bionomics of cattle ticks and advise some methods of control. (2) To undertake the investigation of those scale insects which are at the present moment threatening the citrus and cocoa and cocoa-nut cultivation in the island of Jamaica, and to devise some method of control. (3) To make a collection of the biting flies and ticks of the island for the use of students attending the course of instruction at the Liverpool School of Tropical Medicine. The work of the expedition covers a wide field, and we wish the scientific explorers all success in their enterprise. Sir Alfred Jones, K.C.M.G., chairman of the Liverpool School of Tropical Medicine, entertained the members of the expedition at luncheon at the University Club in Liverpool on November 9.

The names of the 377 foresters, clerks, and stenographers who are to make up the personnel of the United States Forest Service headquarters of the six districts into which the national forests have been divided have just been announced. The district foresters' offices, located in Denver, Colo., Ogden, Utah, Missoula, Mont., Albuquerque, N. Mex., San Francisco, Cal., and Portland, Oreg., opened on December 1. The new field organization of the Forest Service will greatly facilitate the use of the national forests by the people. It will mean that the national forest business which formerly was transacted in Washington will be handled by officers on or near the ground. The establishment of the district headquarters is the culmination of a plan towards which the Forest Service has been working steadily, since it took charge of the national forests. Each national forest district will be in charge of a district forester. The work at district headquarters will be distributed among four offices, operation, grazing, silviculture and products, each equipped with men of special training for the work of their office. The office of operation will be charged with responsibility for the protection of national forests, for the building of roads, trails and other permanent improvements upon them for the organization of the force on national forests, and with the supervision of all business relating to the special use of national forest resources. The office of silviculture will have supervision of the free use and sale of timber from national forests, forest planting upon them, and will conduct forest studies on national forests as well as in cooperation with private owners in the district. The office of grazing will supervise grazing business in the district, except for the actual fixing of allowances, periods and rates, and will make studies looking to the improvement of the forage crop on national forests. The office of products will make both independently and in cooperation with private owners, studies leading to a more profitable use of timber on and off national forests within the district and to their preservative treatment. From the district foresters down, the personnel of the district offices is made up of men picked for their proved capacity, for their thorough training, and for their experience in the west. Most of them are men who not only have worked in the west after they entered in the service, but who lived in the west before they took up the government forest work. Many of them are men who formerly were employed on the national forests and have been promoted to larger responsibilities as a result of their high efficiency.

The decline in price of ingot platinum on the New York market from $38 per troy ounce on January 1, 1907, to $25 per ounce on December 31 of the same year, was accompanied by a notable decrease in production of fine platinum—from 1,439 ounces, valued at $45,-189, in 1906, to 357 ounces, valued at $10,589, in 1907. Of the total output in the later year, 300 ounces came from Butte, Del Norte, Humboldt, Placer, Plumas, Trinity and Sacramento counties, in California, and 57 ounces from Coos, Curry and Josephine counties, in Oregon. In an advance chapter from "Mineral Resources of the United States, Calendar Year 1907," on the production of platinum in 1907, David T. Day, of the United States Geological Survey, says: "The decline in price in the United States increased the feeling of insecurity on the part of the platinum miners as to the value they would secure from their material and rendered the search for platinum less active." The total value of platinum metals imported and entered for consumption in the United States in 1907 is given as $2,684,642—a decrease of $1,104,117 as compared with the value of the imports in 1906. Continued interest is shown in the project for developing the platinum localities in the department of Cauca, Colombia, but development work has not yet reached the point of commercial production. Contracts for practically the entire supply of platinum in Russia have been made for a number of years ahead, and fluctuations in prices have no significance in regard to the total annual output.

Up to the present time Chinese weights and measures have been distinguished by their extraordinary diversity. In nearly every province different standards have obtained, and even in some towns carpenters, surveyors and tailors use measures differing from one another by quite an appreciable amount. A new system has now been introduced, which according to the London *Times*, is defined in terms of the metric system, and the various units are as follows. The new unit of length is the "tchi"; it is defined as exactly 32 centimeters. The capacity table has, as its unit, the "to," which is equal to 10.355 liters; while the unit of weight is the "lian," of 37.301 grams.

UNIVERSITY AND EDUCATIONAL NEWS

An unconditional gift of $50,000 to the endowment fund of the University of Virginia has been made by Col. Oliver H. Payne, of New York.

A gift of $50,000 from Mr. Frederick W. Vanderbilt, of New York City, for the purchase of additional property for the enlargement of Vanderbilt Square, now occupied by the two Vanderbilt dormitories, is announced.

MR. G. H. KENRICK, Lord Mayor of Birmingham, has made a gift of £10,000 towards the funds of Birmingham University. This is his third contribution toward the development of the university, his total gifts amounting to a sum of £25,000.

THE Oakland *Tribune,* as quoted in the Boston *Transcript,* says that President Benjamin Ide Wheeler, of the University of California, is at Ann Arbor and may accept the presidency of the University of Michigan, to succeed Dr. Angell, who wishes to retire. Dr. Wheeler's ten-year contract with California will expire on January 1. His salary at Berkeley is $10,000, whereas it is said that Michigan has offered him $15,000.

BY vote of the corporation Harvard University will remit the regular tuition fees in all its departments for any students, not exceeding five in any one year, who shall be accredited by the Prussian ministry of education as students qualified to pursue advanced studies.

DR. ARTHUR L. DEAN has been appointed instructor in industrial chemistry in the Sheffield Scientific School, of Yale University.

DR. GEORGE DEAN, chief bacteriologist at the Lister Institute of Preventive Medicine, has been appointed to succeed Professor D. J. Hamilton in the chair of pathology in the University of Aberdeen.

DISCUSSION AND CORRESPONDENCE

A REPLY TO THE COMMUNICATION OF MESSRS. LOEB, MAXWELL, BURNETT AND ROBERTSON[1]

THE idea of using temperature coefficients for the analysis of living processes developed in two distinct stages. The first stage was the thought of employing the method whenever chemical reaction was supposed to be the primary cause of a living process. For, if the process were chemical then its velocity must follow changes of temperature as does the velocity of chemical reaction. This was the Cohen-Loeb portion of the idea, as was clearly stated in the present writer's doctor's dissertation on the subject, from which Professor Loeb himself quotes in his search for evidence on his side, and as has been reiterated by him in his "Dynamics of Living Matter" (1906).

The second stage was the thought that if primary chemical action can be detected by comparing temperature coefficients—why then primary physical (non-chemical) action can also be detected by comparing temperature coefficients. This part of the idea was original with the writer, to the best of his knowledge, and was communicated by him as such in a letter to Professor Loeb from Berlin during the winter of 1906–7—a letter to which no reply was ever received. The idea was later published and received its first clear and unmistakable enunciation in April, 1907, in the *Archiv für Anat. und Physiologie,* Physiol. Abt., p. 113, in a paper entitled "Der Temperaturkoefficient der Geschwindigkeit der Nervenleitung."

At no previous time did Professor Loeb or any of his colleagues ever so much as hint to Snyder that they had grasped, to say nothing of having contemplated or having begun work along, this extended line of thought. All the work proceeding from their laboratory up to October, 1907, was, so far as the writer knew, a constant and unswerving effort to obtain chemical reaction temperature coefficients.

However, in a paper, which the writer has never been able to see, until the present writing, it would appear that Professor Loeb did have an inkling of a thought concerning the further application of temperature coefficient determinations. This paper is entitled, "On Chemical Methods by which the Eggs of a Mollusc, *Lottia gigantea,* can be Caused to become Mature."[2] Here the author says that he wanted to find out whether NaOH, by which he succeeded in removing the chorion (ovarian-membrane ?) of the eggs, had a "physical or chemical action."

As the title of that paper implies, he decided it was chemical action, for, in a single case the velocity of maturation was 105 at 18° and 315 at 8°.[3] But from the whole tenor of

[1] SCIENCE, November 6, 1908.

[2] Univ. of Calif. Public., Physiology, Vol. III., p. 1, 1905.

[3] *Loc. cit.*, p. 4.

the article on *Lottia*, and from the fact that nowhere else in the publications from his laboratory—not in Burnett's paper on latent period of cross-striped muscle[4] nor in Robertson's on heart rate in *Daphnia*,[5] nor in the "Dynamics of Living Matter," 1906—from the fact that nowhere else, before the appearance of Snyder's April, 1907, paper, do we find another indication, even so slight as that in the *Lottia* paper, that Professor Loeb had thought of searching directly for *physical* temperature coefficients, it is quite evident that this part of the idea had not yet fully developed and crystallized in his mind.

However that may be, the writer wishes to repeat that, until the present writing he has never had access to the paper on *Lottia*, and was ignorant of the particulars of its contents. He could only quote it indirectly from Robertson's reference,[6] as he did in the *Amer. Jour. of Physiol.*, XVII., p. 350. Robertson, it is to be noted, expressly states that Loeb found the chemical temperature coefficient to hold good in the artificial maturation of *Lottia* eggs, and says nothing about a search for *physical* (non-chemical) coefficients.

On the other hand, the burden of Snyder's letter to Loeb in the winter of 1906–7, and of the entire introduction to his paper, "Der Temperaturkoefficient der Geschwindigkeit der Nervenleitung" (April, 1907), and of the "Comparative Study of Temperature Coefficients,"[7] *was in every case a deliberate and direct search for physical, and not chemical, temperature coefficients.*

This search was a distinct departure from the idea of demonstrating that the 2–3 rule of chemical reaction velocity holds good in living processes, such as is the one and only object in Cohen's "Physical Chemistry," 1901; in "The Dynamics of Living Matter," 1906; in Arrhenius's "Immunochemie," Leipzig, 1907, and in all the papers on temperature velocities which came from the California laboratory up to October, 1907.

As to the short-comings in the "Comparative Study," as already indicated, that paper was ready to print in March, 1907. It was only received back from the Warren prize committee in the fall of 1907; was sent then to the *American Journal of Physiology* for publication, but was refused on account of the great number of tables (20–30 pages). It was likewise returned from the *Journal of Physiology*, Professor Langley saying that its historical part was unnecessarily long and its text, being a compilation of known experiments, rather than description of new, the paper did not come within the scope of his journal.

For that reason the historical part was curtailed as well as nearly all the tables of observations. In that form the paper was received for publication by the *American Journal of Physiology* and appeared there a year and a half after having been written. There was no attempt to bring the literature up to the date of publication. The results of Burnett, Robertson and Loeb were not incorporated because those papers were not accessible to the writer at the time of compiling the "Conspectus." The only attempt to mention later work was in that hasty and unfortunate foot-note, "It is encouraging to note," etc.

That reference was written with the feeling of having been complimented by one whom the writer had always thought of as friend and master—complimented in knowing that whatever his master meant by that paper of October, 1907, yet he too, thought well enough of his pupil's work to repeat it, and verify it.

But, unfortunately, Professor Loeb chose to give that foot-note, which the wording permitted, another interpretation.

And so it happens that the communication in SCIENCE for November 6, last, as the reader will readily see, hinges upon the old question as to the relation between teacher and student.

Had Snyder had a generous master that article would never have been written.

And now since the question is not a question of science at all, but one of ethics be-

[4] *Jour. of Biol. Chem.*, 1906, II., p. 195.

[5] *Biol. Bull.*, 1906, X., p. 242.

[6] *Loc. cit.*, p. 242.

[7] Warren Triennial Prize Contest, April, 1907; International Congress of Physiologists, Heidelberg, August, 1907; *Amer. Jour. of Physiology*, August 1, 1908.

tween physiologists and their students, the writer wishes to suggest that this dispute can best be settled by a competent committee of physiologists.

If there are enough persons really interested in the matter, such a committee can easily be appointed, say, by the American Association of Physiologists. The writer for his part would be quite willing to place his case in their hands and abide by their judgment.

Charles D. Snyder
Johns Hopkins University
Medical School,
Baltimore, Md.,
November 10, 1908

AN ECONOMICAL INSECT BOX

The price of cork-lined insect boxes has always seemed to me to be unnecessarily high. As listed in the dealers' catalogues these glass-covered boxes cost from one to three dollars each, according to the size and finish.

It may be of interest to some of the readers of Science to know that a very satisfactory box may be obtained at about one third of the above price.

While corresponding, recently, with the Jesse Jones Paper Box Co., of Philadelphia, in regard to cardboard museum trays, I asked if they could furnish me with insect cases. The box that they finally made at my suggestion is extremely neat, and will, I believe, prove quite as durable as the wooden boxes that are now sold by the regular dealers in entomological supplies.

The boxes could, of course, be made of any size, but the ones I have are of the larger size, $14 \times 22 \times 2\frac{1}{2}$ inches. They are made of heavy "stock board," which is a very stiff pasteboard about one eighth of an inch in thickness. They are covered outside with black book-cloth, which has a very attractive appearance and does not scratch as does a polished wooden surface. The lid is hinged, and is of glass; it fits closely over a three-fourth inch shoulder. The inside of the box is lined with white glazed paper.

Instead of the expensive sheet cork, the bottom of the box is lined with corrugated paper, such as is used for wrapping glassware. This corrugated paper receives the pins almost as well as does cork, and costs nothing. It may either be put into the box before the glazed paper lining is introduced, probably the better way, or it may be covered with the glazed paper and fastened in with pins or glue, so that it may be removed and recovered when it becomes filled with pin holes. Being covered with white paper, this corrugated paper bottom looks as well as any other.

The only defect of the box is that the lid is not pest-proof. This defect may easily be remedied, when the box is filled, by sealing the lid with a strip of black passe-partout cloth, which will just match the book-cloth covering; the box will thus be made absolutely pest-proof, and there will be no danger of open cracks such as sometimes appear in wooden boxes on drying.

If it be necessary to keep the box unsealed, a moth-ball in each corner will keep out the few pests that might work their way under the lid.

Albert M. Reese
Zoological Laboratory,
West Virginia University

LIGHTS ATTRACTING INSECTS

To the Editor of Science: I should like to inquire through the columns of Science whether any of your readers have had an opportunity of observing the relative efficiency of mercury vapor lights, flaming arc lights using sodium carbons, and ordinary arc lights in attracting insects, especially moths. My experience has led me to believe that an ordinary arc light is a very much stronger attraction to moths than an incandescent light with a carbon filament, even allowing for differences in candle power. It therefore occurred to me that it might be the rays in the blue end of the spectrum which attracted them most. Inside a room moths will always leave a sixteen-candle power incandescent light or a series of them to go to the window as soon as there is any daylight. In the evening they will go to the windows at the approach of twilight and will not leave them for incandescent lights in the room until it is quite dark outside, although it may have seemed much lighter inside than out for some time. Here again the difference may be due to the blue rays which are most conspicuous at twilight. If this hypothesis were correct it would seem natural that the mercury vapor light would be most, the ordinary arc less, and the sodium carbon of the flaming arc least attractive to the moths.

In July when a swarm of brown-tail moths swept over Boston the vicinity would have been a good time to observe the effects of the various kinds of lights. Any information which the readers of SCIENCE could furnish would be gratefully received.

OWEN BRYANT

COHASSET, MASS.

QUOTATIONS

THE AMERICAN UNIVERSITY AND THE COLLEGE PRESIDENT

JUST now, in academic circles, there is a strong disposition to question the necessity and the usefulness of the president in American colleges and universities. It is claimed that this official as now existing is an anomaly in academic development. He is a monarch in what should be a democracy. While our universities are growing at an amazing rate, in wealth, in influence, and in population, the position of the individual professor in the university is not improving. In dignity and in freedom his condition compares very unfavorably with that of his colleagues in Germany or England. It is claimed that one prime cause of this evil condition is found in the exaggerated importance attached to the university president, who holds a monopoly of public attention on the one hand and of academic power on the other. If all authority of the president, and most of that of our boards of trustees were relegated to the university faculty, it is claimed that these evils would disappear.

In this statement there is considerable truth. The university president is an anomaly. He represents a temporary stage in the development of the democracy of science, of the republic of letters. The university as such requires no leader. Its executive should be its servant, and as time goes on scientific eminence will more and more outbalance administrative skill. The university president of the next century, should the title continue, will stand in relations to the university faculty very different from those which now obtain. All this we may admit, but in the institutions of higher education, as they now exist in America, the practical need of a continuous and firm-handed executive can not be questioned. In my judgment the president ought not to stand alone in this responsibility; no appointment in the faculty and no single act of importance, as related to academic work, should be accomplished without the consent and approval of the academic faculty. The president should represent his colleagues in all forward movements. But the initiative should rest somewhere, and as things now are it should rest with the college president. I use the term "college president" advisedly, not "university president." A university actually organized needs no central controlling authority, but a college takes its individuality, its color and its movement from some master spirit. To call our colleges universities does not make them such. To draw the line between "college" and "university," terms which with us still mean the same thing, is now the most important matter in our higher education.

The formation of boards of control, made partly of professors, partly of alumni, and in part of outside business men and men of leisure, as known in England and Australia, is in every way less satisfactory than is the American adjustment at its best. Such boards seldom handle investments to the best advantage, while they are likely to occupy themselves to the more interesting labor of meddling with the individual affairs of the college faculty.

In a university, as finally organized, the professors are equal. Their position in science and in education is assured. They are chosen by their fellows on the strength of well-established reputations. It is not necessary to introduce on short notice a dozen new instructors to meet an incoming class of unusual size.

Such assistants as there are are personal helpers of the professors, below whom there is a great gulf fixed, and administration is divisible among two score heads instead of being centered in one office. Each professor is the head of his own department of *Anstalt,* and quite independent in most of his affairs. He is his own president, and the university is no more than the sum of all its parts.

The American universities are not yet universities. They are destined to become such, but not until as a first step the first two years, the students and the teachers of the junior college are relegated to the high school, or the college. To abolish the president, or to cut off his salary, to change his powers materially, or to find some other type of man, would not affect the case materially, so long as teaching of boys is regarded as university business. This is college business. The college is a cooperating organism far more than the sum of all its parts. It has moral duties, more vital than its duties to research. So long as the institution tries to carry this double function of college and university in the same buildings with the same staff, the present difficulties must persist. In this same period we must bear the double criticism that our professors do not do their part in the advancement of science, and on the other hand that they talk too much of research and give too little attention to mental drill, and to the moral and social development of boys under their charge.

Besides all this, all our universities or colleges are still in process of creation. Not one of them is an existing institution. The president must furnish the initiative, set the pace, mark the color of a growing institution. He must consider relative values, what expenditure of money will count for most in the long run, and the ways and means by which the necessary money can be obtained. The Duke of Wellington once observed that an army may be commanded by a very ordinary man, but "not by a debating society." "An institution is the elongated shadow of a man."

Taking any of our great state universities as an illustration, can we believe that any one of these has reached its final status? Do we not feel sure that every one of these will have in another ten years double the resources, double the equipment, double the prestige it has now? Do we believe that in any case this change would be possible unless the university had the service of individuality in its executive relations? The people pay for the university, and the people in America pay not because the maintenance of universities is a function of government, but from the feeling that the university is doing their work and that there is no better use to be made of their money. The universities on private foundation depend equally on public appreciation, and in equal degree they are forced to appeal to their own public. So long as no single institution of higher learning in America has its permanent form, so long as its administration is a struggle, not a function, so long as we all agree that each school must and should die if it can not progress rapidly and toward some ideal, every college or university will recognize some leader, and this leader will have most of the functions of a college president. This fact will not justify all the things any college president may do, not even most of the things some individuals among them do. Still on the whole their operations have been marked by wise patience and well considered action. We can not do without them yet. No one will look forward more eagerly than they to the time when they and their kind will be found unnecessary in the higher education of America.—President David Starr Jordan in *The Independent.*

SCIENTIFIC BOOKS

Principles of Microscopy, being a Handbook to the Microscope. By Sir A. E. WRIGHT, M.D. (Dublin), F.R.S., Director in Medical Charge of the Department for Therapeutic Inoculation, and Pathologist, St. Mary's Hospital, London, W. Pp. xxii + 250; 18 plates and 97 figures in the text, also a diffraction plate for use in the experiments. New York, The Macmillan Company. 1907.

The distinguished author of this treatise is better known to medical men than to microscopists, using the latter term in its more restricted sense.

As his work, especially upon the "opsonins," has been so largely dependent upon the aid of the microscope he came naturally to appreciate that instrument and to realize the need of a thorough understanding of its possibilities and limitations for the investigator who must enlist its help in his researches.

The keynote of the work is struck in the opening paragraphs of the preface:

> Every one who has to use the microscope must decide for himself as to whether he will do so in accordance with a system of rule of thumb, or whether he will seek to supersede this by a system of reasoned action based upon a study of his instrument and a consideration of the scientific principles of microscopical technique.
>
> The present text-book has no message to those who are content to follow a system of rule of thumb, and to eke this out by blind trial and error.
>
> It addresses itself to those who are dissatisfied with the results thus obtained, and who desire to master the scientific principles of microscopy, even at the price of some intellectual effort.

The book in carrying out the plan just indicated deals with the microscope itself. It is not a work upon animal or vegetable histology with just enough about the microscope to enable the student to know which end of the instrument to look into, and with this to expect the student to elucidate all the complex structure of animal or plant.

Part I., included in the first 48 pages, deals with what the author calls the "stage picture," that is, the object and its illumination. It is shown by abundant and easily performed experiments just what it is necessary to do to prepare and illuminate objects so that they may be visible with the microscope by the so-called dark outline (refraction image) or by coloration (color image). In forecasting the future with respect to the discovery of the causes of diseases such as scarlatina, measles and many other human and animal diseases, he controverts the assumption made by many that the organisms, if they exist at all, are of "ultra-microscopic minuteness" and adds:

> This failure appeals only as an illustration of the rule that micro-organisms (with rare exceptions) remain for all practical purposes invisible and unidentifiable in the interior of the organism until methods of differential staining are discovered which allow of their representation in the stage picture. If we have here, as the present writer believes, the true explanation of the ill success of the bacteriological microscopist in the matter of the discovery of the germs of the diseases specified above, that discovery can not be expected until further progress shall have been made in those comparatively unregarded, but in reality fundamentally important, chemical researches which lead up to the invention of new processes of differential staining.

In Part II., including about 190 pages, the author takes up the formation of images by the microscope and the function of each one of the optical parts or elements involved.

In the first place it is shown that a simple aperture may form an image and that the inversion of the image and the magnification are the same as when a lens is used; but while this is true he proceeds to illustrate, again by abundant experiments, the difference in clearness of the lens-formed image and that of the simple aperture (pin-hole picture). In this study there is shown with admirable simplicity how to determine the aperture and the significance of the same in image formation.

The aberrations (spherical and chromatic) of lenses are illustrated and the methods of elimination discussed, as well as the effects produced by diffraction. It seems to the reviewer that the question of diffraction in microscopic vision receives in this work the most lucid treatment on record; and going with this is the most satisfactory discussion of the relation of microscopic and naked-eye vision. It must be confessed that for the average worker with the microscope it is disquieting to have it impressed upon him that microscopic vision is totally unlike naked-eye vision, as is done in many works and papers upon the subject. Just where the break comes in between naked-eye vision and that with spectacles, the simple or the compound microscope, no one has determined. That diffraction plays an important rôle in high-power work with the microscope no one will deny. This author gives it its true value in microscopic vision, connecting all vision together instead of making a violent change somewhere.

In this work the statement is frequently reiterated that the eye of the observer forms a part of the optical apparatus, being in this respect in refreshing contrast to those that ignore the eye in dealing with the microscope. The author takes up every other difficult question relating to the microscope, as angular and numerical aperture, dark-ground illumination, the production of critical images, the limitation of microscopic vision propounded by Helmholtz and others, and each subject is simplified.

With reference to the Helmholtz theory of the limitation of resolution in microscopic vision, the statement or formula of Helmholtz is cast in a form familiar at present in microscopical optics and is shown to be $0.6\,\lambda/\text{N.A.}$, that is, the wave-length of the light used multiplied by 0.6, and this divided by the numerical aperture (N.A.) of the objective will give the limits of visibility. Numerous examples are given showing that this theoretical limit is very close to the actual limit with the best modern microscopes as ordinarily used. The point is not yielded, however, without showing a possible escape from the apparent restrictions. In dealing with high magnifications he says:

> The three impediments to resolution just referred to are: (*a*) diffusion, (*b*) conspicuous antipoint and (*c*) obfuscation in the eye.

He shows that all these defects are directly referable to the contraction of the beam incident to high magnifications, and that the only way to escape these limitations is to increase the aperture or, as he puts it, "to open up the terminal beam." He then considers the method of Gordon by which the terminal beam is widely opened by means of a disc of ground glass placed at the level of the diaphragm in the Huygenian ocular, that is, at the level where the real image is formed. This real image is then observed by a second, low-power microscope. To avoid the obscurity given by the grain on the ground glass the latter is rotated.

It is stated that by this means Mr. Gordon has shown repeatedly before the Royal Microscopical Society objects under "magnifying powers of 10,000 diameters and over," the retinal image being free from obfuscation and conspicuous antipoint. To enforce the argument and to show the reader the appearance with and without the opening up of the terminal beam, Plate XVIII., with five photographs, is given, illustrating in the most striking manner the points mentioned in the text.

This book is beautifully printed and its numerous figures really illustrate the text. In a word it is the clearest and most authoritative exposition of the microscope and its accessories and the interpretation of microscopic appearances to be found in any single work. It is sincerely hoped that it will speedily find its way into the hands of teachers and advanced students.

S. H. G.

Selectionsprinzip und Probleme der Artbildung. Ein Handbuch des Darwinismus. Von Dr. Ludwig Plate. Dritte, sehr vermehrte Auflage, mit 60 Figuren im Text. Leipzig, Engelmann. 1908. Pp. viii + 498.

That Plate's work on the principle of selection and the problem of the origin of species should in eight years have passed through three editions is welcome evidence that the reading public appreciates a good biological treatise; that it should in the respective editions pass from 153 pages and 247 pages to over 500 pages with illustrations is evidence both of the great recent growth of contributions to the subject and of Plate's enterprise in following them up.

The principal additions to this last edition consist of a brief review of Darwinism, a discussion of Darwin's and de Vries's views of the rôle of individual variation; an extension of the section on "Sprungevolution"; a consideration of a new objection to Darwin's principle of selection, viz., that selection can not be demonstrated in detail; additional consideration of the forms of the struggle for existence and selection; de Vries's mutation theory; a new section on "Heredity" (in former editions omitted, singularly enough, as a presupposition of selection); an extensive enlargement of the section on variation, and a thorough revision of the final chapter—"the applicability and limitations of the Darwinian and Lamarckian factors." Through these additions the book has been doubled in size and value.

The greatest interest naturally attaches to the author's position on the newer questions of the day relating to mutation and heredity—questions that were merely shaping themselves at the time the second edition was written, four or five years ago. In regard to the theory of saltation, which is considered historically in a thorough fashion, the author concludes that, on account of their rarity and their prevailingly pathological character, saltations have only the significance of exceptional phenomena not properly to be considered as playing the part of making variations that are, on account of their size, directly of selectional value.

As for the mutation theory, which the author treats quite separately from saltation, he concludes—after a valuable summary of de Vries's work—that it is a modified theory of selection from which the idea of the inheritance of somatic variations has been eliminated. At the outset Plate calls attention to the fact that de Vries has not only applied the name mutation in a new (and ill-defined) sense, but has used the term "fluctuating variability" in an opposite sense from Darwin; since for Darwin[1] fluctuating variability is the ordinary inheritable variability as opposed to "definite variability" resulting from direct action of changed conditions and commonly regarded as non-inheritable; while for de Vries fluctuations are due to variations in nutrition and so fall into Darwin's category of "definite variations." Using for the present de Vries's terminology, the type of mutation is that of *Œnothera lamarckiana*, in which a number of characters change simultaneously to produce each of the mutants. Unfortunately this type case is an exotic in Amsterdam, where its mutability was first discovered, is unknown in the wild state and is very probably a hybrid. In any case the proportion of mutants produced is small, they lack adaptive features, and, in general, mutation is a rare phenomenon. In consequence of all these reasons mutations can play little part in nature. Plate opposes the extension of the term mutation to cover saltations and fluctuations in Darwin's sense (the ordinary variation of single characters), and so leaves it reduced to its lowest limits and shorn of any great significance. This treatment strikes the reviewer as not altogether just. De Vries's theory deserves more credit at least for this that it stemmed the tide of exclusive attention to quantitative variation that was threatening to obliterate the study of the origin and inheritance of new characters; *i. e.*, variations of the qualitative order; it stimulated a study of the origin and inheritance of variations by the method of experiment.

The section on heredity contains two principal parts: The first deals with the inheritance of acquired characters, the second with Mendelism. As for the first the author accepts as demonstrated the inheritance of the effects of heat, light, etc., on insects, fishes and plants; he lays stress on the difference of pigmentation on the two sides of the flounder—a difference which, while associated with the different exposure to light of the two sides of the body in the adult, begins to appear before the young fish abandons its vertical attitude in the water. He regards as critical Semon's investigations upon the seedlings of sensitive plants which, without having experienced the alternation of daylight and darkness, nevertheless show an innate tendency to open their leaves for twelve hours and shut them (for sleep) during the alternate twelve hours. He cites the loss of pigmentation of cave animals as evidence of the transmission of a somatic character to the germ plasm, but fails (the reviewer believes) sufficiently to appreciate the evidence for an orthogenetic tendency in these cases toward loss of pigment.

[1] "Variation of Animals and Plants under Domestication," chapter XXVI., summary.

Some of the best evidence on the inheritance of acquired characters has been too recent, perhaps, for consideration in this edition. Unless we are much mistaken in the next edition this section will chronicle the greatest advances in the theory of evolution.

As for Mendelism the treatment given by Plate is all too brief, though appreciative. He entertains the view that the Mendelian result follows between closely related individuals but not between distinct species; between the latter the characters blend. This conclusion seems to the reviewer insufficiently founded; the cross between a goldfinch and a canary shows in the first generation no more blending of characters than that between two races of canaries. The method of inheritance probably depends less on the degree of relationship of the individuals crossed than upon the nature of the characters concerned.

Of the book as a whole one can speak only in praise. Notwithstanding its conservative attitude, it affords, in the reviewer's opinion, the best general résumé extant of modern evolutionary data and theories; there are other excellent résumés but, for the most part, now out of date. How quickly a book on this topic may become out of date is indicated by the growth of the bibliography in the successive editions of Plate's book. In the first edition there were about 210 titles; in the second, 260; and in the last 450. The new edition will be widely read, but it deserves the greater accessibility that an English translation would give. In any case it seems well adapted to hold its ground, for some time to come, as the standard treatise on Darwinism.

Chas. B. Davenport

The Fossil Turtles of North America. By Oliver Perry Hay. Carnegie Institution. Pp. 568, pls. 113. 1908.

The appearance of Dr. Hay's extensive and richly illustrated memoir upon the fossil turtles of North America will mark a new departure in the study of this important and interesting order of reptiles. A bulky volume of nearly six hundred pages and over one hundred plates, aside from the numerous text illustrations, it will enable the student, for the first time in many years, to understand and appreciate the material at his command, for there are few collections of extinct vertebrates in America which do not have some remains of turtles. We may now expect a rapid increase in our still very defective knowledge of these animals, since but very few of the 276 species described in the present work are completely known; indeed, much the larger part are yet imperfectly known. The author, after the examination of nearly all the types, as well as most of the known material in America, has systematized and correlated our present knowledge so that the work will serve as the basis of the literature for future studies.

The reviewer has read attentively the extended and detailed introductory parts of the volume on the structure, classification, geographical and geological distribution and evolution of the Testudinata, and for the most part has only commendation and approval. But he can not approve the classification that Dr. Hay adopts. The division of the order into two chief groups or suborders, the Athecæ and Thecophora, first proposed by Dollo and Cope, has been carried to an extreme by the author, in that he would have the former a primitive branch from the testudinate stem, arising in early Trias or late Permian, and all its aquatic adaptations and chelonid resemblances purely of parallel origin; an hypothesis difficult to accept. He assumes that the primitive turtles possessed two dermal coverings, an inner represented by the carapace and plastron of ordinary turtles, an outer persisting in *Dermochelys* of the present time; that, in all other turtles, the outer has been wholly lost save a few ossicles in *Toxochelys*, while in the latter only vestiges of the inner covering have persisted. Such a development of an outer dermal covering is not impossible, as evidenced by osseous scutes overlying the dermal clavicles in certain lizards, yet one can hardly conceive of a condition in the early reptiles which would bring about the concurrent development of two coverings; certainly we have no warrant in calling the inner carapace or any part of it "fascia bones"; they must certainly have arisen as purely dermal, membrane bones, and must have preceded the development of an outer layer. And one can not understand why such ossicles might not have developed, under the stress of peculiar environmental conditions, in the aquatic turtles after the loss of the true dermal carapace. Furthermore, this phylogeny seems yet to be based almost wholly on hypothesis, for we have little evidence of such a primitive condition, save that possibly afforded by the neural ossicles of *Toxochelys*. Here, too, it seems to the writer the argument is against the hypothesis, since the more specialized aquatic *Toxochelys* has the neural ossicles, while the nearly related, and less aquatic *Porthochelys* is without them.

The usual suborders, Cryptodira, Amphichelydia, Pleurodira and Trionychoidea are made superfamilies by the author, and, so far as the Trionychoidea are concerned at least, the writer agrees with him under any classification.

Dr. Hay recognizes the difficulty in deriving the turtles from any except the most primitive of reptiles; in other words, the order represents a phylum all its own in the evolution of the reptiles, a view first offered by Cope, with which the present writer is wholly in accord.

From his wide and accurate acquaintance with the literature of American fossil vertebrates it would be expected that little has escaped the author's attention; but he is not infallible. He expressly states that no fossil turtles are known from the Dakota Cretaceous, overlooking the fact that only a few years ago (1899) a very interesting specimen from that formation was described and figured by Parmenter in the *Transactions of the Kansas Academy of Science;* and it is to be regretted that he did not examine and describe the remains of a large marine turtle from the Benton of Kansas now in the University of Kansas Museum, to which attention was called six years ago by the present writer in the *Kansas University Quarterly*. However, such omissions will be found to be very rare in the work, and are not disquieting.

The illustrations are for the most part good, especially the text figures, of which there are over seven hundred. The Carnegie Institution is to be congratulated on the publication of this valuable and useful work.

S. W. Williston

The Study of Stellar Evolution. By Geo. E. Hale. Pp. xi + 252; 104 plates; 7 text-figures. University of Chicago Press. 1908. Price, postpaid, $4.27.

The past quarter of a century has witnessed a complete revolution in the conception of astronomy and of an astronomical observatory. The astronomy of twenty-five years ago was the science of position and of motion. The problems which then confronted the investigator were those concerning the size and shape of the planets, their distances from the sun, the periods of time in which they complete their orbits, and the discovery and explanation of the laws which govern their motions. The solution of these problems requires the precise measurement of the positions of the various bodies in the heavens at frequent intervals covering long periods of years. The old observatories were built and equipped with this end in view; the fundamental instruments were the meridian circle and the clock. The chief use of the equatorial was to measure the position of objects too faint to be seen with the meridian circle. Photography and spectrum analysis, as applied to astronomy, were beginning to obtain recognition, but were hardly regarded as the work of a "simon-pure" astronomer.

To-day this is changed; the astronomer is concerned not so much with the position and motions of the bodies, as with their physical characteristics; he wishes to know what they are, not where they are; from what they developed and what their future life history will be, rather than the exact path through space which they have traveled and are traveling. To solve these problems an astronomer to-day must be a physicist and a chemist, as well as a mathematician. The simple observatory of the past has become a great complex laboratory, in which the spectroscope of the physicist, and the electric furnace of the chemist are of almost equal importance with the telescope.

Professor Hale, in this most interesting volume, describes the new type of observatory and explains the work of a modern astronomer and the problems which confront him. From his great experience in designing and equipping two great modern institutions of astronomical research—the Yerkes and the Mount Wilson observatories—Professor Hale has drawn freely for concrete illustrations of the difficulties which confront the student of stellar evolution. He shows how the feeble rays of light from a scarcely visible star are gathered together by the giant lens or mirror of the telescope and brought into a physical laboratory, where they are analyzed by the spectroscope, and forced to reveal the secret of the star's evolution.

The book is essentially a popular treatise; it was planned as a handbook to the Yerkes Observatory. It is non-technical, readable and gives a clear explanation of the purposes and observational methods employed by the author in his notable researches upon the sun and the chemistry of the stars. The book is discursive, however: the problems are treated individually, without showing clearly their interrelation and their bearing upon the general problem of stellar evolution. But the work was not intended as a scientific presentation of the subject; it was planned for the general reader, not for the investigator. The illustrations, from photographs taken principally at the Yerkes and Mt. Wilson observatories, are very beautiful, but are, if anything, rather too numerous.

Charles Lane Poor

ACTION OF THE RADIUM EMANATION ON SOLUTIONS OF COPPER SALTS [1]

A year ago Messrs. Ramsay and Cameron announced in several journals that they had observed the formation of the alkali metals and of lithium in solutions of copper salts which had been subjected to the action of the radium emanation. They concluded that the metal copper was *degraded,* in the presence of the emanation, into elements of the same series having lower atomic weights: potassium, sodium, lithium.[1]

These important results attracted a great deal of attention and it seemed desirable to repeat the experiment in laboratories possessing a sufficient quantity of radium. The experiment to be repeated was as follows. A solution of a copper salt (sulphate or nitrate) was placed in a small glass flask into which was introduced a large amount of the emanation and this was allowed to decay spontaneously. The copper was then removed, the resulting solution was evaporated to dryness, and the residue examined. The same processes were performed with a solution of the same copper salt which had not been subjected to the action of the emanation. The experiments were repeated several times. The residue consisted chiefly of sodium salt (with a small amount of potassium and calcium). In the four experiments described, in which the emanation acted, lithium was detected by means of the spectroscope. In the blank experiments there was much less residue and the presence of lithium could not be detected. Messrs. Ramsay and Cameron made one experiment to determine the quantity of lithium observed and they estimate the presence of about 0.00017 milligram in the residue which weighed 1.67 milligrams, the amount of copper taken being 0.27 g. (0.815 g. copper nitrate). In the corresponding blank experiment the residue was only 0.79 milligrams.[2]

We have tried to reproduce the results under conditions as free from error as possible. The experiment is a delicate one and there are several sources of error, chief among them being the use of a glass vessel as Mr. Ramsay himself remarks.

[1] Translated from the paper by Mme. Curie and Mlle. Gleditsch, *Comptes rendus,* **147**, 345 (1908).

[1] *Nature,* July, 1907; *Jour. Chem. Soc.,* September, 1907; *Comptes rendus,* 1908; *Archives de Genève,* April, 1908; etc.

[2] This quantity of metallic lithium does not check with the value indicated by the mixture of sodium and lithium salts which was taken as a comparison. There must be some error of calculation which we have not been able to locate.

Our preliminary experiments showed that it was very difficult to obtain chemical reagents which contained no lithium. We found it in the distilled water and in nearly all the reagents. If there were none in any reagent, it was only necessary to leave the reagent for a little while in a glass vessel; after some time, traces of lithium could be detected. The following experiment was made: When water has been distilled from a platinum retort and has been kept in a platinum flask, it leaves no visible residue when 250 c.c. are evaporated in a platinum dish; and the last drop, when thus concentrated, does not show the spectrum of lithium. But if water, prepared in the same way, is kept for twenty-four hours in a glass vessel, we find, on evaporation, a small residue consisting chiefly of a sodium salt but containing also a trace of lithium.

It seemed to us essential to replace glass by some other material. We have established that it is just as dangerous to use quartz, the material actually employed by Mr. Ramsay. The commercial quartz vessels contain lithium. Hydrofluoric acid containing no lithium was allowed to act on the fragments of an opaque quartz crucible and on a piece of a transparent quartz tube. In the residue there could be detected a notable quantity of lithium, and there was a good deal more of it in the transparent quartz than in the opaque quartz. We then decided to use platinum vessels.

The apparatus which we used consisted of a cylindrical platinum vessel, 7.5 cm. in length and 1.5 cm. outside diameter, placed horizontally. At one end of the vessel was a small vertical platinum tube through which we could introduce the solution. The small tube had a platinum cover which protected the solution but which did not make a tight joint. A glass tube, with a side-arm and a stop-cock, was fastened on the outside of the platinum tube. The solution was introduced into the apparatus by means of a platinum siphon and never came in contact for a moment with the glass of the apparatus.

The water and the acids necessary for the experiment were redistilled in platinum retorts and were kept in platinum bottles. We found that all these reagents originally contained lithium, especially the sulphuric acid. After purification lithium could not be detected in the residues obtained by evaporating 80 c.c. of nitric acid, 25 c.c. of sulphuric acid, 25 c.c. of hydrofluoric acid and 250 c.c. of water.

As Mr. Ramsay himself points out, the so-called chemically pure salts of copper contain notable amounts of lithium. We have tried different methods of purification: repeated precipitation by hydrogen sulphide; electrolytic precipitation of copper; fractional crystallization. We have finally made use of copper sulphate which had been re-crystallized a number of times in a platinum dish, each solution being made up with pure water. At first this treatment is very effective; but it is very difficult, if not impossible, to remove the last traces of lithium. When we stopped further purification we could just manage to show the presence of lithium in the residue resulting from treating 50 g. of copper salt; but we could not detect its presence at all in the residue resulting from the treatment of 2 g. of salt.

The emanation was furnished by a solution containing 0.19 g. of radium (0.25 g. $RaCl_2$). It was first condensed in a condenser immersed in liquid air and then drawn over into the apparatus. In order to know accurately the amount of emanation introduced, we compared the penetrating radiation of the apparatus with that of a flask containing a known amount of radium. To do this we used a specially-prepared condenser having very large plates.

Two exactly comparable experiments were made. We introduced into the apparatus about 7 c.c. of a pure copper sulphate solution; the liquid had a large free surface relatively to its volume. The apparatus was sealed with a blow-pipe. The emanation was introduced in several lots; to ensure its dissolving, the solution was shaken by tipping the apparatus in its bath of melting ice. This operation was repeated a number of times. The amounts of metallic copper taken were 0.269 g. and 0.14 g. The total amount of emanation introduced was equivalent in both cases to the saturated emanation from 0.37 g. of radium. The quantity of emanation which was effectively destroyed in the apparatus was a little less and was equivalent to the saturated emanation from 0.27 g. of radium. When the experiment was considered finished, the solution was transferred from the apparatus into a platinum crucible and a few drops of nitric acid added. Into this same crucible we dipped a piece of platinum foil on which we deposited the copper. When the solution was freed from copper, it was evaporated to dryness in the crucible and the latter was heated just enough to drive off the sulphuric acid. The residue was dissolved in a few drops of water and treated with hydrogen sulphide to remove the last traces of copper still remaining. The liquid was filtered through a platinum filter into a platinum watch-glass of known weight and was evaporated to dryness at a very moderate temperature. The minute residue was weighed.

The same treatment was applied to 7 c.c. of a copper sulphate solution which had not been subjected to the action of radium. The final residues were examined spectroscopically. Their weights were 0.0004 g. and 0.0005 g. in the real experiments, 0.0003 g. and 0.0002 g. in the blanks. It is to be noted that the amount of copper taken is very close to that used by Mr. Ramsay. The amount of emanation consumed is also approximately the same (1.85 $mm.^3$ in Mr. Ramsay's phraseology). In spite of this, the residue finally obtained is much less.

The spectroscopic examination showed that the residue consisted chiefly of sodium with a little potassium; the presence of lithium could not be established. An experiment with a mixture of sodium and lithium sulphates showed that we could detect, though only with difficulty, the presence of one part of lithium sulphate in ten thousand parts of sodium sulphate. With the same ray it was easy to detect one part of lithium sulphate in three thousand parts of sodium sulphate. Consequently the amount of the metal lithium which could be present was less than 0.6×10^{-5} milligrams.

With the same amounts of copper and of emanation, Messrs. Ramsay and Cameron found 1.7×10^{-4} milligrams of lithium. If there is an error in calculation and this number refers to lithium chloride, there would still be 3×10^{-5} milligrams of metallic lithium.

The residue which we obtained was in each case much less than that obtained by Messrs. Ramsay and Cameron and this difference is probably due to our not using glass vessels. The difference in the weights of the residues obtained by us in the real experiments and the blanks is very small (0.1 to 0.3 milligram). The difference is probably due to the introduction of traces of foreign substances into the apparatus along with the emanation. In the most reliable experiment of Messrs. Ramsay and Cameron, the same difference is 0.88 milligram and we believe that this is due to the solution attacking the glass more vigorously in presence of the emanation.

The following check experiment was made. Into a copper sulphate solution containing 0.27 g. of copper we introduced an amount of lithium sulphate corresponding to 1.7×10^{-4} milligrams of LiCl; this solution was then treated in the same way as in the other blank experiments. In the residue finally obtained it was very easy to see the red ray of lithium. This shows that the lithium was not eliminated by the treatment adopted.

To sum up, we must say that we have not succeeded in confirming the experiments of Messrs. Ramsay and Cameron. It is evidently impossible for us to say that no trace of sodium or lithium is formed during the experiment. We believe, however, that the formation of these elements can not be considered as an established fact.

SPECIAL ARTICLES

MOMENTUM EFFECTS IN ELECTRIC DISCHARGE

In the issue of July 17 a partial report was made of experiments on electric discharge around a right angle in a wire. Since then some of the methods have been modified, and additional results have been reached.

In all of the work thus far, an eight-plate static machine has been used. It may be driven by hand or by a motor. Sparks from four to eight inches long are taken from the two terminals into parallel conductors having high resistance. These resistances consist of long, thin strips of cloth moistened with salt solution. These lines spark to ground contacts, which are about fifty feet apart, in the yard outside.

A thin wire is bent into a series of sharp right angles. This wire may be looped into either the positive or the negative line. Photographic plates inclosed in hard rubber holders are placed at these angles. Some of them are exposed to the wire on the ground side of the angle, and some on the machine side. Their distance must be so adjusted that they give symmetrical results when the spark discharge around the angles is reversed.

With the negative discharge the plates on the ground side of the angles are much more strongly fogged than those on the machine side. Negative electrons having a mass of about one one-thousandth of that of the hydrogen atom leave the wire at the angle, because they can not turn the corner. They pass on through the cover of the hard-rubber holder, which may be three sixteenths of an inch thick, and fog the plate, which is developed in the ordinary way. These particles have momentum. They have energy of motion. They are a component of matter, as is well established by radio-active phenomena, and by well-known electrical experiments.

When the wire having these angles is looped into the line from the positive side of the machine this effect is also observed, but it is very much feebler. With a cover to the holders one sixteenth of an inch thick, 9,000 spark discharges in the positive line produce about the same intensity of image as is obtained with a single spark in the negative line. And here the effect is vastly stronger on the machine side of the angle than on the ground side. The negative electrons are therefore doing the work in the positive line also. They flow through this line from the ground to the machine. But they are not forced in under pressure, as they are forced out from the machine on the negative line. It is these little particles of negative electricity which constitute the electric current. They have kinetic energy which they impart to the conductors through which they are beating their way. In an arc light they plunge across from the negative carbon to the positive carbon. Their impact upon the positive carbon results in the formation of a crater which is intensely heated. About 85 per cent. of the light comes from this crater in the end of the positive carbon, which is, as has long been known, more than 1,000 degrees centigrade, or 1,800 degrees Fahrenheit, hotter than the negative carbon.

In order to obtain the results here described electrical oscillations must be prevented. This is attained by means of the moistened strips of cloth. When this has been accomplished the sparks are large and brilliant at the negative end in both positive and negative lines, and thin out towards the positive end. The negative terminals are large spheres of about 10 cm. diameter. The positive terminals are small knobs, of about 1 cm. diameter. While on the large spheres the electrons repel each other. But when they start into motion across the spark-gap, they attract each other electromagnetically. This appears to be the reason why the spark thins out as the electrons proceed in their motion across the spark-gap. A "fat" spark is a sure indication of an oscillating discharge.

The fact that sharp shadow pictures are formed of any thin object like a glass slide lying on the photographic film under the wire, shows very clearly that these effects are due to a cathode discharge. Whether or not X-ray effects are also involved, is still an open question.

Arrangements are now being made to place the angle-wire in a vacuum tube. This may perhaps render these momentum effects visible.

Francis E. Nipher

SPINAL SHOCK: A PRELIMINARY NOTE

A few months ago, the writer, in conjunction with Professors G. N. Stewart and C. C. Guthrie, stated his belief that the cause of spinal shock lies solely in the interruption of the long conduction pathways of the spinal cord.[1] Experiments which were then in progress have been extended until still more of the details of spinal shock following anatomical transection of the cord have been duplicated (1) by the method of cerebral anemia described in the paper cited, and elsewhere, and (2) by freezing the spinal cord with a spray of ethyl chloride or by the direct application of liquid air. Freezing the brain as a means of stopping the reflexes was probably first done by Professor D. J. Lingle (unpublished experiment on frog). Practically all of the effects observed after anatomical rupture of the conduction pathways may be observed when either of the other methods is employed, if the time limits be kept the same when comparing the results of the different methods. We called attention in a previous paper to the fact that strychnine spasms might appear immediately after the beginning of cerebral anemia, or at any time during which the reflexes of the skeletal muscles are absent. I have since shown that, in a curarized animal, strychnine does not cause the return of vaso-motor reflexes in "shock" sooner than they would appear under the usual conditions of the experiment.

The evidence for my views, drawn as it is from a laborious study of the phylogenetic development of the function as well as the structure of the central nervous system, can not be presented here. Nor is this the place to develop my hypothesis of the return of the reflexes after interruption of the long pathways, which depends upon facts of the same nature. Both hypotheses will be developed in detail in later papers. It will be sufficient to point out here that, in my opinion, the real problem is to explain the return of the reflexes after injury to the brain or spinal cord, and that a simple solution to both problems lies in the application of the general principles of organic evolution to function as well as to structure.

F. H. Pike

Hull Physiological Laboratory,
The University of Chicago,
November 10, 1908

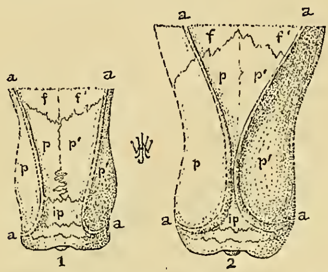
[1] Pike, Guthrie and Stewart, *American Journal of Physiology*, 1908, XXI., p. 359. See, also, Rosenthal and Mendelssohn, *Neurologisches Centralblatt*, 1897, XVI., 978.

A NEW SPECIES OF THE GENUS MOROPUS

Since the fall of the year 1904 the Carnegie Museum has carried on extensive excavations in a quarry near the Agate Spring Stock Farm on the Niobrara River in Sioux County, Nebraska. The work has resulted, among other things, in the recovery of an almost perfect skeleton of an adult specimen of *Moropus elatus* Marsh, which will shortly be mounted and exhibited, and upon which the writer intends in the early winter to publish a memoir giving a full account of the osteology of this great mammal. Among the material collected are a number of bones representing the remains of another species of the same genus to which, in honor of my esteemed colleague, Mr. O. A. Peterson, I propose to apply the name *Moropus petersoni.* A more detailed description, accompanied by figures and plates, will be published in the forthcoming *Memoir.* For the present I content myself with the publication of a brief diagnosis wherein are pointed out some of the differences which distinguished this species and permit of its separation from *Moropus elatus* Marsh.

Moropus petersoni, sp. nov.

Adult. Considerably smaller in size than *Moropus elatus.* The dentition, so far as ascertained, does not materially differ from that of the larger species. The top of the cranium is not, however, characterized by a sagittal crest as is the case in *Moropus elatus.* In order to understand the difference between the two species the accompanying somewhat diagrammatic figure, representing the posterior portion of the top of the skull of the two species, is given. It will be seen that the narrow elevated ridges marked *aa* do not converge on the median line in *Moropus petersoni* as they converge upon the skull of *Moropus elatus.* It will further be observed that the interparietal bone *ip* in *Moropus petersoni* is quadrate in form, whereas in *Moropus elatus* it is subtriangular in form. The cervicals in *Moropus petersoni* are less massive; the fore limbs are proportionately slenderer; the scapula is relatively longer and narrower than in *M. elatus*. The lateral transverse process of the fifteenth dorsal is simple at its outer extremity and does not form an oblique plate



Diagrammatic view of upper back part of skulls of (1) *M. petersoni*, (2) *M. elatus*. *aa*, superior ridges; *pp'*, parietals; *ff'*, frontals; *ip*, interparietal.

of bone projecting downward and backward and perforated by a large foramen, as is the case in the corresponding vertebra in *Moropus elatus*. The prezygapophyses of the anterior lumbar vertebræ in *M. petersoni* more closely resemble those of the preceding dorsals and are not as distinctly lumbar in their character as is the case in *Moropus elatus*. The prezygapophyses of the posterior dorsals all look more decidedly upward in *M. petersoni* than they do in *M. elatus*, and their anterior extremities are relatively far more widely separated from the superior margin of the centrum. The general structure of the feet is the same as in *Moropus elatus*, having four toes in the fore foot, the outer toe being obsolescent, and three toes on the hind foot; but the feet are slenderer and the bones not nearly so massive as in the larger species.

The type specimens representing the species are contained in the Carnegie Museum and are in part the series of bones to which have been attached in the Carnegie Museum Catalogue of Vertebrate Fossils the numbers 1703A (cervicals), 1703B (anterior dorsals), 1703C (posterior dorsals and lumbars), 1700 (mounted hind limb and pes), 1701 (a mounted fore limb and manus), 1707 (a partially restored skull).

Associated with the skull as a paratype may be mentioned the upper posterior part of a cranium of a skull designated by the figures H. C. 133, kindly loaned to the writer for study by Mr. Harold Cook. Professor E. H. Barbour in Volume III., Part 2, of the Geological Survey of Nebraska (Fig. 2) has represented a fragment of the posterior part of the skull of an immature specimen of *Moropus petersoni*, without naming it.

W. J. Holland

Carnegie Museum,
November 13, 1908

AN ELECTRICAL RESISTANCE METHOD FOR THE RAPID DETERMINATION OF THE MOISTURE CONTENT OF GRAIN[1]

The shipping and storing qualities of grain are so dependent upon its moisture content that an accurate knowledge of the moisture in grain in storage and transit is highly desirable. This subject has been given special attention by Brown and Duvel,[2] who have described a rapid method of making such moisture determinations. Their method consists in boiling the grain in an oil having a flashing point much above the boiling point of water, condensing the water which distils off, and collecting and measuring it in a suitable graduate. Moisture determinations can, by this method, be made in about one half hour, whereas determinations in the water oven require several days. This method is, however, suitable for laboratory use only, necessitating the collecting of samples before the determinations can be made, and does not appear to be adapted to grain products such as meal and flour. At the request of the Office of Grain Standardization, the writer undertook the development of an electrical resistance method of measuring the moisture content of grain adapted to measurements in the car or elevator as well as in the laboratory, and requiring only two or three minutes for a determination. The measurements so far have been confined to wheat. The results obtained are so promising that a brief preliminary

[1] See Circular 20, Bureau of Plant Industry.

[2] Bulletin 99, Bureau of Plant Industry, U. S. Department of Agriculture, 1907.

description of the method is given. Corresponding measurements will be made for other grains as well as for flour and cornmeal. A portable apparatus suitable for measurements in cars and elevators is also being constructed.

Description of the Electrical Resistance Method for Measuring the Moisture Content of Grain.—This method consists essentially in the measurement of the resistance offered to the passage of an electric current through the grain from one metallic electrode to another. The electrical resistance decreases rapidly as the moisture content of the grain increases. The electrical resistance of wheat containing 13 per cent. of moisture is seven times that of wheat containing 14 per cent. and fifty times that of wheat containing 15 per cent. of moisture. This method, therefore, gives a very open scale, and a considerable variation in resistance can take place without seriously affecting the accuracy of the moisture determinations.

The relation between the electrical resistance and the moisture content of wheat is shown graphically in Fig. 1. The moisture percentages in this figure are plotted as ordinates and the natural logarithms of the corresponding resistances are plotted as abscissas. Five widely differing types of wheat, including soft red winter, hard red winter, No. 1 hard spring, durum, and a badly mixed wheat containing many weed seeds, were used in these determinations. The closeness with which the different points on the diagram approach the straight line drawn through them illustrates the accuracy with which moisture determinations can be made by this method. The logarithms of the resistances instead of the resistances themselves are plotted in this diagram in order to condense the diagram, and to show the linear relation between the two variables.

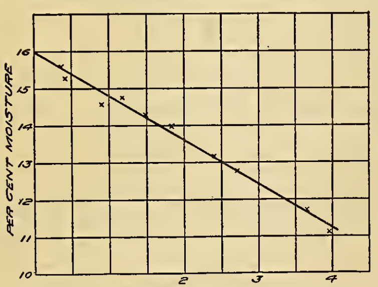


Fig. 1. Chart showing the Relation between the Moisture Content and the Electrical Resistance of Wheat. Measurements made at 75° F. For description of electrodes see text. Resistances expressed in megohms. Moisture percentages based on weight of moist grain.

Relation of Electrical Resistance to Temperature.—The electrical resistance of wheat is also dependent upon the temperature of the grain. In fact, the rapidity with which the resistance decreases as the temperature increases is quite remarkable, and greatly exceeds that occurring in most substances. The change in the electrical resistance of wheat with the temperature is shown graphically in Fig. 2, in which temperatures are plotted as ordinates and electrical resistances as abscissas. The resistance at 4° C. is seen to be eighteen times the resistance at 24° C. This curve is based upon 34 groups of measurements made upon hard red winter, soft red winter, hard red spring, durum, and a mixed wheat. Dots on the diagram refer to one sample, crosses to another, and so on. In order to construct a mean temperature resistance curve, the resistances corresponding to the different samples were all increased or decreased by an amount corresponding to the mean of the ratios of the resistances to the corresponding resistances of one curve taken as a standard. In making these determinations, the wheat, after being cooled in an ice chest, was allowed to approach the temperature of the room, and a series of resistance measurements was made as the temperature increased. The grain was in each case stirred to obtain as uniform a temperature distribution as possible before each set of measurements. Temperatures above that of the room were obtained in a similar manner by heating the grain and measuring the resistance as it cooled. It is difficult to determine the true temperature of grain while it is being warmed or cooled in this way, which accounts for the rather wide departure of some of the points from the mean curve.

The Determination of the Moisture Content of Wheat at Different Temperatures.—By combining the data shown in Figs. 1 and 2, we can construct a chart showing the moisture content of the sample of wheat corresponding to a given electrical resistance at any temperature within the range of the experiments. Such a chart is shown in Fig. 3. This chart is similar to that of Fig. 1 except that we have here lines showing the relation between moisture content and resistance, not only for a single temperature, as in Fig. 1, but for temperature intervals of 5 degrees from 80° to 40° Fahr. In this chart, the moisture contents are plotted as ordinates and the logarithms of the electrical resistances as abscissas. To facilitate the use of the chart, resistances are written in the place of the corresponding logarithms. To illustrate the use of the chart, suppose that a resistance of 55 megohms was observed in a given sample of wheat at a temperature of 75° F. Referring to the chart, it will be seen that the imaginary line corresponding to 55 megohms

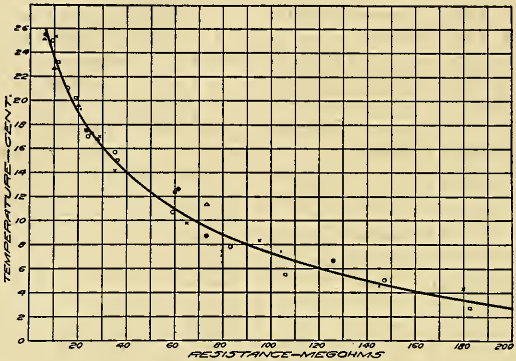


FIG. 2. Chart showing the Influence of Temperature upon the Electrical Resistance of Wheat.

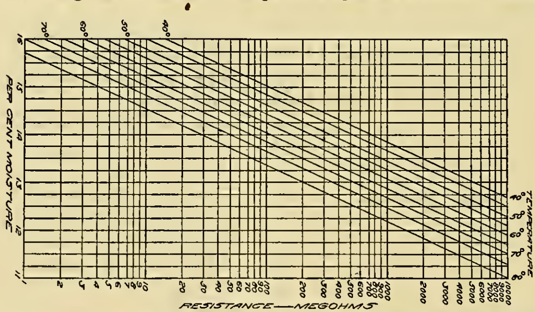


FIG. 3. Chart for Determining the Moisture Content of Wheat when the Electrical Resistance and Temperature are known. Electrodes having the same dimensions as those described in the text must be used in connection with this chart.

crosses the 75° line at a point corresponding to 13.95 per cent. of moisture. This statement assumes, of course, that the measurements were made with electrodes of standard size, to which this chart is only applicable.

Apparatus for Measuring Electrical Resistance of Grain.—Unless the grain is very wet, its specific electrical resistance is very high. The resistance, while electrolytic in character, is so great that polarization is not troublesome, and measurements can be made with direct currents. The electrical apparatus required for such measurements is therefore similar to that used for testing the insulation of cables. The measurements described were made principally with a Wheatstone bridge, using a fairly sensitive galvanometer, and an electromotive force of seventeen volts. In the driest samples (below 12 per cent.) the resistance was so high, that it could not be measured by this method. For these samples, the direct deflection method was used, the galvanometer and grain resistance being connected in series with a battery having an electromotive force of ten volts.

In all the measurements described, the electrodes used consisted of two parallel one half inch round brass rods, one and one half inches between centers, and twelve inches long. These rods were kept parallel and insulated from each other by being supported in a hard-rubber block at their upper ends. Connecting wires with extra heavy rubber insulation were soldered to the two upper ends of the electrodes. The grain during measurements was held in glass battery jars five inches in diameter and eleven inches high. The height of the grain, inside measurement, was ten inches. The lower ends of the electrodes rested upon the bottom of the jar. The temperature was measured with a mercurial thermometer having a cylindrical bulb, which could be readily forced into the grain.

Before each measurement, the electrodes were removed, and the grain was packed by jarring the bottom of the container against some solid object. It is important that this precaution in packing be observed if satisfactory results are to be obtained. This will not be necessary in measurements made in cars, since the settling of the grain in transit will have reduced it to a stable condition.

Portable cable testing sets can be used for the resistance measurements necessary for moisture determinations, providing the grain is not too dry. A special testing set is now being constructed in which a resistance coil for determining the temperature of the grain is placed within one of the electrodes. A shunt box for use in connection with the direct deflection method is also being constructed.

This method is similar in principle to that developed some years ago in the Division of Soils for the measurement of the moisture content of soils.[3] The difficulties that developed in connection with that method, namely, the translocation of salts and the cracking away of the soil from the electrodes, are not encountered in the measurement of the moisture content of grain. There is a possibility that wheat grown in different localities will show a sufficient variation in salt content to affect the moisture determinations, but such variation has not been indicated in the samples so far examined.

Summary.—This paper deals with an electrical resistance method for the rapid determination of the moisture content of grain. The experiments have so far been confined to wheat. The electrical resistance of wheat containing 13 per cent. of moisture is fifty times that of wheat containing 15 per cent. The temperature of the grain must be determined. The results of the experiments indicate that the moisture content can be determined by this method with a probable error not exceeding 0.3 per cent. Measurements can be made rapidly, requiring only two or three minutes. The apparatus is portable in character so that measurements can be carried on in cars or elevators as well as in the laboratory. The use of this method in connection with other grains and grain products is now being investigated.

Lyman J. Briggs

Physical Laboratory,
Bureau of Plant Industry,
October 17, 1908

[3] Bulletin 6, Division of Soils.

SOCIETIES AND ACADEMIES

THE NATIONAL ACADEMY OF SCIENCES

The program of papers for the meeting of the National Academy of Sciences, held at the Johns Hopkins University, Baltimore, Md., on November 17 and 18, was as follows:

Henry F. Osborn: "The Close of the Cretaceous and Beginning of the Eocene in the Hell Creek Region of Montana." Based on explorations of the American Museum between 1902 and 1908.

A. G. Webster: "On the Distribution of Sound from the Megaphone, or Speaking Trumpet."

H. S. Jennings (introduced by Ira Remsen): "Elementary Species and the Effects of Selection in a Unicellular Organism."

R. W. Wood (introduced by Ira Remsen): "Absorption Spectra of Mixtures of Metallic Vapors."

R. W. Wood (introduced by Ira Remsen): "The Mercury Paraboloid as a Reflecting Telescope."

H. N. Morse: "Results Obtained in the Direct Measurement of Osmotic Pressure."

Simon Flexner: "Certain Examples of Biochemical Control of Cell Development. (*a*) Metaplasia of Transplantable Tumors. (*b*) Inhibition of *Spirocheta pallida*."

Russell H. Chittenden: "Further Studies on the Effect of a Low Protein Diet on High Protein Animals."

A. Agassiz and H. L. Clark: "The Echini of an Insular Fauna."

Alexander Agassiz: "The Work of the U. S. Fish Commission Ship *Albatross*."

H. C. Jones and John A. Anderson (introduced by Ira Remsen): "The Absorption Spectra of Solutions of Certain Salts."

John B. Watson (introduced by Ira Remsen): "The Reactions of Primates to Monochromatic Lights."

E. G. Conklin: "Effects of Centrifugal Force on the Organization and Development of the Eggs of Certain Animals."

C. R. Van Hise: "The Phosphates of the Soil."

B. O. Peirce: "Biographical Memoir of Joseph Lovering."

W. H. Dall and W. H. Brewer: "Biographical Memoir of William M. Gabb."

Charles S. Hastings: "Biographical Memoir of Josiah W. Gibbs."

THE SCIENTIFIC ASSOCIATION OF THE JOHNS HOPKINS UNIVERSITY

The Scientific Association of Johns Hopkins University held the first monthly meeting of the present scholastic year in Hopkins Hall, November 11. Two important papers were presented.

The first was by Professor J. B. Watson, the newly-elected professor of experimental and comparative psychology, upon the subject of "Methods and Apparatus in Comparative Psychology."

Professor Watson gave a brief description of the nature of the problems in comparative psychology. The position was taken that the behavior of animals can be studied in a scientific way; that the facts thus obtained can be stated objectively and that they deserve to have equal rank with other observations in experimental psychology and in biology.

The view was expressed that the study of the sensory processes of animals is the most hopeful field at present. Exact and scientific statements concerning the nature of color vision, hearing, smell, contact, etc., in animals are much needed. At present almost nothing is known in any exact way of the functioning of the sense organs of the higher animals. Such studies should be undertaken in a more comprehensive way than has heretofore been the case. Observations made by the same investigator on many species of animals are desirable at present. Only in this way can a true phylogeny of mind be obtained. When the facts are before us we shall be in a position to begin the comparison of the behavior of animals with the behavior of man.

Several pieces of apparatus for testing hearing, vision, temperature, etc., were briefly described. A description of an apparatus for the study of olfactory sensations was given at length. The principal feature of this apparatus consists of a constant air blast supplied with two vents. Two leads of glass tubing attached to these vents pass respectively into two flasks containing different odorous solutions, or different intensities of the same solution, and from the flasks to short metal tubes which project into a glass-lined, air-tight compartment. The ends of the two tubes protruding into the compartment are narrowed to an opening of 1 mm. The tubes are placed about twelve inches apart and are inclined at an angle such as to force the two streams of air, laden with the olfactory particles, to converge in a funnel situated in the opposite side of the compartment. To the stem of this funnel (which projects from the compartment) a tube is attached leading to a vacuum pump. Two fine streams of air are thus forced out over the surface of the odorous fluids and thence into the compartment. At the same time the vacuum system at the opposite side of the compartment tends continuously to draw forward the two streams and to keep them in a straight line. Two partitions of glass extend from the side of the compartment through which the two streams are admitted. They run parallel to the air columns, meeting near the point at which the latter converge. The animal is admitted into the compartment at the point where the partitions meet. These partitions serve to keep the odors from mixing. Food is kept always with one of the two odors. The tubes and flasks are so arranged that they may easily be interchanged with respect to the right and left position. The animal has to go first to the right in order to get food, and then after the odors are interchanged, to the left. In the final control tests a special electric food dropping device serves to keep all food out of the compartment until the animal has actually made the correct choice.

The hope was expressed that, with the help of such an apparatus, much needed knowledge concerning the development and the manner of functioning of the olfactory sense organ might be obtained. It ought to be possible, *e. g.*, to find out whether the animal is sensitive to all the range of stimuli to which the human organism responds, and how far animals differ in this respect: whether or not it is easier for the animal to associate the *nauseous, hircine* and *fecal* odors with the getting of their food, than the *fruit, flower* and *musk-like* odors, etc. The quantitative study (delicacy) of the functioning of this sense offers great difficulties, but it is hoped that these can be overcome, at least to such an extent as to enable us to obtain records which may be compared with similar records from man. Functional problems similar to those which arise in the study of the olfactory field arise in the study of every other sensory field. Experimental psychology is recognizing this and is rapidly coming to extend its study of sensory processes to the animal world. There is no reason to limit experiment along these lines to man alone.

Such functional questions when answered will give us the much-needed complement to all the painstaking and exact structural work which has already been accomplished so abundantly.

The recent work of Madame Curie was then reviewed by Professor H. C. Jones, his subject being "Lithium not Produced from Copper Salts by the Action of the Radium Emanation."

About a year ago Sir William Ramsay announced that when the radium emanation is allowed to act upon a copper salt, there are formed sodium, potassium and a minute trace of lithium.

Quite recently Madame Curie has repeated this experiment and has failed to obtain the same result. The chief difference in the experiment as carried out by the two investigators is that Ramsay used glass vessels, while Madame Curie used vessels of platinum. In other respects the work as carried out in Paris seems to have been practically identical with that done in London. The amount of copper salt used, the amount of the emanation employed and the precautions taken by Madame Curie are strictly comparable with the conditions under which Ramsay worked.

In the Paris experiments small amounts of sodium and potassium were obtained, but no trace of lithium. Madame Curie thinks that the small quantities of sodium and potassium salts obtained by her were introduced along with the radium emanation.

The minimum quantity of lithium which could be detected in the residue obtained was tested by Madame Curie, and found to be much less than that which was present in the residue examined by Ramsay. She suspects that a part of the sodium and potassium, and all of the lithium found by Ramsay came from the glass vessels which he employed. She is, however, far from dogmatic, concluding her paper with the following words:

"In conclusion, we may say that we have been unable to confirm the results of Ramsay and Cameron. It is evidently impossible to affirm that no trace of sodium or lithium was found in the experiment; we believe, however, that the formation of these elements can not be considered an established fact."

If it is impossible for Madame Curie "to affirm," it is certainly impossible for any one else to do so at present. We must wait until further communications have been received from Sir William Ramsay; not forgetting that some of the finest experimental work that has ever been done in any branch of science has come from Ramsay's laboratory.

Charles K. Swartz,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

At the annual meeting of the Botanical Society of Washington, held November 10, 1908, the following officers were elected for the year 1908–9:

President—Professor C. V. Piper.

Vice-president—Mr. Thos. H. Kearney.
Recording Secretary—Dr. Haven Metcalf.
Corresponding Secretary—Mr. Wm. E. Safford.
Treasurer—Mr. J. H. Painter.

Dr. J. N. Rose, of the U. S. National Museum, was elected to represent the society as vice-president of the Washington Academy of Sciences.

Wm. E. Safford,
Corresponding Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The forty-ninth regular meeting of the society was held on the evening of April 25, 1908, Vice-president C. V. Piper presiding. Papers were read as follows:

Flies as Distributors of Spores: N. A. Cobb.

Dr. Cobb called attention to the ease with which spores and other small bodies may be carried about on the feet of flies, especially of the Muscidæ and Sarcophagidæ, which are provided with viscous hairs or papillæ. But a more probable source of the transmission of spores and disease germs is the depositing of excreta on food and on living organisms. On examination, fly-specks were found to contain spores of many kinds of fungi, sometimes fifty or sixty widely different kinds, which had been taken into the alimentary canal with the flies' food and had not been injured by the processes of digestion. In studying a certain fungus disease of the sugar cane Dr. Cobb found in the excreta of flies visiting the plant spores of practically all the fungus diseases which attack the cane. They undoubtedly are the chief if not the sole agents in transmitting the disease investigated.

Notes on Fomes igniarius: Perley Spaulding.

This fungus occurs very commonly in the deciduous forests of America. It is limited to deciduous trees. The aspen, butternut and beech are very susceptible to its attacks; the sugar maple and the balm-of-gilead are relatively resistant. The destruction caused by it is tremendous in many parts of the world. It may practically destroy all the mature timber of a certain species in a given locality; instances have been found where 90 to 95 per cent. of mature beech trees were affected. The investigations have shown that *Fomes igniarius* is strictly a wound parasite; it may live saprophytically on the dead tree or stub for several years; the death of the tree attacked is certain. The age of the host tree, presence of wounds and rapidity of healing of wounds are factors controlling the entrance of the fungus into the trunks.

The Problem of the Cuban Coconut Planter: John R. Johnston.

A serious disease has recently invaded the coconut groves of Cuba. It is there known as the bud-rot. In some localities it has destroyed all of the trees, in others it is just appearing. The disease is not confined to Cuba, but is widely spread in tropical America. Thus far, Porto Rico has escaped it. The disease proves to be bacterial. It is confined to the crown, or terminal bud, of the tree, in which it causes a soft, vile-smelling rot. Owing to the great height of the coconut trees and the difficulty experienced in getting at the terminal bud, surrounded as it is by the sheathing cases of the petioles of older leaves, it is almost impossible to treat the disease locally. It is not yet known how the disease is transmitted from one tree to another, but it is suspected that this may be through the agency of insects. Experiments are being carried on by the Department of Agriculture, the results of which will probably be published at a not very distant date.

Some Cases of Delayed Germination in Seeds: G. F. Klugh.

In attempting to cultivate drug plants, the life-history of which in most cases is little known, it was found that, almost as a rule, germination was delayed for at least a year. In planting *Aconitum navellus*, five spring plantings gave two total failures, two cases of germination, and one case of germination the same and the following spring. Mr. Klugh gave the results obtained in the cases of *Aragallus lambertii, Aristolochia serpentaria, Atropa belladona, Datura stramonium, Hyoscyamus niger, Solanum nigrum, Colchicum autumnale, Echinacea angustifolia, Glycyrrhiza glabra* (in which germination was increased after the seeds had been shaken with crushed glass), *Hedeoma pulegioides, Humulus lupulus, Hydrastis canadensis, Lobelia inflata* and *Panax quinquefolium*, the last of which required eighteen months or two years to germinate. The presence or absence of moisture seems to play the most important rôle in germination. Sometimes the vitality is destroyed by drying. In the case of Solanaceæ the lack of oxygen was fatal. Plants of this family failed to germinate when buried in moist soil even less than an inch in depth. The same seeds germinated when brought to the surface.

Haven Metcalf,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 11, 1908

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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.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY

INTRODUCTORY ADDRESS BY THE CHAIRMAN[1]

IN opening this session of our society, and as an introduction to the subject of this evening's program, I dare take the risk of making a few general remarks.

Our meetings have for object not only to bring before members facts and ideas, but more specially to provoke discussions. I consider a paper without a discussion as an unfinished program, and I sincerely hope that the subject of to-night will lead to a lively exchange of ideas.

For us, if we are worthy of the name of chemists, our God means Truth; and nothing helps so much to correct our views and to arrive at the truth as an honest discussion: "Du choc des idées jaillit la lumière."

I believe that in our meetings we can go beyond the dictates of cold, boresome, uninteresting formality. There is no department of science more closely interwoven with the welfare of humanity than our field of chemistry; indeed many branches of chemistry have a very direct bearing on economics and sociology.

Every speaker who appears before us has the right to treat his subject in accordance with his own sincere convictions. Anybody who speaks about explosives is naturally led to talk of their uses for defensive and aggressive purposes. To deny a speaker this privilege would be as

[1] Delivered at the Chemists' Club in New York City, October 9.

unliberal as to forbid him to talk about alcoholic-fermentation industries because the Prohibition Party thinks alcohol ought not to exist; it would be as if a paper on the uses of saccharine was objected to by the Pure Food Law advocates or as if a discussion on the therapeutic value of chemicals was distasteful to the followers of Mrs. Eddy; it would be as unwarranted as if, in a geological society, a paper was considered as objectionable because it contained statements contrary to the text of the Bible.

The chemistry of explosives has always been narrowly connected with the so-called art of war, and it is almost impossible to talk broadly on one subject, without touching upon the other.

I admit, I consider this a very unfortunate attitude of mind, a sign of the yet very incomplete development of the human race; yet, to the average man, this attitude is predominant. For too many generations our race has been perverted by a pernicious education where writers and artists have glorified and misrepresented war. We are all laboring under the harm which has been done by the so-called classic writers of antiquity whom I shall take the liberty of calling here the "braggarts" of antiquity, for they it were who, in their bombastic rhyme and prose, made so much out of a little scrimmage between a handful of excited fighters, as to make it appear as a feat worthy of the gods. As long as the plastic little brains of our children are influenced by this class of literature, so long will explosives and war go together. Men like Grant, Sherman, Tolstoi, Verestschagin, men who have participated in the horrors of war, do not talk nor write, nor paint the glorification of war.

If I kill a man and take what he has and what he was not willing to give me, you will call it murder and theft, but if some people kill and rob under association rules, they will call it war and conquest. There was a time when agriculture, industry and commerce were considered of very scant importance, because it was so much easier to get rich by conquering other nations and return triumphantly home, laden with plunder and stained with blood, but greeted with the applause of young and old. The Romans and the Greeks and even the armies of Napoleon knew very well how to play this game successfully. I am glad to say that since those times we have made some little progress. Wars are no longer remunerative except to army contractors and newspapers. Statistics show that nowadays it costs every warring nation about one million a day to keep an army in the field. Even then the results for the victor are about as disastrous as in a successful patent lawsuit where patentee and infringer both lose money after they have paid for attorneys and chemical experts. The financial crisis in Germany after the Franco-Prussian war, the present poverty of Japan after two successful wars, are striking instances of all this.

Nowadays people who want to get very rich have surer ways than those of plunder by war: law-makers and lawyers have given them easier opportunities for plundering their fellow-men by the skillful use of so-called "business methods" and so-called "honesty" as defined by law. Sure enough, in the midst of all this live some dreamers who in their visions of the future behold the disappearance of war. I admit I count myself amongst these visionaries, these cranks, these unorthodox, unrespectable people, although I fear that our dreams are still far from complete realization. Nevertheless, the fact that some people dare dream such dreams and dare dream them in public is already a very hopeful sign. There was a time when even the most radical philosophers of Greece could not conceive a nation without chattel slaves and it is not so long ago that the question of slavery whenever touched upon in this country brought forth ridicule and violent opposition.

The people of the United States by putting in their waste baskets the old solemn formula of the "Divine Right of Kings" have done much to abolish war. But this country did more by showing to other nations that a great, happy, prosperous commonwealth can be built up quicker and surer by the power of higher ideals and of honest work than by war and conquest.

It is a current idea that to be prepared for war is to avert war. This may be quite true, but the main question remains to determine what you call "being prepared for war." I very much believe that if we had had no navy we should never had had a war with Spain and we should not now be burdened with a "Philippine Problem."

Let me remind you of the fact that there are $180,000,000 invested in our fleet that is now in the Pacific which costs the people of this republic a sum of money which would irrigate permanently 6,000,000 acres of arid land and transform it forever into a bountiful, rich agricultural district that would provide permanent, prosperous homes for 120,000 families of good, self-respecting, independent citizens. It would build 60 to 100 great electric power plants. It would utilize some of the natural resources of this country, make them available for transportation, light, heat and power to all citizens of this republic instead of leaving them to be exploited for private gain.

Every battleship which now goes to the junk pile after a few years of parading, costs a sum of money which would enable us to build, equip and endow every time, a splendid university or technical school that would rank with the very best of the world's institutions and the benefits of which would be increasing and everlasting.

Yet I know there are many among my friends who believe that the surest way to avert war is to make it so horrible that nobody dares to engage in it. If the conservative military class had been left to themselves they probably would still be fighting with bows and arrows, but scientists and inventors have been encouraged to give them their support. Whenever a new invention appears, the question is raised immediately, How can it be used in war? Napoleon's interest in Fulton's ship was exclusively inspired by the possibility of using steamships in his war with England. Even nowadays balloons and flying machines receive their main encouragement from those who concentrate their attention on war and its engines.

Let me tell you that this attitude of mind is practically the same as if every time our friend, Professor Bogert, discovers a new synthetic product with a never-ending name, somebody would come around and pay him to make a ripping and killing poison out of it.

The intervention of science and engineering has not only made war more horrible than before, but has shorn away its picturesqueness which used to inspire the Don Quixotes whenever worms killed other worms. Furthermore, the gods of war no longer are influenced by the offerings or sacrifices or clamoring prayers of long-robed priests. They do not even take into consideration the so-called righteousness of the cause. On the other hand, they seem to have become very decidedly partial to the nation whose artillerists do not forget their logarithms during the heat of battle or whose explosives are best nitrated. Instead of the bards of olden times who were paid by the war-lords to sing their praise and to tell lies in prose and in rhyme, we now have the modern newspaper. But even if some newspapers are glad to have a war on hand which increases their circulation, they can no longer arouse enthusiasm since their war reporters with their deadly kodaks take away all the bombast from their descriptions and only picture stern, prosaic, nasty reality.

Fortunately for us the study of explosives and engines of war has a broader interest. In the same way as the deadliest of poisons have become some of the most valuable therapeutic agents, so have explosives and engines of war found their most valuable applications in the arts of peace. Nitro-cellulose or gun-cotton, one of the most violent explosives, found immediately its applications in surgery, later on in the manufacture of celluloid and also made possible the photographic film. Shall I call your attention to the splendid example of our fellow chemist, Nobel, who with his valuable work on nitro-glycerine, dynamite and similar explosives, has made his discoveries and inventions incomparably more useful in mining and in engineering than in war, and thus created more good than the harm they ever will do in the art of killing. Noble, too, was one of those who did not love war, and he showed it when, after his useful life, he made of his enormous but well-acquired fortune an international bequest for furthering peace and civilization.

Shall I remind you of the time when chemistry did not exist, when the only encouragement which was given to experimental research was dictated by greed, that tried to make gold and thus bribed the skill of the alchemist? And yet what an immense amount of knowledge was thus accumulated! Knowledge which was afterwards utilized for the benefit of mankind.

Let me remind you also, my friends and fellow chemists, that our God-given mission is to utilize our science for the welfare of our whole race; to develop and improve our knowledge, our thoughts, our aspirations, to lead to a better, a higher, a happier race; a race where individual selfishness and conceit shall not count a life by three score and ten, but a race where an individual and a nation are only considered as temporary cells or groups of cells in an everlasting organism that lives through centuries and æons; and which shall keep on improving and improving towards higher and higher standards; unless ignorance, greed and selfishness make it unhappier and unhappier, until finally it finds a fitful and merciful annihilation and perishes and follows the way of the dead races of animals and plants that have only left their traces on past geological periods, and now proclaim to us that they were not apt, not fit, not warranted to perpetuate themselves.

Gentlemen: I now have the pleasure of introducing to you our distinguished fellow chemist, Mr. Hudson Maxim, an American, who by his discoveries, his inventions, by his originality of thought and action, has shown over and over again that he is most eminently qualified to treat the subject of this evening.

L. H. Baekeland

THE WARFARE OF THE FUTURE[1]

How will the battles of the future be fought? In our reasoning we are obliged to proceed from the simple to the complex, from what we know to what we would

[1] Address before the New York Section of the American Chemical Society at the rooms of the Chemists' Club, 108 West 55th Street, on Friday evening, October 9, 1908.

learn. In order to forecast the future, it is necessary to recast the past.

We are to-day marching in the van of achievement with a vast wealth of accomplishment behind us. Still, relatively speaking, we are merely entering at the very threshold of invention.

When primitive man first learned that with a club as a weapon he could vastly reinforce his teeth and fists and claws, he doubtless thought that there remained but little chance for further improvement in weapons of warfare.

The human hand has been forged from the fin of a fish by the human brain. The hand, in its turn, has built upon the microscopic terminal ganglion of the primitive cordworm the giant brain of a Herbert Spencer, infinitesimal piece by piece. Hand and brain have always worked together in a close partnership.

When we compare the course of human invention with the evolutionary processes of nature, we are struck by the parallelism. Everywhere in nature there is a fierce rivalry that stimulates to improved variation to meet the exigencies of necessity. The complex is evolved from the simple and the large has small beginnings. The intelligently selective grows out of blind inertia tending always toward the survival of the fittest. Had we infinite powers of understanding of natural processes, we should then have infinite foresight too and should be able to forecast with unerring accuracy what the future has in store. A sufficient knowledge and observation of nature would have foretold each before its invention, by some parallelism or counterpart in nature, many of the greatest inventions of man.

The screw propeller would have been foreseen in the tail of the fish. The armored saurian of the reptilian age would have given a foreview of the armored knight of the middle ages, destined to hold the mastery awhile, and doomed in turn, just as the old hard-hided antediluvian monsters went down before the agile sharp-toothed carnivora, to fall beneath the supremacy of the light-footed unhelmeted soldier, without shield or cuirass, but whose powers of offense with firearms become his best means of defense too.

The old flint-lock blunderbuss charged with lead and black gun-powder was thought pretty near perfection as a weapon of war. Still, the coat of mail was laid aside slowly and reluctantly; also slowly and reluctantly with the further improvement in firearms did armies break from solid rank formation and disperse over large areas and fight in skirmishing order.

To-day it has become a recognized truism of military science that victory depends upon the concentration of attack upon the most vital points of an enemy's position, while offering to the enemy the minimum of vital exposure. To this end, wisdom has led to the division and dispersion of the men and enginery constituting the units of attack, while still enabling each attacking unit to concentrate upon any desired point of the enemy's position.

The greatest means of defense are efficient means of offense. The greatest protection against receiving heavy blows is to be able to strike heavy blows. A heavy blow upon an enemy is far better than heavy armor on one's self.

Naval warfare too must soon conform to the wisdom of this lesson, and the battleship, the gigantic armored saurian of the sea, is destined to be dominated in the near future by some agile, swift, sharp-toothed carnivora of destruction.

In ancient times, when men fought with clubs and swords and spears, victory depended upon the actual amount of brute force that could be opposed to brute force, and little depended upon science. With improvements in weapons, warfare becomes more and more a matter of exact science and the military man becomes more and more a civil and mechanical engineer. In the military land operations of the future, science will more than ever be supreme above mere brute force.

Nothing is more apparent than a simple proposition after it has been well learned. To hitch up a steam engine to propeller wheels and drive a boat looks simple enough to us all now, but when Fulton proposed a steamboat voyage up the Hudson, the undertaking appeared about as incredible to most people of the time as a suggested voyage to Mars would now be.

The old wooden hulk was in its day a dare-devil innovation. He was a revolutionist, in the inventive sense, who first fired heavy guns from a ship's deck. The present battleship is only a highly developed *Monitor,* just as the old wooden sailing ship was a highly developed trireme.

It is the same conservative spirit to-day that believes in the battleship as the final arbiter of national supremacy that once believed in the old wooden-sides and adhered to them, opposing all innovations; the same spirit of conservatism that adhered to the Roman galley and placed its faith in the crew of the galley slaves rather than upon the uncertain wind; the same conservatism that made the Carthaginians adhere to their outclassed triremes; and, in inverse order, it is the same spirit of invention combating entrenched conservatism that led the Romans to build their galleys for close-order work, armed with grappling hooks, with which they secured their vessels to the Carthaginian triremes, where the Roman short sword could be brought into play.

When, in the first Punic war, the primitive Roman fleet met and was vanquished by the Carthaginians, the order of battle was the same as it is to-day. The vessels lined up at such a distance apart as would enable the Carthaginians to strike the Romans with their long-range arrows and the stones hurled by their Balearic slingers. When, however, the Romans devised a means whereby they were able to run them down and grapple with them in hand-to-hand conflict, victory was with the Romans.

The next great improvement in naval warfare will be on the lines of ways and means of repeating what the Romans did—ways and means of charging upon and grappling with the mighty war-vessels of an enemy, to sink them with the short sword of high explosives.

There is no one thing so much needed in naval warfare at the present time as a more efficient means of reaching battleships and cruisers with a sufficient quantity of high explosives for their destruction; in other words, there is a more imperative demand for improvements in torpedoes and torpedo-boats than in any other branch of the naval service.

The effective range of the modern high-power gun is now about five miles, and it is the range of the guns that determines the distance between the lines of battle of modern fleets; and the fleet with guns of the longest range has the opposing fleet at its mercy.

A little while ago the Whitehead automobile torpedo was thought to be a valuable adjunct to the armament of the modern battleship, but the range of the guns has now been so increased that such torpedoes become a useless incumbrance, because of the shortness of their range, notwithstanding the fact that their manufacturers have done everything possible to perfect them and to increase their speed and range. Their range is necessarily limited to that attainable by the charge of compressed air they are capable of carrying.

During the past few years the air pressure has been increased from 1,300 pounds to the square inch to 2,250 pounds to the square inch, and the weight of air from sixty pounds to one hundred and thirty pounds in the eighteen-inch torpedo; and still the maximum range of the eighteen-inch torpedo is only from 3,000 to 3,500 yards, practically about one-third of the range of the high-power guns which determine the distance apart of the lines of battle; and the maximum rate of speed of this torpedo is about thirty-five knots.

In order to carry the air under the enormous pressure, a very strong and very heavy steel air flask is needed; and as the weight of the entire torpedo must not exceed the weight of the water displaced by it, the propelling mechanism has necessarily to be made very light and delicate for the energy it has to transmit.

But what is far more important, the explosive charge also has to be reduced to a minimum, in order to float the heavy air-flask and the weight of air it contains; and this notwithstanding the fact that the quantity of high explosive ought to be greatly increased in order to ensure destruction of the warship struck by it. In the recent war between Russia and Japan the Whitehead torpedo proved a great disappointment.

If the speed of an automobile torpedo could be increased fifty per cent., its accuracy also would be greatly increased, for it would be far less affected by currents, and would be far more likely to strike a moving target, while if its range could be increased one hundred per cent., it would then become an efficient adjunct to the armament of every war vessel, whereas if its range could be increased to five miles—practically three times what its range now is—even though its speed were to remain at thirty-five knots, it would be able to pass over the intervening space separating the lines of battle of opposing fleets.

During the last ten years I have conducted a large number of experiments at a cost of more than $50,000 in the development and demonstration of a system for the propulsion of automobile torpedoes and torpedo-boats by energy derived from the products of combustion of a self-combustive fuel called motorite, consisting of seventy per cent. nitroglycerin and thirty per cent. gun-cotton. The gun-cotton is gelatinated by the nitroglycerin, forming a dense, tough and rubbery material. This material is made into bars about seven inches in diameter and six feet long, for use in torpedoes the size of the eighteen-inch Whitehead torpedo. For the twenty-one-inch torpedo the stick will be both bigger and longer.

The motorite bars are forced into and sealed in steel tubes for use, and these steel tubes containing the motorite are inserted into the torpedo and are surrounded by a water-jacket. The motorite can be ignited and can burn only at and from one end, and water is forced through the water-jacket into the combustion chamber, to be evaporated by the flame blast forcing the water along with it through an atomizing device, whereby it is instantly converted into steam, and the combined steam and products of combustion form the motive fluid.

The water will be taken in from the sea as required, so that it will not be necessary to carry the water-supply on board the torpedo.

One pound of motorite evaporates a little over two pounds of water, so that one pound of motorite produces the equivalent of three pounds of steam, for the products of combustion of the motorite mingle with the steam produced. The steam from the combustion chamber is conducted to turbines, or other engines or devices for propelling the torpedo through the water. By means of this system of propulsion, the range of the automobile torpedo can easily be doubled, while at the same time its speed can be increased fifty per cent. The heavy air-flask will be done away with and will be replaced by a shell merely strong enough and heavy enough for structural rigidity.

This will enable the carrying of one hundred and sixty pounds of motorite in place of the one hundred and thirty pounds of air now carried, and as each pound of motorite will evaporate two pounds of water, we have available four hundred and eighty pounds of motive fluid; and as steam and products of combustion of motorite are much more efficient as a motive fluid per unit of weight than compressed air, it is safe to assume that we have available four times the energy now available in the eighteen-inch torpedo.

Instead of carrying but two hundred pounds of wet gun-cotton—the present charge—we should be able to carry three hundred pounds of maximite, which is practically twice as powerful per unit of weight as gun-cotton, while its density is fifty per cent. greater than that of gun-cotton, so that we should have a warhead easily three times as powerful as the present war head.

The thing most needed at the present time is a torpedo-boat capable of passing unscathed through the fire of quick-firing guns of a battleship in order to get near enough to reach her with certainty with torpedoes carrying a sufficient quantity of high explosives in the warhead to ensure her destruction when hit.

It is a recognized truism in the field of invention that when there is a very strong demand for anything against which there is no physical law barring its accomplishment, it is sooner or later sure to be accomplished.

There is an enormous demand for a system for reaching and torpedoing battleships with destructive quantities of high explosives. I am strongly of the opinion that the most effectual way of accomplishing the result is to construct a torpedo-boat in the following manner:

Build the hull of the boat somewhat on the lines of the cigar-shaped automobile torpedo—even a perfect counterpart of the torpedo in shape would serve the purpose well; but I would suggest a little greater vertical than longitudinal diameter. In other words, I would build the boat a little more fish-shaped than the torpedo, and I would construct it so that it would be adapted to travel both upon the surface of the water and in a semi-submerged position, or rather, in a nearly submerged position.

I would drive the boat with gasoline engines under normal conditions, and when going into action—that is to say, in making the run of attack—the boat would be in its nearly submerged position and would be driven by the combined power of the gasoline engines and motorite.

The gasoline engines will be provided with a shift gear, something like that employed on automobiles, so that under normal conditions, that is to say, when the boat is propelled along the surface of the water by the gasoline engines alone, the propellers will be driven at a slower speed, and a speed adapted to the speed of the boat thereby secured; but when going into action in a submerged position and traveling at possibly double the speed, the gear will be shifted so that the propellers will travel at a speed commensurate with the higher speed of the torpedo-boat.

The boat will be provided with a top keel or fin a little thicker than a man's body across the shoulders at the rearward end, being narrowed down forward, and a conning-tower large enough for a man to stand in erect.

The front end of the superstructure will be sharp, and water will be thrown to right and left and will not obscure the forward view of the occupant of the conning-tower. The superstructure will be subdivided into small compartments, filled with cellulose. The partitions between the compartments will be thin sheet metal.

The whole superstructure, except the conning-tower, will be very light and entirely dispensable, and can be shot away without actual damage to the boat itself. The superstructure will be for flotation purposes only, serving to tie the boat to the surface of the water, while the boat itself will be actually submarine. The superstructure will project above the surface of the water about a foot.

The conning-tower will be protected by thin armorplate thick enough to resist the projectiles of small quick-firing guns, and there will be no danger of being hit by guns of a larger caliber.

It will be extremely difficult to hit either the superstructure or the conning-tower, even with small quick-firing guns, for the conning-tower will not be more than two feet above the surface of the water, and will not exceed three feet in diameter, and will be moving forward at the rate of from forty to sixty miles an hour.

Of course, it will require stupendous energy to propel a submarine boat through the water at so high a rate of speed, and there is nothing available known to me except motorite which can supply the required energy. With motorite, however, we have easily all the energy that may be required for any desired rate of speed until the motorite be entirely consumed.

Enough motorite can easily be carried to drive such a submarine boat at a speed of sixty miles an hour for a distance of thirty miles. This will be sufficient to overtake and sink any battleship that might be sighted. Of course, a speed of forty-five miles an hour can be maintained for a much longer time, probably for an hour and a half, with the same quantity of motorite.

The Whitehead torpedo is in reality a sort of submarine torpedo-boat and what is true of it also holds true of the torpedo-boat I propose. Of course, the keel and superstructure in the boat I propose would offer additional resistance, but, on account of the larger size of the boat and its greater length and the enormous quantity of motorite that may be carried, we shall have available more than enough energy to make up for the increased resistance.

The boat will carry, say, a couple of torpedoes in the prow and launch them when getting within close range of a warship. These torpedoes should each carry at least five hundred pounds of high explosive. It would be better if they carried half a ton each in the warhead.

The cost of the torpedo-boat will be slight compared with the destruction it can work. Besides, there need be only two men on board and the lives of but two men will be endangered anyway, and notwithstanding the danger to the men making such an attack, even though the chance of being killed were to be one in two, or even more, there will be no lack of volunteers for the job.

A portion of what I have just said about my system of propulsion of torpedoes and torpedo-boats appeared in the September number of the *Metropolitan Magazine;* but I have several inventions relating to the construction of torpedo-boats that have never yet been published, and one of these is a method for taking on and discharging water with very great rapidity for the submergence and emergence of a semi-submarine torpedo-boat of the type already described, whereby these evolutions could be performed with nearly the facility with which a duck can dive.

Another invention is a torpedo-boat warhead, carried by or forming a part of the bow of the torpedo-boat itself instead of forming a part of an automobile torpedo to be launched by the torpedo-boat.

I have shown how a torpedo-boat may be made so that it may be safely run through the zone of fire of a battleship to launch its torpedoes at close range. I am, however, of the opinion that a far better way, and one which will be adopted in the near future, will be to employ a torpedo-boat which shall itself constitute an enormous torpedo. It will be a species of ram; but instead of depending upon the steel prow for punching a hole in a warship, it will be armed with a ton of high explosive. How about the crew? No, it will not be necessary to sacrifice the crew. The boat will be made, say three hundred feet in length over all, and a hundred feet of the prow portion of the boat will be wholly dispensable and may be blown away without injury to the boat proper, the boat proper being but two hundred feet long.

The warhead of the torpedo-boat will strike the battleship below its armor belt and the blast of the explosion will be inward and upward through the warship, while the reacting blast of the explosive charge will not be very severe upon the occupants of the torpedo-boat. They will be hurled back by an enormous wave of water, but it will not be a quick, sharp destructive blow, dangerous to the occupants of the boat or to the boat itself.

After torpedoing a warship, the torpedo-boat, with its dispensable bow blown off, will still be in perfect trim to retreat and escape. The crew of the battleship at this juncture will be busy with their prayers.

Of course, this torpedo-boat will not supplant the automobile torpedo, for that will be employed in other evolutions; but for the direct run in upon a warship, this form of torpedo-boat with a ton of high explosive in the warhead will be the main arm of naval service, for nothing under heaven could prevent one of these torpedo-boats from selecting any battleship in any fleet and sinking it without a chance in a hundred of being prevented.

In June, 1897, I delivered a lecture before the Royal United Service Institution of Great Britain, wherein I recommended a gun for throwing aerial torpedoes, that is to say, high explosive projectiles of large dimensions, which would be capable of penetrating the deck of any war vessel or of blowing up any war vessel when striking in the water beside it.

I proposed a gun of twenty-four-inch caliber, which need not necessarily be any heavier than the regular twelve-inch service rifle. I showed that this gun would be capable of throwing a projectile weighing a ton and a half and carrying half a ton of high explosive to a distance up to nine miles, according to the elevation. Our war department has now decided to build some guns of greatly increased caliber for the purpose of throwing heavier projectiles carrying much larger bursting charges of high explosive.

Although the initial velocity of these projectiles will not be as great as those now thrown from our high-power twelve-inch guns, still there will be a far less relative energy lost during flight, and they will have proportionately far greater residual energy, so that the range will still not only be maintained but actually increased, although the trajectory will not be quite as flat as at present.

There is also another enormous advantage of this type of gun, and it is that the initial pressure need not be as great, so that a gun, instead of losing accuracy very rapidly after only the sixtieth round or so, will retain its accuracy up to several hundred rounds. These are some innovations in the right direction.

High explosives are destined to play a far more important part in future warfare than they have played in the past. There are three ways by which high explosives may be brought to bear upon the warships of an enemy for their destruction. One is in the bursting charge of the high explosive armor-piercing projectiles; another is in the submarine torpedo, either in the stationary submarine mine or the self-propelled torpedo, of which latter the Whitehead is the principal type; and the other is in aerial torpedoes, huge projectiles carrying charges of half a ton of high explosives dropped upon and about the warships of an enemy.

During the last decade the principal progress in the use of high explosives has been in the perfecting of bursting charges for armor-piercing projectiles; and to-day we are able to fire high explosive projectiles from powder guns and to penetrate the thickest armor plate, without explosion until the projectile has passed through the plate, to be exploded behind the plate with a proper delay action fuze.

In the land battles of the future, lines of battle will circle sky line and opposing sky line, and over the stupendous arena missiles of death will shriek and roar, while sharpshooters with silent rifles will make ambush in every copse and hedge and highway. Aerial scouts will race across the sky, some in high flight and others hovering low.

In this age of marvels with which the inventor is constantly surprising us, it does not do to sleep too late in the morning, else when we awake we may find ourselves laggards in the abject rear. Achievement now runs on so fast that it often outpaces the adjustment of our senses, and though we pinch ourselves to prove our wakefulness, still the sense of dreaming intrudes on consciousness and harasses conviction.

Many of us in still full life are able to go back far enough in yesterday to view the present through the wide eyes of wonder, while we are so fortified with expectation for the morrow that we look a second time to be assured whether or not that flock of clouds that skirts the sunset may be a fleet of airships climbing up the sky.

The flying machine is no longer confined to the realm of fancy or imagination, but the conquest of the air is already far advanced, and the era of practical utility is near. The wonder of yesterday becomes the commonplace of to-day, and the marvels of to-day will be commonplace to-morrow.

Now that the flying machine has become an actuality, and as all that now remains to be done is to perfect already existing means and apparatus in order to complete the conquest of the air, it is well for us to forecast some of the adjustments that will be necessary to meet the changed conditions when we shall have our aerial navies of commerce and of war.

That the flying machine will find very wide application in future warfare, there can be no doubt. Furthermore, it will be the demand for the flying machine as an engine of war that will give to the industry its greatest stimulus.

Inventors will have to delve in the depths of their genius in order to develop, perfect and bring the flying machine to the very high efficiency necessary to meet the requirements of government specifications.

There is no other incentive to invention so great as that which impels to the development and perfection of implements of war, for the very security of property, country, home and life itself often depends upon a little lead over an enemy in war inventions.

Some terrible things have been predicted for the flying machine as a war engine. Many a sanguine inventor has claimed that with the advent of his flying machine, battleships, coast fortifications and cities could be utterly destroyed by dropping dynamite from the air. It is comforting to know that no very great loss of life or property would result from dynamite dropped from flying machines, for the reason that dynamite requires confinement to work very wide destruction.

Dynamite must penetrate and explode inside battleships, earthworks and buildings in order to do very great damage. Half a ton of dynamite dropped upon the deck of a battleship might kill a few men, wreck some of the superstructure and dent the deck a bit, but the destruction would not be widespread and the crew below would be uninjured. Dropped on coast fortifications the damage would be negligible.

Half-ton bombs dropped into the streets of a large city, or on top of the great buildings, would shake a few foundations, break a lot of glass and kill a few people. The blast of the dynamite, not being confined, would rebound up into the air in the form of an inverted cone, and the effect in a horizontal plane would be small.

The flying machine will have very great use in war as a scouting craft for the purpose of locating an enemy and inspecting his position; but the enemy will have his aerial pickets out too, and there will be many a tilt in the air between the warring craft. Then it will be that speed will count for much and there will be intense rivalry between the nations in the production of flying machines that will fly fast and fly high, for those able to fly the highest will have a tremendous advantage over their enemies. It will be the high flyers who will win.

I have noticed that great personal bravery is often a concomitant of great intellectuality, and it is proverbial that inventors are the dare-devilest men in the world; and when the flying machine inventor casts the earth loose and rounds the ecliptic with the Pleiades, leaves the earth road and cup races with Jupiter on the cloud way, or goes tobogganing down the sky slide, then the old soldier's oft-spun yarn of how his company mixed their bones with grape and canister, becomes commonplace.

It will be great sport by and by to outrace and override the thunder storm, and there in the bright sunlight look down upon the rolling, seething mass of cloud spitting fire like an angry cat. We shall then seem to have nature at a disadvantage.

In the not distant future, we shall have our automobiles of the air, and in the wars of the future, we shall have our aerial battelships, our cruisers, our torpedo-boats and torpedo-boat destroyers. But they'll be airy, frail and fairy craft indeed compared with the grim steel monsters of the sea.

Although the value of the flying machine in future wars will be mainly as a scouting craft, still its value and importance for that service alone is hard to over-estimate, for the flying machine vedettes will be at once the eyes and ears of the armies of the future; and they will have their use in naval warfare too, for there will be the aerial torpedo scout on the lookout for torpedoes and torpedo-boats, which will signal the approach of danger.

Possibly, too, we shall have our torpedo hawk, taloned with dynamite, which will swoop down out of the sky in swift pursuit of the torpedo or torpedo-boat and blow it up before it reaches its destination. But the torpedo craft will have their sky guns then and attack will be dangerous work.

The debt we owe the inventor is the difference between all that is ours to enjoy in modern civilized life and the indigence of barbarism. But for the inventor, we should still be denizens of the unbroken forest, clothed in the skins of beasts. Like Antony, the inventor has with his "broad sword quartered the world, and on green Neptune's back with ships made cities." He has hewn highways through the granite hills and web-worked the world with the iron rail.

With his instruments of science the inventor has sounded the deeps of the eternal skies. He has discovered whence Orion came, has felt the pulse of Arcturus, and he knows the fortune and the fate of a million worlds. He has seen them quarried out of chaos far beyond the troubling touch of time; and he views their onward drift toward death in the infinite night and cold of immensity.

He foresees our own bright sun a paling ember on the hearth of time, and he reads our destiny in the scroll of the milky way by light that left its source so long ago that it was already old upon its flight ere Babylon was builded and when the Egyptian pyramids were still unquarried.

In aerial navigation the inventor is obliged to hang his life on the hazard of his mastery of unaccustomed principles, where there are innumerable untried variables—a stunt of the imagination like taking a flight through the fourth dimension.

Aerial naval tactics will include the use of the thunder head to mask manœuvres. When the cloud-hung navies war and ride the storm to battle, then conjecture will attend the fall of slaughtered combatants and wreckage from the sky to know if it be Jove or man that thunders there.

The more highly scientific war enginery becomes the more the game of war will be one that can be played only by the most scientific and enlightened nations.

We, the people of the United States, are to-day dominated by a boundless egoistic obsession concerning our importance and our power compared with the importance and the power of other nations and of other races. This is an outgrowth of our unprecedented prosperity.

Our hitherto isolated geographical position has relieved us of the burden of armaments that other nations have had to bear; but conditions have now changed and the changes are taking place faster than we are waking up to them.

The great increase in the speed of battleships and cruisers, together with their enormously greater size and carrying capacity, has brought the other great war powers nearer home to us and their fleets are now practically at our doors and their vast armies of veterans are almost within gunshot of us.

We have no real army, and though we have a somewhat powerful fleet, England has one far more powerful, and in proportion to our needs for a fleet, ours is the least adequate of that of any country of consequence in the world.

Mr. Reuterdahl told us some ugly things about our navy recently and we were mighty glad when we learned that there was not a word of truth in what he said, and we were made glad again when we learned that the errors of construction which he pointed out would not occur again.

Last winter, President Roosevelt asked for four new battleships and Congress was straightway petitioned by hundreds of prominent turn-the-other-cheekers not to build any battleships. "Shoo, fly, don't bother us. Let us sleep."

We are the greatest industrial people in the world, and we do not want to be burdened with a large standing army. Furthermore, we are fearful that a large standing army would be a menace to our liberties under the guidance of some favorite general or autocratic president.

But we do need *something* of an army, and at the present time we have practically no army at all. The standing army of the United States to-day numbers 75,000 men—mostly engaged as common laborers and servants to the officers. We ought to have at the very least an army of 250,000 men.

The ordnance department asked the last congress for the privilege of keeping important inventions secret and not to make them public by being obliged to advertise for bids for manufacture; but this petition congress has denied.

Water can not rise above its source, and the wisdom of the American congress can not be expected to rise far above the average intelligence of the common people. This is a government of the people, by the people and for the people; and altogether it is the best government in the world for white men to live in. But a government of the few, by the few, and for the few, may make a better war machine.

In Japan, it is only necessary for the Mikado and a few advisers to hold a board meeting and to decide and act upon any measure. Such facility of action as compared with the cumbersone methods of our congress, is like fishing for trout with a light rod and reel compared with fishing with a huge pine tree and making every movement with a derrick.

All the other great powers are arming themselves to the teeth. "But how does this concern us?" asks the American egotist. "We believe that we are the beloved of all the nations. They are all our personal friends."

The present attitude of our American egoism is that we are absolutely without fear. "We have whipped and shall always be able to whip all creation. We are such terrible fighters that guns would only be an encumbrance and burden us in our headlong rush upon the enemy to wring his neck.

"Besides, there is the great American genius which we can draw upon at any time, as we would draw cider from a barrel, and it is only necessary for the conjunction of the American genius with opportunity to make the fantasies of Jules Verne, H. G. Wells and Roy Norton become actualities. The world would have to step in and hold us then or we should do something awful."

Armies can not be made in a day. It takes three years to convert the average citizen into a real soldier. For the first year an army of raw recruits is only a mob.

The modern battalion of veterans is like the flying wedge of a football team—it acts as a unit. How many undisciplined citizens would be required to oppose the onslaught of the flying wedge of Yale? A plain citizen may have the making of a very great pugilist, and still, without training and experience, he could not stand for long in front of a lusty prizefighter.

Arm the American soldier and train him as the soldiers of other nations are armed and trained, and protect him from sickness as the Japanese soldiers are protected, and there is no army in the world that could whip an American army on equal terms.

We do not want to become a great military power and the only way to prevent it is to maintain a navy so powerful as to preclude any possibility of an invasion of a foreign foe—a navy strong enough to withstand any possible coalition against us.

Then we should not need a large standing army. Then we might love and trust our neighbors—but cut their cards.

Should our fleet by any possibility be destroyed, and our country invaded by a foreign foe, it might cost us five billions of dollars and 500,000 lives to dislodge the enemy and to build another fleet such as we would then know we ought to have. Five billions of dollars would build us a navy far larger and more powerful than the combined navies of the world and place us in a position to enforce universal peace.

The peace advocates are so short-sighted that they do not see that if we build but a few guns, we are obliged to slaughter with them, whereas if we were to build guns enough, we could then make war on war and put an end to slaughter.

When we have only a few guns, and not enough to prevent war, then we must use them for killing. If we build guns enough, then we prevent war, and the gun is converted from a death-dealing implement into an instrument for saving life.

HUDSON MAXIM

PUBLIC LECTURES ON MEDICAL SUBJECTS AT THE HARVARD MEDICAL SCHOOL

THE faculty of medicine of Harvard University offers a course of free public lectures, to be given at the medical school, on Saturday evenings at 8, and Sunday afternoons at 4, beginning January 3, and ending April 25, 1909. No tickets are required. Following is a list of the lectures and their subjects, with dates:

January 3—"Fifty Years of Surgery: A Review," Dr. David W. Cheever.

January 9—"Some Things Parents should know about the Teeth of their Children," Dr. Charles A. Brackett.

January 10—"Anatomical Variations," Dr. Thomas Dwight.

January 16—"Auditory Vertigo: Deafness due to Ear Disease," Dr. Clarence J. Blake.

January 17—"Inflammation," Dr. William T. Councilman.

January 23—"Diphtheria and Scarlet Fever," Dr. John H. McCollom.

January 24—"The Circulation of the Blood," Dr. William T. Porter.

January 30—"On the Work for the Relief of the Sick of Various Agencies Other than Medical," Dr. James J. Putnam.

January 31—"Rabies" (illustrated), Dr. Langdon Frothingham.

February 6—"Curvature of the Spine, and School Life," Dr. Edward H. Bradford.

February 7—"Methods of Testing the Acuteness of Vision and Color Perception," Dr. Charles H. Williams.

February 13—"Psychotherapy: Its Use and Abuse," Dr. Richard C. Cabot.

February 14—"Infantile Paralysis and its Treatment," Dr. Edward H. Bradford.

February 20—"The Teeth of Public School Children: How Related to the Children's General Health and Development," Dr. William H. Potter.

February 21—"Psychotherapy: Its Use and Abuse," Dr. Richard C. Cabot.

February 27—"A Study of the Inoculable Tumors of Mice, with Special Reference to Heredity" (illustrated), Dr. Ernest E. Tyzzer.

February 28—"The Hygiene of Pregnancy" (to women only), Dr. Charles M. Green.

March 6—"Glucose," Dr. Lawrence J. Henderson.

March 7—"Pneumonia," Dr. Elliott P. Joslin.

March 13—"Feeding and its Relation to the Infant's Development," Dr. John Lovett Morse.

March 14—"School Life and its Relation to the Child's Development," Dr. Thomas Morgan Rotch.

March 20—"Some Facts as to Disease of the Heart," Dr. Henry Jackson.

March 21—"The Relation of Gastroenteric Conditions to the Development of Early Life," Dr. Charles Hunter Dunn.

March 27—"Dental Hygiene in the School and Home," Dr. Samuel A. Hopkins.

March 28—"State Work in Tuberculosis," Dr. Arthur Tracy Cabot.

April 3—"The Work of the Boston Consumptives' Hospital," Dr. Edwin A. Locke.

April 4—"Psychotherapeutics," Dr. Philip C. Knapp.

April 10—"The Diagnosis and Prognosis of Surgical Affections, with Special Reference to their Early Detection and Treatment," Dr. Maurice H. Richardson.

April 11—"Progress in the Treatment of Cancer," Dr. James G. Mumford.

April 17—"Good and Evil Results of Athletics," Dr. Edward H. Nichols.

April 18—"The Artificial Illumination of Schoolrooms," Dr. Myles Standish.

April 24—"Athletic Sports at Various Ages and their Probable Results upon the Body" (illustrated), Dr. J. Bapst Blake.

April 25—"Louis Pasteur," Dr. Harold C. Ernst.

THE SARAH BERLINER RESEARCH FELLOWSHIP FOR WOMEN

The committee in charge of the Sarah Berliner Research Fellowship for Women will offer, every two years, a fellowship to the value of twelve hundred dollars, available for study and research in physics, chemistry or biology in either America or Europe. This fellowship is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research; it will be awarded only to those who give promise of distinction in the subject to which they are devoting themselves.

Applications for this fellowship must be in the hands of the chairman of the committee by March 1 of the year of each award (March 1, 1909, for the first award). They should state as clearly as possible the candidate's claim to the appointment, and they should contain, in particular, (1) testimonials as to the value of work already done, (2) copies of published contributions, or other accounts of investigations already carried out, (3) evidence of thoroughly good health, (4) detailed plans for the proposed use of the fellowship. The members of the committee are Mrs. Christine Ladd Franklin, Chairman, Johns Hopkins University, Baltimore; Miss M. Carey Thomas, President of Bryn Mawr College; Miss Laura D. Gill, President of the Association of Collegiate Alumnæ; President Remsen, of the Johns Hopkins University; and Professor Howell, Dean of the Johns Hopkins Medical School. The donor of this fund is Mr. Emile Berliner, of Washington. well known as one of the perfectors of the telephone and the inventor of the gramophone. It is named in honor of the donor's mother.

THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS

The second meeting of the International Association of Medical Museums was held in the National Museum, Washington, on October 18 and 22, in connection with the International Congress of Tuberculosis. This association, formed for the furtherance and promotion of the efficiency of medical museums as storehouses of material useful for teaching and for research as well as for recording the results of research, will also serve as a medium for the interchange of specimens, and for the discussion and publication of technical methods useful in such work. To aid in making this work more generally available, a Bulletin is published in which the papers communicated will appear and through which exchanges may be effected.

All persons engaged in or interested in the work of medical museums are eligible for election to membership in the association, and the list of members is already large and includes many prominent pathologists and medical men from all countries of the world.

At this meeting Dr. W. G. MacCallum was elected president to fill the place vacated by the death of Major James Carroll, the first president, and Dr. Maude E. Abbott, of McGill University, was made secretary and treasurer. Beside the transaction of business and the discussion of questions of organization and policy, the following papers were presented:

"On the Preservation of the Results of Research as Material for Medical Museums," Dr. W. G. MacCallum, Baltimore.

"On the Classification of Museum Specimens," Dr. M. E. Abbott, Montreal.

"Demonstration des photographies en couleur des pièces et des coupes microscopiques," Professor Arloing and Professor Courmont, of Lyons.

"Preservation of Museum Specimens in their Natural Color," Professor Souchon, New Orleans.

"Demonstration of Methods of Mounting Specimens in Gelatin," Dr. Watters, Boston.

"Methods of Mounting Museum Specimens," Mr. E. L. Judah (presented by Dr. Adami, Montreal).

"A Rapid Method of Macerating Bone," Mr. Izzard, Cambridge, England.

"Demonstration of a New Form of Museum Jar," Dr. Warthin, Ann Arbor.

"Demonstration of Anomalies of the Heart," Dr. Abbott, Montreal.

THE SECTIONAL MEETINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Section A—Mathematics and Astronomy—will meet for organization on Monday morning, December 28, immediately after the first general session of the association. Monday afternoon will be devoted to astronomical papers of general interest, beginning with the address of the retiring vice-president, E. O. Lovett, president of the new William M. Rice Institute for the Advancement of Literature, Science and Art, of Houston, Texas. The subject of this address is "On the problem of three bodies." On Tuesday the section will hold two sessions which will be devoted exclusively to astronomical papers.

As the American Mathematical Society will hold its annual meeting in affiliation with the association, all the mathematical papers are expected to appear on its program. The sessions of this society will begin on Wednesday morning and extend through Thursday. The retiring president, Professor White, of Vassar College, will give an address on "Bezont's theory of resultants and its influence on geometry," which will be of general interest to scientific men. The complete program of this society and that of Section A of the association will be distributed on Monday morning.

It is hoped that many of the astronomers may attend the meetings of the American Mathematical Society and that many members of this society may avail themselves of the opportunity to listen to the astronomical papers to be read before Section A on the days immediately preceding those of their own special meetings. Titles and abstracts for the Mathematical Society program should be sent to Professor F. N. Cole, Columbia University, while those intended for Section A may be sent to the secretary, Professor G. A. Miller, University of Illinois. Abstracts should be in a form immediately available for publication, and should be accompanied by detailed explanations in case the importance of the results can not be readily determined from the abstract alone.

The usual arrangement for joint meetings of Section B and the Physical Society for the reading of papers will doubtless be made. The last annual meeting at Chicago was a great success and a still larger one is expected at Baltimore. The presiding officer of Section B is Professor Karl E. Guthe, of the State University of Iowa, and the address of the retiring vice-president will be given by Professor Dayton C. Miller, of the Case School of Applied Science. It is probable that one session will be devoted to a program of general interest to all scientists.

The program of Section D—Mechanical Science and Engineering—includes papers by the following: G. M. Brill, Chicago, Ill., L. F. Moody and A. M. Greene, Jr., Troy, N. Y., J. F. Hayford, Washington, D. C., W. G. Raymond, Iowa City, Iowa, N. C. Ricker, Urbana, Ill., J. J. Flather, A. E. Haynes and B. F. Groat, Minneapolis, Minn., C. M. Woodward, St. Louis, Mo., A. H. Blanchard, Providence, R. I., G. W. Bissell, East Lansing, Mich., and the possibility of three or four other papers. The vice-presidential address will be given by Professor O. H. Landreth, of Union College, Schenectady, N. Y.

The meeting of Section E—Geology and Geography—this year will be one of special interest to all geologists and geographers. The president of the association is Professor T. C. Chamberlin, one of our most distinguished geologists. The vice-president of Section E has prepared a most interesting symposium on correlation. The Geological Society of America and the Association of American Geographers will both meet in affiliation with the American Association for the Advancement of Science, and it is proposed to hold a joint meeting of the three organizations to discuss their mutual relations, in order that the officers of the three may be able to plan future meetings for the reading of papers and for field excursions, so that the needs and wishes of all geologists and geographers may be met as fully as possible.

The sessions of Section G—Botany—will convene under the vice-presidency of Dr. H. M. Richards, in the rooms of the botanical department of the Johns Hopkins University, and will alternate with the sessions of the Botanical Society of America, as at the Chicago meeting. The address of the retiring vice-president, Dr. C. E. Bessey, will be on "The Phyletic Idea in Taxonomy."

Section L—Education—will hold five sessions, three independent sessions and two joint sessions. The topics and speakers for the independent sessions are: 1. The Relation of the Bureau of Education to the Other Educational Work of the Country, President Harry Pratt Judson, Professor Edward C. Elliott, Superintendent E. C. Moore. 2. American College Education and Life, Professors Josiah Royce, Wm. North Rice, President Wm. L. Bryan and others. 3. The Relation of Governments to Education (address of the retiring vice-president), Hon. E. E. Brown, U. S. Commissioner of Education. The first of these sessions will be held on Tuesday, December 29, at 2 P.M.; the second on Wednesday, December 30, at 2 P.M., and the third on Thursday, December 31, at 3 P.M.

One of the joint sessions will be held on Tuesday, December 29, at 10 A.M. with the American Federation of Teachers of the Mathematical and the Natural Sciences at which the topic: The Problems of Science Teaching will be discussed by Presidents R. S. Woodward and Ira Remsen, and Professors John M. Coulter, N. M. Fennemann, George F. Stradling and William T. Campbell. The other joint session will be held on Wednesday, December 30, at 10 A.M., with the American Psychological Association, at which meeting reports of experimental work in educational psychology will be presented and discussed by a number of investigators in this field.

THE ANNUAL DUES OF MEMBERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The permanent secretary of the American Association for the Advancement of Science begs to call the attention of members to the fact that the annual dues (three dollars) for the year beginning January the first should now be sent to him. The financial year of the association now ends on October 31, and the dues for the following calendar year should be paid as soon as possible after that date. The dues are so small and the membership of the association has become so large that the sending of statements involves an expenditure of time and money, which, so far as possible, should be saved. The office of the permanent secretary must be removed to the place of meeting at Baltimore during the last week in December, and the dues should be paid prior to that time. If they are not paid before January 1, there are serious complications in regard to the sending of Science to members. The association can not make itself responsible for sending Science to those whose dues are in arrears, as there are some who may regard the non-payment of dues as equivalent to resignation from the association. The back numbers will be sent to those who pay their dues after January the first upon application to the publishers and the payment of postage at the rate of one cent a copy, so far as the edition permits, but the publishers do not guarantee that this will be done. Should the edition threaten to become exhausted, it will be necessary for those who wish to keep their sets of Science complete to pay for the numbers at the rate of fifteen cents each.

The permanent secretary takes this occasion to remind members of the desirability of assuming life membership in the association. By the payment of fifty dollars at the present time, all future trouble and expense is avoided. The fees of life members are ultimately transferred to the permanent fund, the income of which is used exclusively for the encouragement of research, and those who assume life membership thus contribute materially to the advancement of science.

L. O. Howard,
Washington, D. C. *Permanent Secretary*

SCIENTIFIC NOTES AND NEWS

It is announced that the Nobel prizes for 1908 are to be awarded as follows: For chemistry, Professor Ernest Rutherford, director of the physical laboratories of the University of Manchester, England; for literature, Algernon Charles Swinburne; for physics, Dr. Max

Planck, professor of physics in the University of Berlin; for medicine, divided between Dr. Paul Ehrlich, of Berlin, and Professor Elie Metchnikoff, of the Pasteur Institute of Paris.

At a recent meeting of the board of directors of the Rockefeller Institute for Medical Research, Dr. Rufus I. Cole, of the Johns Hopkins Medical School, Baltimore, was appointed director of the Hospital of the Rockefeller Institute for Medical Research and Dr. Christian A. Herter was appointed physician to the hospital. Work on the hospital buildings is in progress. It is expected that the hospital will be completed and ready for occupancy in November, 1909.

Dr. S. F. Harmer, F.R.S., fellow and assistant tutor of King's College, Cambridge, has been appointed keeper in zoology at the British Museum of Natural History.

Mr. A. H. Kirkland, superintendent of the Massachusetts state work against gypsy and brown-tail moths, has resigned his office.

Dr. William Morton Wheeler, who, during the past summer accepted the professorship of economic entomology in Harvard University, has recently been appointed honorary curator of social insects in the American Museum of Natural History, where, until the present year, he had been curator of the department of invertebrate zoology since 1902. At the close of his term of service at the museum, he presented to the institution his entire collection of Formicidæ—the result of many years of earnest effort and study—a gift of such value as to make the museum the possessor of the finest collection of its kind in America and one of the three largest in the world.

Mr. Eduard Essed, B.Sc. (Edinburgh), has been appointed forest botanist to the government of Dutch Guiana.

Professor John M. Coulter has been appointed to represent the University of Chicago at the University of Cambridge Darwin memorial celebration.

MM. Edmond Perrier and Van Tieghem have been appointed delegates from the Paris Academy of Sciences to the Darwin centenary in Cambridge.

Dr. Percy Gardner, professor of archeology at Oxford, and Dr. Barclay Vincent Head, some time keeper of the department of coins and medals in the British Museum, have been elected corresponding members of the Prussian Academy of Sciences.

The council of the University College, Bristol, has appointed Dr. John Beddoe, F.R.S., honorary professor of anthropology.

We learn from *Nature* that Mr. N. W. Thomas has been selected by the secretary of state for the colonies to conduct an investigation into the laws and customs of the native tribes of southern Nigeria. The tribes to be studied are, in the first instance, those of the old kingdom of Benin, but it is probable that the inquiry will be continued and include the natives of the other West African colonies in addition. Mr. Thomas is leaving to take up his duties in a few weeks.

Dr. Charcot and his companions left Buenos Ayres, on November 23, on the exploration ship *Pourquoi Pas* for Punta Arenas, whence they will continue their journey to the South Polar regions.

In reply to an invitation sent him by the president of the Royal Geographical Society, President Roosevelt has promised when he goes to England, about April, 1910, after his journey in Africa, to address the society.

Professor Edwin G. Conklin, of Princeton University, is to deliver the address at the public semi-annual meeting of the Ohio Eta Chapter of Phi Beta Kappa, Ohio Wesleyan University, on the twentieth of February. The exact title of the address has not been announced, but it is to be in the nature of a Darwin centenary memorial.

The three hundred and forty-ninth meeting of the Middletown Scientific Association was held in the Scott Laboratory of Physics, Wesleyan University, on December 8, when Gordon Ferrie Hull, Ph.D., professor of physics in Dartmouth College, gave an illustrated lecture on The Electron Theory of Matter.

The former library building of Oberlin College has been remodeled and is now the

Spear Zoological Laboratory. Some of those who were students under Albert A. Wright, the former professor of geology and zoology, have placed in this building a tablet bearing the words:

To
Albert Allen Wright
for thirty-one years
Professor of Geology and Natural History
in Oberlin College
1874–1905

An expression of the honor and love of its pupils.

Labor that in lasting fruit outgrows
Far noisier schemes, accomplished in repose,
Too great for haste, too high for rivalry.

The Empress Auguste Victoria has presented to the Senckenberg Natural History Society of Frankfort a bust of Goethe by the sculptor Ernst Freese, which has been erected in the entrance hall of the new museum of the society.

Dr. Andrew J. McCosh, professor of clinical surgery at Columbia University and eminent as a surgeon, died on December 2 at the age of fifty years. His death resulted from being thrown from his carriage while on the way to the Presbyterian Hospital, where he had been a surgeon for nineteen years.

The attendance of the joint Conservation Conference, meeting at Washington this week, is composed of men who have been active participants in the work for conservation since the White House Conference. About half the governors have definitely said that they will be present and the others will send representatives of their states. These governors or their representatives are accompanied by the members of the state conservation commissions which have been named during the summer and fall. In addition to these there will be present the special conservation committees which have been formed by twenty-five or more national organizations. The session on the morning of the eighth was a more or less informal gathering in the Red Room of the Willard Hotel for the purpose of organizing. At 4:15 o'clock that afternoon was the general meeting at the Belasco Theater, at which President Roosevelt and President-elect Taft were among the speakers to address the members of the joint Conservation Conference, the Rivers and Harbors Congress, the Southern Commercial Congress and other organizations with allied objects whose sessions in Washington at that time will help to make up what has been called "Conservation Week." After that the joint conference was to take up its business at the Hubbard Memorial Hall. The plan was to take up one after another the main subjects which the National Conservation Commission has been studying—waters, lands, forests, minerals.

At the General Assembly of the International Institute of Agriculture, held in Rome on November 27, Signor Tittoni, the Italian minister for foreign affairs, was appointed president, and M. Muravieff, the Russian ambassador, and Sidney A. Fisher, the Canadian minister of agriculture, were chosen vice-presidents.

A free public museum and scientific laboratory has recently been established in Reading, Pa. The public school board is furnishing the cases for the exhibition of material now on hand. The museum is located in the old boys' high school, recently vacated. The material now on hand is largely of the nature of commercial interests although it is proposed to include all branches of natural history. The administration is under the direction of the Reading school district. Professor Levi W. Mengel is the director.

The Garden of the Gods, is to become by gift of the children of the late Charles E. Perkins, of Boston, the property of Colorado Springs. Papers have been filed whereby the six children and heirs deed to three trustees the 480 acres comprising the Garden of the Gods, authorizing them to transfer the same free of charge to the city of Colorado Springs before January 1, 1911. The tract comprising the Garden of the Gods was secured by Mr. Perkins in 1879, and has always been free to the public. It was his wish that this scenic attraction forever be open to the world, and it is in accordance with his expressed wishes that the transfer is made.

THE Drapers' Company has granted £500, to be paid in five annual instalments of £100, to the Middlesex Hospital cancer research fund to assist the governors in maintaining the investigations which are being pursued into the cause of cancer and its cure.

UNIVERSITY AND EDUCATIONAL NEWS

THE legislature of Vermont has acted favorably upon the proposition to establish at Middlebury College a department of pedagogy for the training of high school teachers. The bill, which has been signed by Governor Prouty, carries an annual appropriation of $6,000.

RICHMOND COLLEGE, at Richmond, Va., controlled by the Baptists of that state, has collected $350,000, required to secure a conditional gift of $150,000 from Mr. John D. Rockefeller.

EIGHTEEN months have now elapsed since the Chancellor's Fund for the further endowment of Oxford University was inaugurated. The committee then appointed under the chairmanship of Lord Curzon to organize the appeal has so far been successful in its efforts to raise the required sum of £250,000 that it has now received gifts or promises of a total value of more than £133,000. Recent subscribers have been: Sir Julius Wernher, £2,000; Mrs. Craig-Sellar, £1,000; Mr. Otto Beit, £500; the Merchant Tailors' Company, £500; Mr. J. Hamilton Beattie, £300; Mr. Gerard Craig-Sellar, £300; the Skinners' Company, £250. Mr. Henry Phipps has added £200 to his original gift of £1,000, and Lord Brassey has given £200 for the School of Geography in addition to the £1,000 promised by him for the School of Engineering.

THE board of managers of Haverford College and the faculty held recently their annual joint meeting. The topics for discussion were the advisability of increasing the number of dormitories, and as to whether it would be well to limit the number of students by raising the entrance requirement.

THE Central Association of Science and Mathematics Teachers, at its meeting held in Chicago on November 28, unanimously passed the following resolutions as embodying the conclusions of the association with regard to two important matters of interest to all teachers of science:

Resolved, That we believe in the recognition and inclusion within our courses of the practical and applied aspects that make possible an appreciable significance and belief in the worthwhileness in practical life of the various subjects studied; and

Resolved, That we believe that the formulation of secondary school courses should be made entirely from the point of view of the needs of the majority of secondary school pupils; and, further, that any course that is best for the majority of secondary school pupils is best for college entrance.

PROFESSOR WALTER S. GRAFFAM, of Howard University, Washington, D. C., has accepted the instructorship in mechanic arts at Smith's Agricultural School and Northampton School of Technology. He will be placed at the head of the mechanic arts department, and will take up his new duties September 1, 1909.

DEANS of faculties at the University of London have been elected as follows: For medicine, Professor S. H. C. Martin, F.R.S.; for science, Professor J. M. Thomson, F.R.S.; for engineering, Professor W. E. Dalby.

DISCUSSION AND CORRESPONDENCE

AN ELECTRIC STORM ON THE WASHAKIE NEEDLES

To the issue of SCIENCE of November 6, 1908, Professor J. E. Church, Jr., contributes an article entitled, "Electric Disturbances and Perils on Mountain Tops." The exceedingly interesting phenomena there described recall a personal experience, vivid and unpleasant, and of like character, but differing enough in detail to render it possibly worthy of being recorded. It has remained until now unpublished, because I feared that as it came from one who had no pretensions to scientific education, it might not meet with credence. What follows happened near the top of some mountains in Wyoming, to the southeast of the Yellowstone Park, generally known on local maps as the Washakie Needles. Visible from a long distance, these sharp gray peaks are somewhat higher than the surrounding range, and two well-known streams, Owl Creek and Grey Bull, flow from their eastern side and at length join the Big Horn River. The height of these mountains I do not know, but as they rise well above timber line, I think it likely that they are near 10,000 feet high.

Instead of rewriting the story, I transcribe directly from my journal (written on return to camp) such passages as refer to the electric occurrences which I observed during the afternoon of Thursday, August 30, 1888.

We went up toward the head of the valley, watching the big thunder cloud that we trusted was traveling parallel with our course. One last sheep moved away out of sight, in front, and it became very much colder. Two or three valleys off to the right, long black streamers let down from the cloud, waving mistily just over the pines, and if you looked hard, you saw the water come down in them; but still an uninvaded strip remained between that and where we were, where the air was clear and no drizzling had begun. We went on a little way, and when I looked across again the strip had narrowed and gray bars of rain were falling between us and pieces of woodland that had been unblurred the last time I had seen them. . . . I put on my rubber coat. (This was made like a pea-jacket.) When we got to the head of the valley there was a very much larger cloud coming down on us, you may say, across the wind. We turned, following the ridge toward the big Needle which we had gradually got between ourselves and camp. Below us began a new valley at the bottom of a cauldron. On the other side of the cauldron the air became thick white; then a sheet of storm came across. The cauldron went out of sight, and the hail began at a rate to chip pieces off one's ear. The ground swarmed with bouncing pellets, and they soon filled up the holes between the stones which lay on the hillside. We got down, and huddled each under his horse, and the horse did as much huddling by himself as he knew how. We could see nothing but a general shooting slant of white. All the lines of the mountains were gone. I got the brim of my hat down against my collar, but not before a train of hailstones had rolled down my spine. . . . The lightning was constant, and getting nearer. We were the only raised objects in the district, and we had four guns. So George got away from the group of horses, guns and men and crouched along in the hail, and I crouched after him. Every now and then a particularly ugly crash of thunder would happen, and this would seem to prod George a few feet further away from the dangerous mass of attraction. I did not at all relish the situation. I was chilled all the way through, my shoes had been cold a long while and now grew steadily wet. I dragged off a limp mass of slush, once my glove, and I pondered on the phenomenon of lightning. . . . I turned round and saw Richard's bent head, and Paul wearing a most miserable expression (these two men were Indians), and the shrinking horses, with their tails tucked in and their heads tucked down, and all four feet converging into a pivot under their middles. . . . This gave me a notion of my own appearance, and I roared enough to have made me warm in any other weather but what was going on. The hail melted on my rubber jacket, and trickled down on my breeches where the seat of them was thin by the constant saddle. So far as the look of things went, it was mid-winter and no sign of spring. The pelting lasted a long time, at the same unslackened rate, but at last it began to fall more gently and wetter, and the view thinned out in front till part of the valley came into sight, very faint and with impenetrable hail coming down beyond. Everywhere was white that was not too steep for the stuff to lodge upon. Paul and Dick went off to look over the divide and see if we could go home a new way. And then a thing happened which must seem incredible to any but the man who has knowledge of it by theory or experience. I was wandering about with George, noting the decrease of the storm, when something near my head set up a delicate hissing or spitting. I listened and found it was in my hat. . . . The hail came very fine and gently now, but it began stinging behind my ear worse than it had done at all. Getting tired of this, I turned my face to the wind that was left, and found the hail perfectly harmless, while the stinging behind grew a little sharper. My hat continued to hiss. Feeling very uncanny, I called out to George to know if anything was the matter with his head, explaining what was going on around mine. He nodded uneasily, and drew away from me as if I were an explosive. I connected my hat with the stinging somehow, and pulled it off. The hissing was in the brim, and died out as I stared at the leather binding and the stitching. The pricking behind my ears stopped too. George, a little below me on the hill, complained with his hand up to his head that it was getting unbearable. "Take off your hat," I said. He did, but relief not coming at once, "Take off your spectacles," I added. These measures were successful, and we discussed what had ailed us. According to George, our hats, becoming damp, had been charged like Leyden jars and, growing overcharged, had unloaded into our heads.

I have made no attempt to change and render more dignified the somewhat informal character of this chronicle. It was written a few hours after the experience in the hailstorm which had not reached the valley where our camp was. When we returned there, we found the aspect of summer as unchanged as when we had left it in the morning. On the top of the mountains the hail stayed only a few hours beneath next day's sun. As we continued our hunt for mountain sheep, there was not a trace of it.

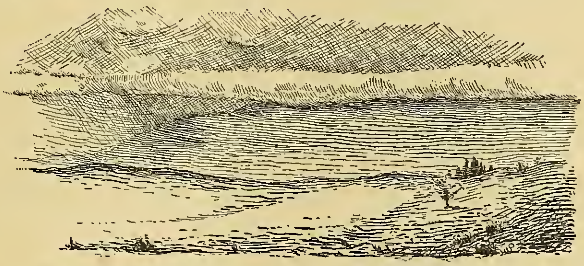
Owen Wister

Philadelphia,
November 21, 1908

A NOTABLE CLOUD BANNER

To the Editor of Science: Early in July, 1907, an exceptionally fine cloud banner formed on the southern end of the Bridger range in southwestern Montana. This range, an isolated outlier of the Rockies, trends north and south, thus acting as an obstruction to frequent squally and showery northwest winds which approach it across the Gallatin Valley to the westward. On the occasion mentioned, the writer was camped six miles east of the southern end of the range. Brisk thunder showers from the northwest had occupied most of the afternoon until about five o'clock, after which the sky remained overcast with nimbus and occasional flying patches of fracto-nimbus. Presently little cloud caps began to form on the range, as a result of the adiabatic cooling of a northwesterly air-current forced to rise in crossing the obstruction. They grew rapidly, very soon uniting into a long cloud cap over the whole visible length of the range (five or six miles) and trailing off to leeward from its southern end to a distance of two—a cloud seven or eight miles long in all. The ragged end at intervals sent off scraps resembling fracto-nimbus, which were gradually dissipated as they drifted away from the parent cloud.

The spectacle of a cloud-waterfall over Bridger Peak, the highest portion of the range visible from camp, was nothing short of magnificent. Enormous billowing masses surged one after another across the peak, cascading down the leeward slopes and vanishing in succession as a result of adiabatic warming.



There was no associated standing cloud to leeward. Either the obstruction offered by the range to the passage of the air-current was insufficient, or the current itself was too weak, to set up a secondary wave high enough to raise the air again to condensation level. In this respect the Bridger cloud differed from the clouds over the Cross Fell range in northwestern England, where the famous Helm Bar often tops the crest of a long standing wave to leeward of the mountains. Its occurrence is described by Brunskill in the *Quart. Jour. Roy. Met. Soc.*, X., 1884, 267–275. Professor W. M. Davis reports a similar case for the Cevennes in the *M. Z.*, XVI., 1899, 124–125.

The present phenomenon lasted about two hours, though in its best development not more than an hour. Toward the end the banner gradually decreased in length, the cascading stopped, the cloud cap broke into isolated patches, until finally only a few bits of gray mist remained clinging to the summits.

The accompanying sketch of the southern two thirds of the cloud was made by Mr. H. W. Packard, of Brockton, Mass., from a photograph taken by the writer.

B. M. Varney

Harvard University,
May 19, 1908

THE TRAINING OF INDUSTRIAL CHEMISTS

To the Editor of Science: May I be permitted to offer a few remarks on Dr. Chas. S. Palmer's recent letter[1] regarding the training of industrial chemists and may I correct at least one rather important error into which he has fallen? He says (p. 726):

> But the quotations also show another thing, namely, that Professor Kipping has never been in active responsibility of a chemical works [*sic*] and really does not understand practical industry.

As a matter of fact Professor Kipping had a very active responsibility in a very large chemical works for a number of years, before he became a teacher.

So far as industrial chemistry is concerned, it will probably be admitted that Germany is highly successful in chemical manufactures and that, broadly speaking, England and the United States are not.

It is well known that in the successful German, American and English works two classes of chemists are employed, the "combined analytical machine and foreman" and the investigators. Before being engaged these latter spent eight or more years in obtaining a *chemical* training, and they have to demonstrate their ability to carry out research—by carrying it out. In the English works from which the loudest complaints come—and I believe that the same is true of the United States—it will be found that their "chemist" is a man of very partial training, which seldom exceeds, if indeed it equals that represented by a bachelor's degree. Not only has this unfortunate person had no practise in research, but, as a rule, he is loaded down with routine tests and analyses, and then the manufacturer wonders loudly why the profits do not increase. It speaks volumes for the native ability of his "chemist" that there are any profits at all. In the meantime the dividends of the German works continue to grow.

Judged by results, can there be any doubt which is the better system?

Practically, every technical problem is divisible into two parts. One is purely chemical and deals with such questions as the nature of a reaction, or the conditions affecting the yield of a substance. The second is more essentially engineering and is concerned with containers, transportation, design or construction of plant, etc. We know, however, that in order to carry out successfully independent investigations in pure chemistry, a man must have a suitable mind and, after leaving the high school, must spend about eight years in training. Nevertheless, some manufacturers take an individual who has had only *four years study of chemistry and engineering combined* and expect him to solve problems in *both subjects*. Moreover, certain of these employers are willing to pay as much as $600 per annum to the prodigies in question!

Dr. Palmer's reference to the numerous "fine young students" who "have information by the brainful"—whatever that may mean—is rather funny. His complaint that they can not "apply one thousandth part of what they know" simply proves that they have not been trained in research work. It would be interesting scientifically to be informed exactly as to how much chemistry is represented by 0.001 of the total chemical knowledge of these wonderful "fine young students." It would be more than interesting to encounter one of Dr. Palmer's theories arrayed in overalls, or indeed, in any other garments!

J. Bishop Tingle

McMaster University,
Toronto, Canada,
November 23, 1908

[1] Science, XXVIII., 725, November 20, 1908.

THE TARIFF AND SCIENTIFIC BOOKS

To the Editor of Science: The House Committee on Ways and Means is now holding hearings on the proposed revision of the tariff and is asking all interested parties to appear before it to state their views. Is any one preparing to appear before the committee armed with the necessary facts to show the folly and injustice of the tariff on scientific books written in the English language? Regarded as a means of raising revenue, this tariff is insignificant; regarded as protection, it is an insult. From any other point of view it is simply an oppression suffered by American men of science, whose efficiency is usually impaired besides by incomes insufficient for their needs, and this tariff has for its sole effect to make good scientific work more difficult than it would otherwise be by hindering the ready access to the literature published in another country.

Of course any effort to remove the tariff on English books will be opposed by the publishers of school books, and perhaps also by those who publish popular fiction. The tariff on these classes of books probably does no great harm, and it might be allowed to stand at the present rate of twenty-five per cent.

This being admitted, there arises the administrative difficulty of distinguishing in the custom house between English books which would be dutiable and those which would be on the free list. But this difficulty would not seem to be insurmountable. For example, there is, I believe, a clause of the copyright law which provides for the admission of foreign books to American copyright. Might not the difficulty be met and our object be gained at the same time by the simple provision that all English books which are copyrighted in the United States shall be subject to the present import duty of twenty-five per cent. *ad valorem*, and that all other books may be imported duty free? Under this provision the publishers of school books and popular fiction in America would receive the same protection as at present; while the English publishers of scientific works, for which the demand is too small to be a temptation for reprinting, might be expected to avoid the copyright as an unnecessary expense and a hindrance to the free entry of their books into this country.

R. P. Bigelow

SCIENTIFIC BOOKS

Climate. Considered especially in Relation to Man. By Robert DeCourcy Ward. 8vo, xiv + 372 pp. New York, G. P. Putnam's Sons; London, John Murray, 1908. (The Science Series.)

In 1903 Mr. Ward rendered excellent service by translating and publishing the first volume of Hann's classic "Handbuch der Klimatologie," thus making available to a larger circle of readers the best text-book on the principles of climatology that has thus far appeared. Ward's "Climate" may be regarded as a supplement to the first volume of Hann's handbook, in which the author sets forth clearly and systematically some of the broader facts and relations of climate, primarily for the benefit of the general reader, although the needs of the teacher and student are not overlooked.

The introduction is essentially a condensed synopsis of the first six chapters of Hann's handbook, preparing the way for a better understanding of the chapters which follow. The classification of climatic zones is treated at considerable length, including a discussion on the climatic types resulting from the control of land, water and altitude. Chapters IV. to VI. give an excellent account of the characteristic features of the different zones, and chapter VII. discusses the relations existing between weather, climate and diseases. The three following chapters are devoted to a consideration of the life of man in the three principal zones. In the final chapter the author considers the evidences of change of climate during the historic period.

In the primary classification of climates Mr. Ward wisely adheres to the simple and time-honored classification into three zones—the tropical or warm zone, the temperate or intermediate zone, and the polar or cold zone—

although considerable space is devoted to a presentation of the principal modifications which have been proposed. While there is a great temptation to break away from the established classification and to introduce a scheme more in harmony with the actual conditions in the separate zones, the advantages of the new classifications are not sufficiently great to outweigh the simplicity and established usage of the old. However attractive may be some of the features of the proposed climatic zones of Supan, based upon common characteristics of temperature, rainfall and winds, or those of Koeppen, based upon the relations of plant life to certain critical values of temperature and rainfall of the warmest and coldest months, or of Merriam's biological zones, based upon the distribution of animal life, there are serious obstacles to their general acceptance; they all lack a simple expression for certain definite combinations of temperature, sunshine and winds. The term "temperate zone" is apparently the most objectionable, as the most extreme climates occur within its limits, especially in portions of the northern hemisphere. Still the word well describes the conditions of the zone as a whole, especially in the southern hemisphere. Even in the northern hemisphere fully half the area of the zone has a water surface, insuring temperate conditions. It is only over the continental portions that great extremes of heat and cold occur. Taking the earth as a whole, the terms warm, temperate and cold fairly well divide the climates of the globe into three natural divisions with the tropics and the polar circles as dividing lines. The secondary classification of climates into continental, marine and mountain is simple and practical and has general acceptance.

The author's summary of the characteristics of the three principal zones is especially valuable, as the student will find in these chapters a clearer and fuller synopsis of an abundant literature than is available elsewhere to those who read English only.

Hygiene in the tropics is, according to the author, mostly a question of sanitation, and a rational mode of living, as most diseases only indirectly depend upon climatic conditions. Change of residence, of habits, of occupation, or of food, is usually of more importance than change in atmospheric conditions.

Many problems of great interest relating to the life of man in the tropical, the temperate and the polar zones receive attention in chapters VIII. to X. Such topics as the labor problem and climate, the government of tropical possessions, dwellings in the tropics, race characteristics and climate, climates and crops, mental effects of weather, weather and military operations, are considered, though most of them are necessarily only touched upon. In closing his analysis of the evidences bearing upon the subject of climatic changes in historic times, the author concludes that, "Without denying the possibility, or even the probability, of the establishment of the fact of secular changes, there is as yet no sufficient warrant for believing in considerable permanent changes over large areas"—an opinion shared by most students who have given the subject attention.

Mr. Ward has succeeded in presenting a well-written volume, suitable for the class-room, being methodical in arrangement, and clear and direct in statement. The illustrations are few in number but well selected and neatly drawn.

O. L. F.

Johns Hopkins University,
November 25, 1908

Ex-Meridian Tables. By Lieutenant Commander Armistead Rust, U. S. N. New York, John Wiley & Sons. 1908.

This work is primarily designed to put at the service of the navigator convenient means for reducing altitudes of celestial bodies, when measured within defined limits of hour-angle from the observer's meridian, to the values that they would have if they had been measured at culmination on the observer's meridian, and thus to provide for the application of the simple method of finding the latitude from a meridian altitude, which consists in algebraically adding together the declination and zenith distance of the observed celestial body.

Delambre's equation, in which the whole of the reduction for practical purposes is expressed in two terms, is employed as the form of reduction to the meridian.

The major term, depending upon the second power of the hour-angle, has been tabulated by the author for each degree of latitude up to 65° and from degree to degree of declination for each two minutes of hour-angle up to sixty minutes or to such lesser extent as marks the limit at which the minor term of the reduction amounts to less than 45″.

The second or minor term of the reduction, depending upon the fourth power of the hour-angle, is expressed in the form of a diagram, from which the numerical value of this part of the reduction may be readily determined.

As the intervals between the arguments of the tabulation of the major term are such that in general the tables must be entered with the approximate latitude and the approximate declination and the approximate hour-angle, convenient auxiliary tables have been supplied for taking account of the effect upon the result of differences between the exact values and the tabular values of the data. Various other diagrams and tables, providing for the identification of stars, facilitating the solution of the equation of equal altitudes, and reducing measured altitudes to true altitudes are also presented to contribute to the completeness of the work.

A navigator who makes this book one of his possessions and utilizes the information contained in it will be repaid many times through the practical benefits that he will derive from it in his daily work. G. W. Littlehales

Chemische Krystallographie. By P. von Groth. Vol. 2. Pp. viii + 914, 522 figures, 8vo, cloth, 32 marks. Leipzig, Wilhelm Engelmann. 1908. (Volumes 3 and 4 are in preparation.)

Two years ago the first volume of this very important work by Professor P. von Groth appeared. Since then the volume has proved of such great assistance to all interested in crystallized substances, but more especially to the chemical crystallographer, that the second volume, which was promised over a year ago, has been eagerly awaited. A review of Volume 1 may be found on pages 143 and 144, Vol. XXV., of Science.

In Volume 2 the inorganic oxy- and sulfo-salts are discussed. The arrangement of the first volume is retained throughout. This consists of placing together all compounds of similar chemical composition and prefacing each group with a critical résumé of the work done upon the same, so that one can see at a glance what gaps exist and also along what lines further research may be necessary. This feature alone makes the work invaluable. The descriptions of the individual members of the group, which then follow, furnish all the data extant which are of use or interest to the chemical crystallographer. This volume is in every respect up to the high standard set by Volume 1. It is hoped that the remaining volumes, 3 and 4, may follow in rapid succession.

Edward H. Kraus
Mineralogical Laboratory,
University of Michigan

House Painting, Glazing, Paper Hanging and White-washing. A book for the householder. By Alvah Horton Sabin, M.S. 8vo, cloth, pp. 121. New York, John Wiley & Sons. 1908.

This is a thoroughly reliable, readable book, dealing with the subjects of exterior and interior painting, varnishing, papering, kalsomining, white-washing and the painting of structural metal. Technical terms and long-winded descriptions are avoided, and the book should be read by every house user and owned by every house owner. The author's statement to the effect that "the talk about people being poisoned by arsenic in wall paper is nonsense," is unfortunate, as the reviewer knows certainly of one case proved to be due to this cause. A. H. Gill

Modern Pigments and their Vehicles, their Properties and Uses, considered mainly from the practical side. By Frederick Maire. 8vo, cloth, pp. 266. New York, John Wiley & Sons. 1908.

This is a most excellent book written by one who evidently knows the practical side thoroughly. There are several books which are more scientific and chemical, but there is none which will be of greater value to the chemist, the practical man or the young apprentice at the painter's trade. As an illustration of this may be cited the reason—which the reviewer has never seen before given—why American linseed oil is inferior, owing to the fact that it is made from unripe seed. Other good features of the book are the tables of color synonyms and for preparing tints.

No mention is made of artificial graphite, corn or Chinese wood oil or wood turpentine.

A. H. Gill

Man in the Light of Evolution. By John M. Tyler, Amherst College. New York, D. Appleton & Co.

Nothing could be more suggestive of the change that has come over the attitude of thought toward modern scientific ideas than this book. A generation ago our scientific fathers were in the midst of a bitter contest with the world of theistic thinkers over the truth and meaning of the doctrine of evolution. Evolution and atheism were regarded as going hand in hand, and any one who was inclined to look with kindness upon the possibility of human evolution was regarded at once as a foe to any and all forms of theism. One can not read this book of Tyler's without being impressed with the wonderful change in standpoint which a generation has produced. Not only does the work accept without question the doctrine of the natural origin of man, but its central aim is to show that the goal of evolution in the human race is to be found along the line of religious instincts, and that the church to-day is the expression of this highest development of evolution. To our fathers of a generation ago, both theistic and scientific, this would have seemed the strangest radicalism; to us to-day it seems natural and deserving of earnest thought and favorable consideration. Nothing can be more indicative that a new era in this discussion has arrived than the reading of this work.

The book traces, in a most sketchy manner, it is true, the salient features of animal evolution; the production of a stomach by the Cœlentera; of muscles by the worms; of a backbone by the vertebrates; of a brain by the mammals; and of mentality by man. It concludes that the highest phase of mentality which is now unfolding itself involves the expansion of righteousness, of unselfishness, and of the religious instinct. Not only does the religious idea become a part of evolution, but the evolutionary doctrine becomes the interpretation of the religious idea. Truly "the stone which the builders rejected, the same has become the head of the corner."

The tone of this discussion is eminently optimistic, as indeed must be any discussion of evolution that takes a broad conception of this doctrine. The indisputable law that the best adapted *must,* in the long run, be the victor, leaves no room for anything but advance, and hence for optimism. The only disquieting suggestion is, that some phases of life which we think "best" are not best. Of course, many a side branch, adopting lines of ease which led downward, will disappear; but they disappear because something better takes their place. Even the alarming tendency that has been so emphasized in recent years, towards the decreased reproductive rate among the higher classes, receives its interpretation in this discussion. These classes have adopted the easier line of life and are simply following the universal law of nature toward extinction, in order that their places may be taken by those races or classes that have retained their hold upon the line of possible advance, instead of rejecting it for the easier life. Each generation is only an incident in the great purpose of the ages, and many a side line is crowded out of existence by the greater adaptability of the central line of advance. Advance is the law of nature, and with this great doctrine of evolution fully realized, only optimism is possible.

Many other phases of the evolution doctrine are touched upon in this work that can not be referred to here. Professor Tyler is to be thanked for presenting thus a wholesome picture of the progress of the ages from a somewhat new standpoint.

H. W. Conn

SPECIAL ARTICLES

RECENT DISCOVERIES IN THE HISTORY OF THE COMMON EEL[1]

No fish is more generally and widely known than the common eel and none has been involved in more mystery. The absence of developed sexual organs has given rise to many strange hypotheses and fables. The true history has been made known only within the last two years. The most satisfactory of recent observations have been made by Dr. Johannes Schmidt, Dr. C. G. J. Petersen and K. J. Gemzöe, of Denmark.

It has long been known that the eel descends into the sea to spawn, but the exact destination has been unknown. For information respecting this, we are indebted to Dr. Schmidt, who has in great detail recorded the results of two expeditions to ascertain the facts.[2]

None of the eels found in the ocean had fully matured eggs, and the ovaries were only moderately developed. Indeed, according to Schmidt, as recently as 1906, "no one had yet succeeded in finding [in the males] spermatozoa, nor in the female eggs which were larger than 1/3 mm. in diameter, much smaller as a rule, and never clear as the eggs of other species are known to become before spawning. No one had yet described the eggs of the eel in a condition near to spawning or even approximately mature."

The period between the descent into the sea and the appearance of larvæ near the surface has yet to be known, but larvæ have been found by Dr. Schmidt in regions where the depth of the water was about 1,000 meters, and he has concluded that "the eel spawns out in places of at least nearly 1,000 meters depth." In such places, in May and June (especially about the middle of June), larval eels about three inches long are to be found. They are then mostly in the typical leptocephalus stage, diaphanous and without pigment cells, having very compressed and high or ribbon-like bodies, anus far behind, very small heads, large eyes, pointed snouts and full sets of slender teeth directed forwards in the jaws. During the succeeding months, a transformation takes place, in some early, in others delayed.

The body becomes reduced in height, especially backwards, and expands sideways, "the hindmost portion of the gut disappears," and the anus gradually advances forwards, the head at last is less disproportionate and the eyes relatively small, and, above all, the slender spike-like teeth, so characteristic of the typical leptocephaline stage, are dropped. By September and the later autumn the leptocephali of summer have mostly undergone their transformation into a later leptocephalus stage.

All this time the larval eels remain in the ocean not very far below the surface, quite near, it may be, at night, sinking downwards more or less during daylight. Late in the season they gradually approach to the shores, continuing meanwhile their change from leptocephalines into true eels. The time of their entrance into the mouths of rivers depends to some extent on the distance of those mouths from the line of about 1,000 meters or over 500 fathoms. In France, as well as Ireland and England, for instance, they may begin to enter streams as early as January or February, while in Denmark and Norway, none enter earlier than March, and the chief incursion is during April.

During the entire time from the appearance of the leptocephalines near the surface of the ocean to their entry into the rivers, the hyaline condition of the little fishes continues. The body is so diaphanous that only by the closest attention can it be detected, and then chiefly because the eyes are prominent and distinctly colored. Indeed, the first thought on seeing a school of leptocephalines may be wonder that so many eyes are floating about.

The diaphanous condition undoubtedly is an efficient protection against many of the dangers the larval eels encounter. Nevertheless it is only a partial protection. The course of the young fishes riverward is beset with dangers, and these increase as the coast is ap-

[1] Presented to the Biological Society of Washington, October 17, 1908.

[2] Schmidt (Johs.), "Contributions to the Life-history of the Eel (*Anguilla vulgaris* Flem.), Rap. et P. V. Conseil Int. Expl. Mer., V., p. 137–274, pl. 7–13, 1906.

proached. Fishes of the high seas intercept many; still more become the food of the large fishes of the banks and coasts, and of such is especially the cod. That voracious fish rises to them and inflicts great slaughter.

The later changes of the larva into a miniature eel are especially remarkable. Instead of growing larger, the little fish grows smaller and smaller, so that an individual that had been over three inches long may shrink to a length of not more than two inches, and the ribbon-like form may dwindle into a thread-like body. Increase is concentrated into growth sideways and with this the diaphanous character is lost. Meanwhile, "pigment is developed, first on the end of the tail, later on the neck, and lastly over the greater part of the dorsal and lateral aspects."

The gradual changes thus indicated have been segregated by Schmidt into six groups or stages, based on specimens obtained by him.

During all the gradual metamorphosis so illustrated, and which takes a full year for completing according to Schmidt, "the larvæ do not take any nourishment." This abstinence from food has been determined by Grassi and Calandruccio and A. C. Johnsen, as well as Schmidt. Johnsen "investigated over thirty specimens from the North Sea and the Danish waters and found the alimentary canal empty in all of them."

The young eels or elvers that in spring commence their ascent of the streams, which become their homes, must be the offspring of old eels which left the streams not during the last autumn, but the one preceding that; consequently, about a year and a half must intervene between the time a parent eel begins a journey to fulfill her procreative duties and that when the offspring is ready to take up its life under similar conditions. This is a history very different from any ordinary fish's, and so far as known unique outside of its genus.

The growth of the eel in fresh water has this year, 1908, been elucidated by Mr. Gemzöe from examination of the scales.[3]

[3] Gemzöe (K. J.), "Age and Rate of Growth of the Eel," Rep. Dan. Biol. St., XIV., p. 10–39, tab. 14, 1908.

The young eel lives and grows for some time without scales. Indeed, "it has lived in [Danish] waters two years, reckoned from the time it arrives as montée (glass-eel, elver) in its early migration"; it is then about 7 inches (18 cm.) long. The scales grow only during the warm months (June to September) and the intervals of arrest of growth differentiate the growth of the respective years. The early years are passed with a yellowish belly. "The females become silver later, scarcely before they are six and a half years old, the majority not before they are seven and a half years, and many indeed only become silver when they have been eight and a half years" in fresh water. If to these figures we now add a year and a half for the time the eggs are being matured and the leptocephalus stage developed, it appears that an eel must be from eight to ten years old before it assumes the livery of maturity and descends into the ocean to reproduce its kind.

Theo. Gill

Smithsonian Institution

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The ninth meeting was held at the Hotel Victory, Put-in-Bay, Ohio, August 25–28, 1908. In addition to the reading of papers, the society appointed two committees: one on luminous meteors, consisting of Messrs. Abbe, Elkin and Peck; the other on comets, consisting of Messrs. Comstock, Pickering, Barnard and Perrine. Officers were elected as follows:

President—E. C. Pickering.

First Vice-president—G. C. Comstock.

Second Vice-president—W. W. Campbell.

Secretary—W. J. Hussey.

Treasurer—C. L. Doolittle.

Councilors for 1908–10—W. J. Humphreys and Frank Schlesinger.

We give below a list of papers presented at the society's sessions, together with brief abstracts:

Formulas used for the Reduction of Satellite Observations: Asaph Hall.

Doolittle's Measures of the Hough Double Stars: G. W. Hough. (Published in *Popular Astronomy.*)

The Standard Clock at the U. S. Naval Observatory: W. S. Eichelberger.

In December, 1906, in an address before the American Association for the Advancement of Science (SCIENCE, March 22, 1907, p. 451), I presented a table showing the daily rates of the standard clock of the U. S. Naval Observatory, Riefler Sidereal Clock No. 70, from February 8 to May 12, 1904.

This clock was enclosed in an air-tight glass case and was mounted in a vault where the temperature was artificially controlled. However, during the period mentioned it was found impossible to prevent air from leaking into the case so that a nearly uniform pressure was maintained by pumping out 1 or 2 mm. a day. The mean difference between the computed and observed daily rates for that period was $0^s.015$.

DAILY RATE OF RIEFLER SIDEREAL CLOCK NO. 70

Date	B	Obs. Rate	Comp. Rate	$0-C$
1905	mm.	s.	s.	s.
Feb. 6.6	681	— 0.0074	— 0.0173	+ 0.010
10.6	681	— 0.0055	— 0.0187	+ 0.013
14.4	681	— 0.0386	— 0.0199	— 0.019
17.5	681	— 0.0127	— 0.0211	+ 0.008
20.6	680.5	— 0.0317	— 0.0163	— 0.015
24.5	680.5	— 0.0310	— 0.0178	— 0.013
Mar. 1.7	680	— 0.0144	— 0.0131	— 0.001
6.3	679.5	— 0.0038	— 0.0089	+ 0.005
10.5	679	+ 0.0038	— 0.0038	+ 0.008
13.5	679	+ 0.0125	— 0.0053	+ 0.018
18.3	678	— 0.0048	+ 0.0050	— 0.010
25.5	678	— 0.0209	+ 0.0031	— 0.024
28.5	678	+ 0.0199	+ 0.0019	+ 0.018
31.5	678	+ 0.0113	+ 0.0010	+ 0.010
Apr. 2.6	677.5	+ 0.0062	+ 0.0060	0.000
7.6	677	+ 0.0043	+ 0.0101	— 0.006
13.5	677	+ 0.0098	+ 0.0084	+ 0.001
17.5	677	— 0.0019	+ 0.0072	— 0.009
20.6	677	+ 0.0118	+ 0.0058	+ 0.006
24.5	677	+ 0.0173	+ 0.0046	+ 0.013
27.5	677	+ 0.0146	+ 0.0031	+ 0.012
May 2.5	676.5	— 0.0079	+ 0.0074	— 0.015
7.5	676	+ 0.0154	+ 0.0118	+ 0.004
12.5	676	+ 0.0074	+ 0.0103	— 0.003
16.4	676	+ 0.0058	+ 0.0091	— 0.003
19.5	676	— 0.0014	+ 0.0077	— 0.009
23.6	676	+ 0.0072	+ 0.0067	0.000
25.6	675.5	+ 0.0082	+ 0.0113	— 0.003
June 1.5	675	+ 0.0137	+ 0.0154	— 0.002
5.4	675	+ 0.0235	+ 0.0139	+ 0.010
9.5	674.5	+ 0.0142	+ 0.0187	— 0.004
13.4	673.5	+ 0.0403	+ 0.0300	+ 0.010
16.4	673	+ 0.0312	+ 0.0350	— 0.004
19.5				
				Mean 0.009

Immediately following the period named, we succeeded in making the glass case air-tight and during the past four years have had practically no trouble from leakage of air. I therefore desire to present to this society a discussion of the daily clock rates of this same clock from February 6 to June 19, 1905.

The following table gives the dates of observations, the mean pressure in the clock case, the observed daily rate, the computed rate and the difference between the last two. The change in the pressure is due to a progressive change in the temperature of the clock vault. The computed rates are obtained from the formula

$$+\,0^s.00255 - 0^s.01247\ (B - 677^{mm}.5) - 0^s.000366\ (T - \text{April } 14.5)$$

deduced from a least-square solution of the observed daily rates. The mean difference between the computed and observed daily rates is $0^s.009$.

The behavior of the clock can also be shown from the clock corrections during the same period. Each clock correction depending on ten or more time stars has been reduced to April 15.0 by the rate formula given above with the following result:

CORRECTION TO RIEFLER SIDEREAL CLOCK NO. 70, APRIL 15.0

Date of Observation		Clock Correction
1905		s.
February	6.5	— 14.33
	10.7	— 14.29
	17.5	— 14.30
	18.3	— 14.29
	20.6	— 14.28
	24.5	— 14.34
March	10.5	— 14.40
	13.5	— 14.37
	15.5	— 14.33
	25.5	— 14.36
	27.5	— 14.40
	28.5	— 14.44
	29.5	— 14.45
	30.5	— 14.44
	31.5	— 14.38
April	8.5	— 14.38
	13.5	— 14.40
	14.6	— 14.43
	17.5	— 14.39
	18.5	— 14.40
	19.5	— 14.42
	20.5	— 14.42
	22.5	— 14.40
	24.5	— 14.40
	27.5	— 14.36
May	2.5	— 14.30
	12.4	— 14.39
	19.5	— 14.41
	22.4	— 14.42
	23.5	— 14.45
	24.4	— 14.44
	25.5	— 14.45
June	1.5	— 14.44
	2.5	— 14.42
	9.5	— 14.42
	19.5	— 14.44
	Mean	— 14.39

The mean of the residuals obtained by subtracting $-14^s.39$ from each of the above clock corrections is $0^s.04$.

Observations were discontinued for some weeks beginning the latter part of June, so that, in order to show how well the clock correction could be predicted a new rate formula was deduced using the observations from February 6 to June 1. Using this rate formula

$$+0^s.00207 - 0^s.01230\ (B - 677^{mm}.5) - 0^s.000373\ (T - \text{April } 14.5)$$

and the clock correction for April 15.0 as $-14^s.39$, the predicted clock corrections for June, 1905, were obtained as given in the accompanying table:

CLOCK CORRECTIONS FOR JUNE, 1905

Date	Sid. Hour	Predicted Correction	Observed Correction	O—C
		s	s	s
June 1.5	16.8	—14.04	—14.06	—0.02
2.5	16.6	14.03	14.01	+0.02
3.5	16.5	14.01	14.04	—0.03
8.5	16.3	13.95	13.91	+0.04
9.5	16.5	13.93	13.90	+0.03
13.4	14.8	13.85	13.85	0.00
14.4	16.1	13.82	13.88	—0.06
18.5	18.6	13.69	13.66	+0.03
19.5	16.9	—13.65	—13.63	+0.02
Mean		—13.886	—13.882	±0.03

Illumination of the Reflex Zenith Tube: C. L. Doolittle.

As the instrument was originally constructed, the field was illuminated by a small electric lamp placed outside the tube, the light from which fell on a diagonal reflector in the axis of the instrument. The mirror was only eight inches from the micrometer threads. The result was that when the thread was not practically in the axis the reflection back and forth from the under side of the prism and the mercury surface produced a feathery appearance in the threads, making it impossible to obtain a sharp image of the same.

After considerable discussion and some experimenting the following plan was adopted:

The smallest electric lamp obtainable—sometimes called a dental lamp—is placed in the axis of the instrument, six inches above the mercury surface. This is held in place by a thin strip of brass attached to the tube in such a way that it may be readily removed in case repairs or removal of the lamp are called for. The current is furnished by a dry battery, and the brightness controlled by a rheostat. It is all of home construction and gives perfect satisfaction.

On the Constancy of the Period of the Variable Star, M5 (Libræ) No. 33: E. E. Barnard.

This is one of the Harvard cluster variables and has been under observation with the 40-inch for nearly ten years. The period derived from these observations is

$$12^h 2^m 7^s.3040 \pm 0^s.01781.$$

The period was independently determined from normal observations at intervals of one or two years. The deviations among these values did not exceed $0^s.065$. Though this is approximately progressive with the time, it is not believed to be real.

An observation of the variable at its most rapid light change is subject to a probable error of about ± 1.2 minutes, which, when three or four normals are employed, is reduced to ± 0.5 minute.

The light curve shows that the star, after remaining faint for a large part of its period, rather suddenly begins to brighten and in one hour has reached maximum. It remains but a short time at maximum. The decrease for the first half hour is almost equally as rapid as the rise. It then fades slowly for the next six or eight hours to minimum. The entire light change is about 1.2 magnitudes from $15^m \pm$ to $14^m \pm$.

The Photoheliometer: Chas. Lane Poor.

By an arrangement with Professor Frost a 25-foot photographic heliometer was mounted upon the tube of the 40-inch Yerkes telescope. The lenses were 2 inches in aperture and were specially made for this work by Brashear. The centers of the lenses were at a fixed distance apart and this distance was so adjusted as to make the photographic images of the sun overlap. The common chord of these overlapping images is a measure of the diameter of the sun, and slight variations in the diameter produce relatively large changes in the length of the chord.

During 1907 a series of photographs were taken by Mr. Fox, but owing to bad weather the number was rather limited. They were sufficient, however, to test the value of the method and to show the general lines upon which an instrument should be built.

A Possible Third Body in the System of Algol: R. H. Curtiss.

Spectroscopic determinations of the center of mass velocity of the eclipsing stars of Algol indicate strongly that three bodies enter into this system about the center of mass of which the eclipsing pair revolve in a nearly circular orbit with a radius of not less than 89,000,000 km., a period of 1.899 years and an epoch of minimum radial velocity at the date, 1901.85.

The variations observed in the eclipse period of this star, as well as those suspected in the eccentricity, are possibly largely due to perturbations arising in such a system.

As a consequence of the orbital motion of the center of mass of the eclipsing pair a variation in the time of light minimum with a range of ten minutes and a period of 1.899 years should be shown by photometric observations.

Achromatic and Apochromatic. Comparative Tests. Preliminary Communication: E. D. Roe, Jr.

To test them side by side, two visual telescope objectives, each of the two-lens type, an achromatic and an apochromatic of 2½-inch and 2⅝-inch aperture and 44 inches focal length, were ordered by the writer in March of Mr. Lundin, of the Clark Corporation, and of Steinheil Söhne, of Munich, respectively. Hartmann's Foucault knife-edge test as described in the *Astrophysical Journal* for May was tried by Dr. Saunders and the writer on Mr. Lundin's objective, both visually and photographically. Color screens were used for testing chromatic aberration. Four photographic plates of the objective were secured. The objective showed high excellence under these tests. For the laboratory manipulations and appliances involved the writer is greatly indebted to his colleague, Dr. Saunders. Mounted on a 6½ inch Clark equatorial with clock-work, the writer has tested the objective on double stars with splendid results. As the Steinheil objective was only recently received, the investigation is as yet unfortunately incomplete. Preliminary examination, however, raises the expectation that this objective will accomplish what its maker intended it should.

On a quick Visual Method of redetermining the Focus of a large Visual Refractor when used for Photography with a Color-screen: E. E. Barnard.

Such a large telescope as the 40-inch refractor of the Yerkes Observatory changes its focus largely from changes of temperature. But the photographic focus of such an instrument, where a color-screen is used, having once been determined, can at any time be redetermined accurately, regardless of temperature changes.

The following is the method: Find the photographic focus by the usual method of exposure on the stars. Insert in an adapter on the plate-holder a high-power eyepiece with graduated scale on the tube. With the plate-holder set at the scale reading giving the best result, focus carefully with the eyepiece on a star, and record the reading on the scale of the eyepiece. At any other time, disregarding the temperature, etc., the plate-holder is set at the original scale reading for the best focus, the eyepiece is inserted and the visual focus read off. If it is so many millimeters shorter or longer than the original visual reading, the plate-carrier must be moved in or out by that extent. The plate will then be in the best focus for the moment. If a spider line is inserted in the eyepiece and is brought into the focal plane with the star, then any other observer can at any time determine the focus in a minute's time by bringing a star and the wires into focus and making the proper connections.

On the Focal Changes in Nova Persei and on the Focus of some of the Wolf-Rayet Stars: E. E. Barnard.

In A. N. No. 4232, Dr. J. Hartmann finds that the spectrum of Nova Persei changed to the nebular condition in the fall of 1902. In 1906 it had again changed and was similar to that of the Wolf-Rayet stars. Observations in the rather long interval were lacking to show when the change from the nebular spectrum occurred.

Observations of the focus of this star were made at the Yerkes Observatory with the 40-inch in 1901, 1902 and 1903. They show a change in accordance with Dr. Hartmann's spectroscopic observations.

The focus rather suddenly became nebular about the first of October, 1902, when it was a quarter of an inch longer than for a star. This lasted until the middle of November of the same year, when it slowly returned to the stellar focus, becoming stellar about February, 1903. The last of these focal measures was made September 28, 1903. The result was — 0.03 inch. This value was so small that the sign was not considered real. But for the fact that Dr. Hartmann found the Nova had finally reached a condition similar to that of the Wolf-Rayet stars, it may have a stronger significance than I supposed, for I find that those of the Wolf-Rayet stars I have examined, with the exception of one case, have their focus slightly shorter than for an ordinary star. The focal measures, therefore, verify Dr. Hartmann's results and show, furthermore, just when the change in the spectrum of the star occurred.

Approximate Ephemerides of Fixed Stars: G. C. Comstock.

When only a moderate degree of precision is required, apparent places of the fundamental stars covering a period of many years may be given in very compendious form. Two tables of such places will be published elsewhere, one giving the coordinates of Polaris within a second of arc, for a period of twenty-five years, the other showing the apparent places of fifty equatorial stars for a similar period. The probable error of a right ascension for these clock stars is about two tenths of a second of time.

A New Form of Stellar Photometer: E. C. Pickering.

In this new form of stellar photometer, an artificial star is formed by allowing a small electric light, run by a storage battery, to shine through a minute hole, placed in the focus of a small auxiliary telescope. This telescope is placed at right angles to the main telescope and a piece of plane glass set at an angle of 45° reflects the artificial star into the eyepiece. A piece of opal or ground glass is placed over the hole, and the light of the artificial star is varied by moving the electric light, along the axis of the small telescope, by a known amount. The scale of the instrument accordingly depends on the law of the square of the distances, instead of on the laws of polarized light, or on the empirical law found for wedge photometers.

On the Character of the Light Variations of α Herculis: Frank Schlesinger.

This star has long been thought to be an irregular variable with a period of 35 to 40 days and with rapid fluctuations near minimum. Frost and Adams have shown it to be a spectroscopic binary. In the spring of this year it was placed upon the observing program of the Mellon spectrograph of the Allegheny Observatory and Professor Pickering kindly agreed to have it observed simultaneously at Harvard with the photometer. Our spectrograms were measured and reduced by Mr. Baker, who deduced a period of 2.05 days for the velocity variations, very different from that assigned to the light variations. In discussing these observations with Mr. Baker it occurred to us that the star might be an Algol variable. The character of the spectrum and the form of the orbit (especially the small eccentricity) and most of the observations concerning its light, are in conformity with this idea. Mr. Wendell's observations at Harvard showed that this surmise is correct, and further proved the existence of a secondary minimum, so that the star is more properly of the Beta Lyræ type than of the Algol type. With the help of a diagram it may be shown how all the observed phenomena concerning this star can be explained and how the erroneous conclusions concerning the period and the fluctuations at minimum arose. The case is interesting as showing the intimate connection between photometric and spectrographic observations, the true character of the light variations being first indicated by the latter.

Photographic Light-curve of the Variable Star SU Cassiopeiæ: J. A. Parkhurst.

A lantern-slide was shown of the mean light-curve of this star derived from 86 extra-focal images taken with the Zeiss 6-inch doublet between October 19, 1906, and April 5, 1908. The plates were measured with a Hartmann "Mikrophotometer" and reduced with the writer's "absolute scale." The observations were best represented by a period of $1^d.9498$, giving a correction of $-0^d.0008$ to Müller and Kempf's period.

The range in magnitude found was 0.47, from 6.52 to 6.99. Compared with Müller and Kempf's range of 0.33 (5.93 to 6.26), this gives a color-intensity of 0.59 magnitude at maximum and 0.73 at minimum; the difference being similar to that found for other variables of short period. The star's spectrum is *F* 3 *G* on the Harvard classification. The radial velocity, as determined from 9 one-prism plates taken with the Bruce spectrograph and 40-inch refractor, is about −7 km., with but slight variation between the different plates.

This star has about the smallest range of any well-attested variable, but presents no difficulties to the extra-focal method.

(To be published in the *Astrophysical Journal.*)

On the Irregularity of the Proper Motion of the Star Krueger 60: E. E. Barnard.

From observations with the 40-inch refractor of the Yerkes Observatory, the parallax of *Krueger 60* was determined. The resulting value was $\pi = +0''.247 \pm 0''.010$. This agrees closely with the values determined by Dr. Schlesinger and also with that by Dr. Russell, the three values being:

Barnard	$+0''.247$	$\pm 0''.010$
Schlesinger	$+0''.248$	$\mp 0''.009$
Russell	$+0''.258$	$\mp 0''.013$

One of the components of *Krueger 60* is a rather wide double star, found by Professor Burnham in 1890, of the magnitude 9.3–11.0. The distance between the components is about $3\frac{1}{2}''$, and they are in rapid orbital motion. During the investigation for parallax, it was found that the proper motion of the larger star, as determined from comparison with other stars, was slowly changing its direction, having in the past six or seven years changed about 8° or 9°, from 239° to 247°. This is undoubtedly due to the orbital motion of the two stars. It shows that the small star must have a rather large relative mass. The masses of these two stars can be accurately determined by measuring the position of *A*, with reference to near-by stars.

The Cœlostat Telescope of the Dominion Observatory: J. S. PLASKETT.

This paper contains a description illustrated by lantern slides of a new installation for solar research at Ottawa. A cœlostat and secondary mirror, each of 20 inches aperture, feed a concave of 18 inches aperture and 80 feet focus. Owing to local conditions the beam from the concave has to pass under the secondary mirror to a focus in the basement of the observatory. Notwithstanding the different and less advantageous conditions the solar definition is in general very good, much better than obtained with the refractor more suitably situated. The cœlostat is covered by a house, moving back on rails and the beam passes through a shed and short tunnel to the focus. Both house and shed are thoroughly louvered. A grating spectroscope of the Littrow form, with Brashear 6-inch objective of 23 feet focus, and Michelson plane grating ruled surface, $4\frac{1}{4} \times 4\frac{3}{4}$ inches, arranged to rotate around its optical axis, will be used with this telescope for spectroscopic investigation of the solar rotation, sun spots, etc.

Camera Objectives for Spectrographs: J. S. PLASKETT.

This paper contains an account of tests for definition and flatness of field performed on a number of different types of lenses used in and especially made for spectrographic work. The advantages of some new forms by Brashear and Zeiss over those previously used is illustrated diagrammatically. For work with a single prism a new objective by Brashear with widely separated elements, both of the same material, light crown, gives the best field, while for three-prism work another single material by Zeiss, in this case of the prism material, performs most satisfactorily. Neither of these forms can be used with larger angular aperture than $f/10$. For shorter focus lenses the Zeiss Tessar seems to be most suitable. A description of the effect upon the definition and flatness of field of changing the separation of the elements will be given.

The Distribution of Eruptive Prominences on the Solar Disk: PHILIP FOX.

This communication reviews a paper presented to the American Association for the Advancement of Science at the Chicago meeting on "The Detection of Eruptive Prominences on the Solar Disk" and summarizes the observations on their distribution as follows:

Spot birth is always accompanied by and generally preceded by eruptions. While the spot continues active the prominences will be present, generally following it at the edge of the penumbra. Spots beginning to decline are also accompanied with eruptions which will be seen at the ends of the bridges. In the case of complex spots where we have a large leader spot and another at the tail of the stream the eruptions follow the preceding spot and precede the following spot and are seen among the smaller spots of the stream. Eruptions are rarely seen preceding the leader spot and as seldom found following the trailer.

The eruptions about the spot groups are probably due in part to the interference of the whirls about the spots. Judging from the direction of motion indicated by the whirls of calcium and of hydrogen shown on the spectroheliograms, and from motion in some of the prominences, I find the direction of the whirls in the northern hemisphere as counter-clockwise and clockwise in the southern.

The Work of the Nautical Almanac Office: M. UPDEGRAFF.

The *American Ephemeris and Nautical Almanac* is one of five similar publications, and was first issued for the year 1855 at Cambridge, Mass., under the direction of Lieutenant (afterward Rear-Admiral) Chas. H. Davis, U.S.N. The American Nautical Almanac Office was established in the year 1849, was removed from Cambridge, Mass., to Washington, D. C., in 1866, and after occupying from time to time various quarters in the Navy Department and elsewhere in the city of Washington, was located in the main building of the new Naval Observatory in 1893. During the first forty-eight years the *Almanac* had four superintendents, and during the remaining eleven years six directors, the title of superintendent having been changed to director in 1893.

Professor Simon Newcomb, U.S.N., was superintendent and director for twenty years, 1877 to 1897, and during that time there were published under his direction eight volumes of the "Astronomical Papers" of the *American Ephemeris* as well as the yearly volumes of the *Ephemeris* during that time. During the past eleven years the accuracy of the computations for the *Ephemeris* has been improved, a catalogue of zodiacal stars published, and orbits and ephemerides of certain new satellites of the planets computed. The next volume to be issued is that for the year 1912. It is intended hereafter to leave out the lunar distance tables, to insert the ephemerides of about 300 additional fixed stars, and to substitute for the Struve-Peters constants the constants adopted at the conference of directors of national ephemerides held in Paris in May, 1896. Among minor changes which are under consideration may be mentioned:

(*a*) Moon culminations given for lower as well as for upper culmination.

(*b*) A more convenient arrangement of ephemerides of satellites of the planets.

(*c*) Ephemerides of the brightness of the planets in terms of stellar magnitudes.

(*d*) Ephemerides for physical observations of the sun, moon and planets.

The second edition of the American *Nautical Almanac* for 1909 will contain a star list and map for the use of navigators, and it is hoped later on to add certain tables and ephemerides for the convenience of surveyors and engineers.

Definite suggestions as to possible improvements in the *American Ephemeris and Nautical Almanac* from astronomers, navigators and others who make practical use of that publication, are desired, will be carefully considered and should be addressed to "The Director, Nautical Almanac, U. S. Naval Observatory, Washington, D. C."

The American Nautical Almanac Office cooperates with the British Nautical Almanac Office in certain lines of work, and is also at present cooperating with Professor Simon Newcomb, U.S.N. (retired), in his lunar researches and in a revision of the orbit of Mars. The present superintendent of the Naval Observatory, Admiral Wm. J. Barnette, is disposed to promote the cooperation of the Department of Astronomical Observations of the Naval Observatory with the Nautical Almanac Office, especially as regards the meridian work of the observatory and the places of the fixed stars given in the *American Ephemeris*.

The distributing list for the *American Ephemeris and Nautical Almanac* has recently been enlarged by more than 50 per cent., and that for the "Astronomical Papers" has been more than doubled. The former publication is sent to libraries, though not, as a rule, to individuals, while the "Astronomical Papers" are widely distributed to scientific men and institutions throughout the world.

A considerable number of sets of the "Astronomical Papers," eight quarto volumes bound in cloth, are now available for free distribution, as also are a number of volumes and parts of volumes for the completion of sets, carriage free within the limits of the United States. There are also several hundred copies bound in cloth of an interesting and valuable book on "Astronomical Constants," a supplement to the *American Ephemeris* for 1897, which will be mailed free to those who apply for it.

The publications of the Nautical Almanac Office are no longer sold by the office. On October 1, 1906, the sale of these publications was transferred to the superintendent of documents, Government Printing Office, Washington, D. C.

On an Infinite Universe: G. W. Hough. (Published in *Popular Astronomy.*)

The Luminosity of the Brighter Lucid Stars: George C. Comstock.

Parallaxes have been determined for about three fourths of all stars brighter than magnitude 2.5. These are here utilized to determine the intrinsic brightness of each such star and to derive from these a curve showing the relative frequency of occurrence of the several degrees of luminosity among the stars in question. A theoretical distribution curve for these luminosities, derived from the hypotheses with regard to stellar distribution that are commonly made, is shown to be widely divergent from the curve above found. The cause of this divergence is sought in the hypotheses upon which the theoretical curve is based and it is shown that the theoretical and observed distributions may be brought into agreement by either of the following suppositions:

(*a*) The intrinsically brightest stars are not widely distributed through space, but manifest a distinct tendency to cluster about the sun.

(*b*) There is a sensible absorption of light in its transmission through space, of such average amount that a star having a parallax of a tenth of a second appears one magnitude fainter than it would appear in the absence of absorption.

Photographic Determinations of Stellar Parallax with the Yerkes Refractor: Frank Schlesinger.

This paper is an informal report on work done with the 40-inch Yerkes telescope under the auspices of the Carnegie Institution, from 1903 to 1905. The methods and precautions adopted for making the photographs and for measuring and reducing them were described in some detail and the results exhibited for twenty-three stars. This paper is to be published in the *Astrophysical Journal.*

Measurement of Starlight with a Selenium Photometer: Joel Stebbins.

This paper presents the results of experiments on the use of selenium in stellar photometry. It is well known that the crystalline form of selenium decreases its electrical resistance when exposed to light. The method is to cast an extra-focal image of a star upon a selenium surface, and note the effect by means of a galvanometer. Using a 12-inch telescope, it has been possible to measure first and second magnitude stars with about the same accuracy that is obtained in visual methods. Tests with brighter artificial lights give a probable error of less than one per cent. for a single measurement.

In the course of a year the sensibility of the apparatus has been increased one hundredfold, and it is hoped that further improvements in the elimination of disturbing factors will produce extremely accurate results.

Spectrographic Observations: E. B. Frost.

A favorable report may be made upon the result of re-annealing by the original maker, M. Parra-Mantois, of Paris, of the three large flint prisms first made for the Bruce spectrograph and discarded on account of lack of homogeneity.

The star 46 (Upsilon) *Sagittarii,* which has been qualitatively studied by Miss Cannon at Harvard, and was found to be a spectroscopic binary by Campbell some years ago, has recently been observed, and a number of plates have been measured by Dr. D. V. Guthrie. He finds a range of velocity from + 55 km. to — 25 km. The bright lines are not conspicuous on our plates, and can be seen with certainty only on the thirteenth plate.

Observations of the fainter component of ζ *Ursæ Majoris* (*Mizar*) have been continued for several months, the measures being made by Mr. Lee. A careful study by the writer has failed to bring out a regular periodicity in the radial velocity, and the indications are that more than two bodies are involved.

Mention was made of certain new spectroscopic binaries:

ϕ *Sagittarii* ($18^h 39^m$, — 27° 6′), of Orion type, which shows a large range of velocity.

β *Trianguli* ($2^h 4^m$, + 34° 31′), Ia2, which was suspected from preliminary examination here, and established by measures of the same plates at Columbia University by Professor S. A. Mitchell.

55 *Ursæ Majoris* ($11^h 14^m$, + 38° 44′), Ia2, found by Mr. Lee; range thus far: 40 km.

ι *Andromedæ* ($23^h 33^m$, + 42° 43′), of Orion type, found by Mr. Barrett, probably of rather long period.

The Figure of the Sun and Possible Variations in its Size and Shape: Chas. Lane Poor.

The first part of this paper contains a résumé of the more important investigations of von Lindenau, Secchi, Auwers, Newcomb and Ambronn. In practically every case the original reductions showed periodic variations in the diameter of the sun. Auwers discussed an immense mass of meridian circle and heliometer observations and reached the conclusion that the sun is sensibly a sphere and that the observed variations are due to personal and instrumental causes. This conclusion, however, was reached only by attributing variable personal equations to the different observers.

The second part contains a retabulation and rediscussion of the heliometer observations used by Auwers and of those made by Schur and Ambronn. It is here shown that these observations indicate a periodic variation in the shape of the sun, the period being the same as that of the sun-spot cycle. The observations of Schur and Ambronn were also investigated for short period vibrations by means of the method of "Time Correlation" as developed by Newcomb. These observations indicate a semi-permanent fluctuation in the shape of the sun having a period of about 28 days.

Results of Photometric Investigations: E. H. Seares.

Light-curves were shown for RS *Draconis,* VY *Cygni,* RV *Tauri,* SU *Andromedæ,* RS *Bootis,* 52.1907 *Ophiuchi* and 43.1907 *Draconis.* All are interesting and unusual types of variation. The last four are of the so-called Antalgol type with periods ranging from ten to sixteen hours.

In addition, there was presented a simple and general method of determining the circular elements and relative dimensions of a binary system on the basis of an observed light variation of the Algol type. The arrangement of the method is such that the light-curve corresponding to the first approximation for the elements and dimensions must be tangent to the observed curve at two points. Differential formulæ can then be used for improving the agreement of the calculated and observed curves. The application of the method to a considerable number of cases can be facilitated by the use of tables.

The Temperature Gradients of the Atmosphere and an Attempt to Account for the Upper Inversion: W. J. Humphreys.

During the past few years many sounding balloons, equipped with registering apparatus, have been sent up from different places and under different conditions to altitudes ranging from twelve to twenty kilometers, and observations have been secured indicating a division of the explored atmosphere into the following three regions:

1. A layer some 3,000 meters thick next the surface, in which the change of temperature with elevation is irregular and often locally reversed.

2. A region of fairly uniform and rapid temperature decreases with elevation extending from the top of the first layer to the high cirrus clouds.

3. The upper inversion, or the region above the cirrus clouds, when the temperature slowly increases with elevation.

The upper inversion is due primarily, but not wholly, to long wave radiation from the earth as a planet, and to which water vapor is a black body. When the temperature of the high atmosphere is 218° C. absolute, it can be shown that the temperature of the effective radiating surface is about 260° C. absolute.

Effect of Increasing the Slit Width on the Accuracy of Radial Velocity Determinations: J. S. Plaskett.

Experiments at Ottawa have shown that exposure time is almost proportionally decreased with increase in slit width to about 0.075 mm. Six spectra of β Orionis were made for each of four slit widths—0.025, 0.038, 0.050 and 0.075 mm. —at three different dispersions. The accidental errors of setting, as measured by the probable errors of the velocity from a single line obtained from the six plates in each series, are only slightly increased, scarcely at all in the higher dispersion, by increase in slit width to 0.075 mm. A further discussion shows that the increase of systematic error, so far as it may be determined from the limited number of plates, is also small with high dispersion, although quite marked for a slit 0.075 mm. wide with low dispersion. These somewhat unexpected results show that for stars with single lines the slit may be much widened without much loss of accuracy and with a considerable saving in exposure time.

The Algol System, RT Persei: R. S. Dugan.

With a Pickering polarizing photometer with sliding achromatic prisms, a series of 14,048 settings on RT *Persei* was completed in February, 1908. Most of the observations were made without a recorder.

The period is obtained from nineteen more or less thoroughly observed minima.

The mean curve shows a primary minimum of 1.33 magnitudes' range and a secondary of 0.16, each lasting about four and one quarter hours.

The curve between minima is not a straight line. After recovering from primary minimum the curve rises steadily until it reaches the point midway between the minima, and from that point decreases very little until secondary minimum begins.

The residuals show a constant correction for the night, depending on the average hour angle at which the observations were made.

The eccentricity and inclination are small, the two stars are nearly of the same size, one has six times the intrinsic luminosity of the other, and the radius of the orbit is three times the radius of the stars.

Observations of the Total Solar Eclipse of January 3, 1908: W. W. Campbell.

The paper summarized the more interesting results of the work of the Crocker Expedition from the Lick Observatory, with lantern-slide illustrations copied from the original negatives.

The corona was rather remarkable for the great number of long, straight and slender streamers extending in all directions. There was a conspicuous conical pencil of radiating streamers, near position angle 75°, whose vortex, if on the sun's surface, would lie within the largest sunspot group visible on January 3.

By far the greater part of the coronal light came from the areas lying within two inches of the sun's edge.

Polarigraphic negatives showed the existence of strong polarization in the coronal light, even up to the very edge of the sun.

A spectrogram with continuously moving plate recorded the changing spectrum of the sun's edge as the edge was gradually uncovered by the moon.

The spectrum of the corona was essentially free from absorption lines. Several new coronal bright lines were discovered. The maximum of continuous spectrum of the corona was displaced toward the red from that of the solar spectrum, indicating a lower temperature in the corona than in the photosphere.

The plates for the intra-mercurial planet search recorded more than 300 stars, including some of the ninth magnitude. All were identified as well-known stars. It is felt that the Lick Observatory observations of 1901, 1905 and 1908 bring definitely to a conclusion the observational side of this problem, famous for half a century. It is not contended that no planets exist in the intra-mercurial region, but it is believed that undiscovered planets do not exist in sufficient numbers to provide the mass necessary to explain the anomalies in the motion of Mercury and the other minor planets.

Value of the Solar Parallax from Photographs of Eros taken in 1900 with the Crosley Reflector: C. D. Perrine.

The following determination of the values of the solar parallax is based on 823 images of Eros and the images of surrounding groups of stars contained on 281 photographs. These photographs were secured on eighteen nights from October 6 to December 24 inclusive.

The value of the solar parallax obtained is

$$8''.8054 \pm 0''.0025.$$

The measurements and reductions were made under a grant from the Carnegie Institution by Mrs. Moore and Miss Hobe.

The general results will be published in a Lick Observatory Bulletin, and a full account of the work by the Carnegie Institution.

Harold Jacoby
F. H. Sears

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at the Johns Hopkins University, at Baltimore, during convocation week, beginning on December 28, 1908.

American Association for the Advancement of Science.—Retiring president, Professor E. L. Nichols, Cornell University; president-elect, Professor T. C. Chamberlin, University of Chicago; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. J. Paul Goode, University of Chicago.

Local Executive Committee.—William H. Welch, M.D., chairman local committee; Henry Barton Jacobs, M.D., chairman executive committee; William J. A. Bliss, secretary, Joseph S. Ames, William B. Clark, R. Brent Keyser, Eugene A. Noble, Ira Remsen, John E. Semmes, Francis A. Soper, Hugh H. Young.

Section A, Mathematics and Astronomy.—Vice-president, C. J. Keyser, Columbia University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Carl E. Guthe, State University of Iowa; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor Louis Kahlenberg, University of Wisconsin; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Geo. F. Swain, Massachusetts Institute of Technology; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Bailey Willis, U. S. Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor C. Judson Herrick, University of Chicago; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor H. M. Richards, Columbia University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Professor R. S. Woodworth, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Professor G. Sumner, Yale University; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

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The American Mathematical Society.—December

30, 31. President, Professor H. S. White, Vassar College; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28, 29. President, H. W. Tyler, Boston, Mass.; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor E. L. Nichols, Cornell University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 29–January 1. President, Professor Marston T. Bogert, Columbia University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Socicty of America.—December 29, 31. President, Professor Samuel Calvin, University of Iowa; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—January 1, 2. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor Richard Swan Lull, Yale University; secretary, Dr. W. D. Matthew, American Museum of Natural History, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor John J. Abel, The Johns Hopkins University; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 29–31. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 29–31. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–January 2. Vice-president, Professor H. L. Russell, University of Wisconsin; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 29–31. President, Professor William Morton Wheeler, Harvard University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn. *Central Branch*, December 28–30. President, Professor E. A. Birge, University of Wisconsin; acting secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The Entomological Society of America.—December 29, 30. President, Professor W. M. Wheeler, Harvard University; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor S. A. Forbes, University of Illinois; secretary, A. F. Burgess, Washington, D. C.

The Botanical Society of America.—December 29–31. President, Professor W. F. Ganong, Smith College, Northampton, Mass.; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—December 30, 31. President, Professor L. H. Bailey, Cornell University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Chapter.—President, Dr. T. C. Frye, Seattle, Wash.; secretary, Mr. N. L. T. Nelson, St. Louis, Mo. Address: Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor G. M. Stratton, University of California; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Philosophical Association.—December 29–31. President, Professor Hugo Münsterberg, Harvard University; secretary, Professor Frank Thilly, Cornell University, Ithaca, N. Y.

Southern Society for Philosophy and Psychology.—Convocation week. President, Professor J. MacBride Sterrett, The George Washington University; secretary, Professor Edward Franklin Buchner, The Johns Hopkins University, Baltimore, Md.

The American Anthropological Association.—December 28–January 2. President, Professor Franz Boas, Columbia University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 28. President, Professor Roland B. Dixon, Harvard University; secretary, Dr. Alfred M. Tozzer, Harvard University, Cambridge, Mass.

SCIENCE

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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.

CHEMICAL PRINCIPLES OF SOIL CLASSIFICATION[1]

IT seems appropriate to preface this paper with some direct quotations from a recent publication of national authority which deal with important questions concerning the chemical principles of the soil.

I read from the "Hearings before the Committee on Agriculture of the United States House of Representatives" under date of January 28, 1908.

Mr. Whitney, Chief of the Bureau of Soils. The investigations of the Bureau of Soils, as to the causes of the deterioration of soils, and the causes that limit crop production, have changed the view-point of the entire world. The recent investigations of the bureau in soil fertility have changed the thought of the world, and several foreign governments, notably the governments of France, of Japan, of South Africa, and of Australia, have taken up these new ideas of soil fertility. (Pp. 428, 429.)

The Chairman. A few years ago the bureau issued a bulletin which was generally construed as meaning to state the proposition that all soils had all the plant food necessary for a maximum growth or crop. The inference, of course, from that was that, such being the case, one soil was as good as another. Now, I would like to know whether the popular conception of that bulletin was wrong or whether the position of the bureau has changed.

Mr. Whitney. That touches on the chemical side of the investigations of the bureau, and we have Mr. Cameron here, who did the work, and possibly he might answer that. (P. 439.)

Mr. Cameron. I would say that the main opposition to this view has been from Dr. Hopkins, from the University of Illinois.

[1] Address before the American Society of Agronomy at Cornell University, Ithaca, New York, July 11, 1908.

Again, the bureau does contend that the soil contains enough plant nutrients to support life and give good crops, for it has been shown scientifically in this country and abroad by many investigators in the past, and by many numerous recent investigations, that all soils contain practically all the common rock-forming minerals. Now, it is a principle of chemistry that when a solvent is brought in contact with a substance, that substance will go into solution until there is a state of equilibrium between the quantity of the substance outside and inside; in other words, we get a saturated solution. If these rock-forming minerals were in all soils we should have the same solution in every soil, and that has been shown to be the case. There are various variations, due to absorption, perhaps of the soil. In the first place, I must ask you gentlemen to remember that the soil and the plant and the water in the soil is moving. The soil grains are constantly moving, and the solution in the soil is constantly moving, and the growing plant is constantly moving. If a plant stops for a moment it dies. The soil solution can not stop for a moment, because it has to be moving all the time. When water falls on the soil part of it runs off the surface, and part of it runs through the surface by gravitation and comes out in the subsoil, and part of it starts and rises as soon as we get sunlight on the surface, and this part comes up in films over and through the finer spaces, and is bringing with it dissolved material from below.

The water that falls and goes through down and out goes rapidly through larger openings, and gets very little of the soluble material, because it is not long in contact with the soil grains. It gets some by reason of the fact that, as we know, our springs and rivers and wells are all soil solutions and carry mineral matter. Now, water rising by capillarity can not get very concentrated because it gets saturated with the minerals, and any excess that is contained in it is thrown out, except in extreme conditions, as in the west, and then we get alkali conditions; but under ordinary humid conditions we can not have an excess of it, and the soil solution is bringing materials from below which the plant gets, and as a matter of fact the most important discovery of the Bureau of Soils in recent years is that plants are feeding on material from the subsoils, far below where the roots go. If this is true, and there are many other arguments in the same line, it is absurd to make an analysis of the surface soil and say that is the soil that the plant is feeding on. It is not. The solution is changing around the plant roots, and it is not the surface material alone on which the plant is feeding.

Now, I am sorry to say that I shall have to make this personal, but in Illinois they have been carrying on a long series of experiments and have been making analyses of the soils, and they stated that in the soils of Illinois there are just so many pounds of phosphorus, and we know what a corn crop will take out of the soil, and therefore we can say that a corn crop will take out so much each year, and these soils will last only a certain number of years—I hesitate to say how many, I do not recollect how many—I think about fifty years. The work we carry on, which was largely given in this bulletin which has been criticized, absolutely overthrows that contention. The soil is changing; it is constantly supplying the material of the soil solution, and we know that soils have lasted thousands and thousands of years, and we have records of soils in India that have lasted two thousand years, and we know they do not wear out, and we gave the explanation why they did not, and why the land did not become a sterile waste, and it naturally aroused a feeling of opposition in the breast of this gentleman.

The Chairman. When you say that all soils contain all the elements of plant food, and there is in those soils at all times a saturated solution of which all these elemnts of plant food make a part, do you not practically say that all soils have all the plant food they need, and that it is at all times available for the plant; or is it not available for the plant if it is in a saturated solution?

Mr. Cameron. Certainly, if there is water enough; if the soil is moist.

The Chairman. Is is not, therefore, a justifiable inference from what you have said, that there is all the time in all soils enough plant food available for plant life?

Mr. Cameron. True; perfectly true as regards the mineral nutrients.

The Chairman. Then I come back again to the question, Why is it necessary, or is it in your judgment necessary, ever at any time to introduce fertilizing material into any soil for the purpose of increasing the amount of plant food in that soil?

Mr. Cameron. Not in my judgment.

The Chairman. Then in your judgment the only reason for the introduction of fertilizers is for the antitoxic effect or the mechanical effect they may have on the soil.

Mr. Cameron. Mainly that, but there are probably other functions of fertilizers that we know comparatively little about. We know that certain kinds of life, bacteria, molds, can grow in certain solutions of salts, and can not in others. It may be that fertilizers affect them. But all that is an unexplored field, and little is known about it. . . . If you will allow me to say one more word about fertilizers: What are fertilizers? What are the characteristics that a substance must have in order to be a fertilizer? It must be obtainable in large quantities. It must also be cheap. Now, the substances which are used as fertilizers in fertilizing material are substances which can be obtained in large quantities. They are substances, and are the only substances, which we can get hold of that we can get in large quantities that we can get cheap, and with one exception, that is, sodium chloride—common salt. It has not been much used as a fertilizer, because it has not any so-called plant food in it; and yet it has been used in quite a large number of experiments on quite a large scale, and wherever it has been used it has generally been found to be quite a good fertilizer. In the investigations of the bureau we have used pyrogallol. It contains no plant food, but carbon, hydrogen and oxygen, yet, nevertheless, it is a powerful fertilizer; but it can not be obtained cheaply. It is worth over $2 a pound, and nobody would think of recommending it as a fertilizer.

Mr. Pollard. Is that theory about all soils containing all the necessary constituents of plant food generally held by all scientists?

Mr. Cameron. It is accepted by the physical chemists, and by the majority of plant physiologists, and by a large percentage of the agricultural investigators.

Mr. Pollard. Throughout the country?

Mr. Cameron. Throughout this country and Europe; more in Europe than in this country. We have received far more recognition abroad than in this country, but the acceptance of it is growing very much more rapidly. Within the last two years several of us have lectured at the agricultural colleges and have explained these views, and have shown that the criticism which came to Bulletin No. 22, of which I have spoken, was largely incorrect, founded on false premises, and as a result of that we have a large mass of evidence in the form of letters, and other evidence in the fact that a number of agricultural schools are now teaching this, and are using our bulletins as text-books, that these views are accepted everywhere.

Mr. Pollard. You have reached a point where there is no question about the soundness of that view?

Mr. Cameron. I feel absolutely sure of it, and I think there is no question but that 90 per cent. of the scientific men[2] of this country would back that up.

Mr. Pollard. The reason I asked this question is that it seems to me that all of the bureaus—I do not say it with reference to this bureau in particular, but all the bureaus of the various departments at Washington—ought to be very careful about sending out matter of that kind unless they are sure, unless they have proven their ground, because it is likely to mislead and make trouble. That was the reason I asked the question.

Mr. Cameron. There has not been a publication on the subject of soil fertility going out from the Bureau of Soils—and I think I can speak advisedly, for every one has gone through my hands—in which we did not have the experimental proof long before the publication went out, and that this is being recognized I think I can claim by the fact that a number of agricultural colleges in the country are using our bulletins as text-books. I have recently come from a lecture trip extending from Louisiana to Michigan, and I found everywhere that this was being taught, and, as I say, our publications are being used for text-books. (Pp. 445–449.)

Here we have some very plain, concise, and authentic statements of the teaching of the United States Bureau of Soils concerning the chemical principles of soil fertility; and these statements are in harmony with the teaching in past years. Thus on page 64 of Bulletin 22 of the Bureau of Soils, published in 1903, we read:

That practically all soils contain sufficient plant food for good yields, . . . that this supply will be indefinitely maintained.

And on page 59 in the same bulletin were published the following statements:

In truck soils of the Atlantic coast, when 10 or 15 tons of stable manure are annually applied

[2] See report adopted by the Norfolk Convention (1907), of the committee of seven on the president's address before the Association of Official Agricultural Chemists in 1906, published as Illinois Circular 105.

to the acre, in the tobacco lands of Florida and of the Connecticut Valley, where 2,000 or 3,000 pounds of high-grade fertilizers carrying 10 per cent. of potash are used, even where these applications have been continued year after year for a considerable period of time, the dissolved salt content of the soil as shown by this method is not essentially different from that in surrounding fields that have been under extensive cultivation.

In England and in Scotland it is customary to make an allowance to tenants giving up their farms for the unused fertilizers applied in the previous seasons. The basis of this is usually taken at 30 to 50 per cent. for the first year, and at 10 to 20 per cent. for the second year after application, but in the experience of this bureau there is no such apparent continuous effect of fertilizers on the chemical constitution of the soil.

Again, on pages 21 and 22, Farmers' Bulletin 257, published in 1906, we have the following definite statements from Professor Whitney:

There is another way in which the fertility of the soil can be maintained, viz., by arranging a system of rotation and growing each year a crop that is not injured by the excreta of the preceding crop. . . . In other experiments of Laws and Gilbert they have maintained for fifty years a yield of about 30 bushels of wheat continuously on the same soil where a complete fertilizer has been used. . . . With a rotation of crops without fertilizers they have also maintained their yield for fifty years at 30 bushels, so that the effect of rotation has in such case been identical with that of fertilization.

It is not my purpose in this paper to discuss the work[3] and theories and conclusions of the Bureau of Soils, except so far as seems necessary in fixing upon some chemical principles fundamental to maintenance of the fertility of American soils.

Aside from negative factors, including the prevention of injury by disease, insects, weeds, etc., we must recognize six essential and positive factors in crop production:

First, the seed, whose value is governed by kind or variety, by previous selection or breeding, and by inherent vitality and the vigor of growth to be imparted to the young plant.

Second, the home of the plant, or the physical character of the soil, including structure, texture and tilth.

Next, the heat, light and moisture, which influence so markedly the rate of growth, and which can be controlled to a greater or less extent beyond what is done under the normal conditions of crop production.

And lastly, the plant food, a factor of no less importance to crop production than is animal food to the growth of animals.

It can not be said that any one of these factors is the most important, because every one is absolutely essential; but it can be said that of the factors that may be controlled plant food is certainly the most neglected and possibly the least understood, not only by practising farmers, but also by many agricultural teachers and investigators.

Failure to appreciate the importance of the plant-food factor is due in part to the short-sighted view too commonly given to the problem.

The great question that stands before the soil investigator, and before the American people is not how to grow good crops for the next year or even the next generation alone, but how to permanently maintain the fertility of American soils. As soon as we try to plan for permanent systems then we begin to realize the limitations of our plant-food supplies.

Another matter that has led to much confusion and misunderstanding is the common talk of available plant food, as distinct from the total supply, when as a matter of fact there is no definite line of distinction. The question as to the amount of available plant food contained in the soil at any given time is very insignificant in comparison with the question how to make plant food available. The plant food re-

[3] See Illinois Experiment Station circulars 72 and 105, and the Norfolk report (1907) of the committee of seven on the president's address of 1906, Association of Official Agricultural Chemists.

moved from the soil by a crop is not available when the crop is planted, but it must be made available during the growing season.

Plant food is made available by chemical and biochemical processes, of which ammonification and nitrification are among those best understood. The products of organic decomposition and nitrification, including various organic acids, carbonic acid, and nitric acid, are very efficient as solvents for the mineral plant food. Thus, in the conversion of organic nitrogen into nitrate nitrogen for a hundred-bushel crop of corn, the nitric acid formed is alone sufficient to convert seven times as much tricalcium phosphate into monocalcium phosphate as would be required to supply the phosphorus for the same crop; but, of course, it is not limited to this reaction. The presence of calcium carbonate, or some free base, and of oxygen, as in the aeration of the soil by tillage, will assist greatly in the decomposition of the soil and consequent liberation of plant food.

Some inorganic reactions, many organic reactions, and most biochemical reactions are not instantaneous, but long continued, and the rate of reaction is influenced by many factors, including temperature, concentration, aeration, and the presence of catalytic agencies and bacterial food-supplies. Under controlled conditions the length of time required for many such reactions is now determinable; and any soil investigation is incomplete which disregards the presence or absence of active decaying organic matter. It should be understood, too, that this term is not synonymous with humus. Partially decayed peat has no such value as fresh farm manure, clover or other green manures, even though the peat may contain as large or larger amounts of plant food, and produce similar physical effects. The one is in a sense embalmed and very inactive, while definite and continued chemical action is needed and is produced by the fresh materials.

Among the most unsatisfactory and misleading investigations are those from which the use of insoluble plant-food materials has been condemned because they have not responded when applied in the absence of adequate supplies of active organic matter.

Under similar physical conditions the amount of plant food made available during the season varies chiefly with three factors: namely, the presence of calcium carbonate, the supply of decaying organic matter, and the stock or store of fertility contained in the soil.

To supply the soil with decaying organic matter, and with lime if needed, is a necessary part of all extensive agricultural practise, and, with these provided for, the question of the total stock of plant food becomes of first importance. To illustrate this importance we may well consider some well known soils.

The early Wisconsin brown silt loam prairie, one of the commonest soil types in the Illinois corn belt, contains in the plowed soil of an acre (7 inches deep) 1,190 pounds of phosphorus and 36,250 pounds of potassium. For one hundred bushels of corn each year the total supply of phosphorus is sufficient for only seventy years, while the potassium is sufficient for more than seventeen centuries.[4]

In the unglaciated yellow silt loam hill land, the most abundant soil type in seven counties of southern Illinois, the total supply of nitrogen to a depth of 40 inches is sufficient for less than sixty such crops of corn, while the total supply of potassium to the same depth is sufficient for more than ten thousand crops, assuming in both cases that the grain is harvested and the stalks left on the land.

[4] Illinois Experiment Station Bulletin 123.

For a hundred-bushel crop of corn per acre (grain and stalks) the total supply of potassium in our peaty swamp land (seven inches deep) is sufficient for 41 years, while in the yellow-gray silt loam of the Late Wisconsin glaciation it is sufficient for 670 years.

The amounts of plant food referred to represent neither the so-called available plant food nor the acid-soluble portion, but the absolute total contained in the soil strata mentioned. Many other illustrations might be given showing enormous differences in chemical composition of different extensive types. Thus the soil at Lexington, Ky., upon which are located some of the experiment fields of that station, contains from ten to twenty times as much total phosphorus as the soil upon the university farm at Urbana, Illinois.

While the detail soil surveys and the location of boundary lines must be based primarily upon soil formation, topography, physical composition and appearance, certainly no soil classification is complete which ignores the determination of the total supplies of plant food the soils contain.

Even the figures given above may not be of the greatest interest for the production of a few crops, but shall we confine our attention to the possible production of a few more crops?

Among the great material problems of the United States of America there is one that stands supreme and incomparable; namely, to discover and to practise systems of permanent prosperous agriculture. This is a problem that no country has ever solved as we must solve it.

There is permanent agriculture in the valley of the Nile, enriched by the deposits of silt from the annual overflow. There is permanent agriculture in the rice fields of the Ganges Valley in India and the Yangtze-Kiang in China, where the soil is renewed by the frequent torrential overflows or by irrigation with water carrying suspended fertility brought from unmeasured hillsides and mountain slopes.

There is permanent agriculture, in degraded form, in many countries, on sloping hill lands whose worn-out surface soils are washed away in proportion equal at least to the rate of exhaustion of the mineral plant food; where two or three meager crops can always be grown after the land has been turned back to nature for a decade to be restored in some measure by nature's own method of covering the land with vegetation, mold and sod, largely by the aid of legume plants and nitrogen-fixing bacteria.

There is almost permanent agriculture on the black cotton soils of India which occupy extensive level uplands, where the rainfall is all within three months and where during the nine months of drouth the soil opens every few feet with cracks a foot wide and more than ten feet deep into which more or less of the worn-out surface soil falls or is carried by the winds or torrential rains which break the drouth. Here where the natives turn the soil to a depth of two feet or more, cotton, yielding a hundred pounds of lint to the acre, is still grown, after hundreds, and possibly thousands, of years of continuous agriculture.

These deep black cotton soils of India furnish the only example of apparent permanent agriculture on land that is not renewed by overflow or by erosion or by direct applications of plant food; and even here, it may be noted, the product which leaves the farm, cotton lint, carries away but little plant food from the soil, and the average yield is only one tenth of that from our own best cotton lands.

No other country has yet solved for us America's first great material problem—to discover and to practise systems of permanent agriculture—for the wheat belt, and for the corn belt, and for the cotton belt; but we believe the problem is being solved for the state of Illinois—not by theories or hypothesis, but by mathematical and chemical facts, supported by actual demonstrations in the field and on the farm in all parts of the state. So far as I have been able to learn, the oldest soil experiment fields in the United States are in Illinois, with an authentic record and history of nearly a third of a century; and extensive investigations are in progress on subsequently established fields. Lands that were once poor are becoming rich—rich in materials absolutely required to make crops. Where 12 bushels of wheat were commonly grown, 30 bushels are now produced, and in both cases the same crop rotation is practised, wheat being grown but once in four years on the same field. Where without soil treatment, in the best rotation, corn yields but 50 or 60 bushels, the present average yield on treated land is from 90 to 100 bushels, under the same crop rotation. Where clover commonly fails or yields less than a ton of hay to the acre, two to three tons are now produced on properly treated land.

How is this accomplished? Simply by knowing the chemistry of the air and of the soil and by applying that knowledge mathematically to agriculture, by drawing upon these natural sources for every element of plant food which they contain in inexhaustible amount, and by supplying from other sources such elements as it is mathematically impossible for the air or soil to furnish indefinitely. Where the soil contains a very limited amount of any element of plant food not present in the atmosphere, that element is supplied not in small quantities of high-priced soil stimulants as in the so-called "complete fertilizers" that have helped to ruin much of the lands of the eastern and southern states, but in the positive addition of plant food in larger amounts than are required for the largest crops, so that the soil becomes richer, actually and mathematically, even though large crops are removed from the land. The fertilizers thus used are not artificial, but natural, and chiefly in the same form as existed originally in our naturally rich virgin soil.

Chief among the materials that we have found it necessary to use are fine-ground phosphate rock and natural limestone, together with abundance of legume crops, which must be returned to the land either directly or in manure.

We have absolutely permanent supplies of nitrogen in the air, to be secured as needed by means of clover and other legume crops, and for our system of farming we have in our common soils almost unlimited supplies of potassium and of the other less important essential mineral elements, which may be liberated as needed by means of decaying organic matter; so that with these, as with our inexhaustible limestone deposits, we are agriculturally independent. But, as the result of hundreds of analyses[5] of soils and crops, we know that the average common prairie and upland timber soils of Illinois contain about 2,000 pounds of total phosphorus per acre-foot, and with equal chemical and mathematical accuracy we know that a hundred such crops as we are now growing on our richest and best fertilized lands remove from the soil about 2,000 pounds of phosphorus. A thousand years of such cropping would require every pound of phosphorus contained in our average soil to a depth of ten feet.

Whatever we might wish to believe, we can not alter these absolute facts. We need to conserve our supplies of phosphorus, whether in the deposits of natural phosphate rock or in our farm lands or in

[5] Illinois Experiment Station Bulletin 123.

the products of the soil, as in grain and bone and animal fertilizers. Of course, if we raise crops only half as large as are possible under our normal conditions of rainfall and sunshine, then our draft upon the soil is so much less; and if we return in farm fertilizers a part of the fertility removed in crops, we may still farther postpone the day when the soil will refuse to honor the drafts we try to make.

It would seem not only important and appropriate, but especially necessary, to emphasize these facts, if from the position of highest agricultural authority should continue the wide-spread promulgation of the remarkable theory:

That practically all soils contain sufficient plant food for good crop yields, that this supply will be indefinitely maintained;[6] that there is another way in which the fertility of the soil can be maintained, viz., by arranging a system of rotation and growing each year a crop that is not injured by the excreta of the preceding crop;[7] and that it is not necessary ever at any time to introduce fertilizing material into any soil for the purpose of increasing the amount of plant food in that soil.[8]

In a public address before the American Society of Agronomy upon the Chemical Principles of Soil Classification, I can not conscientiously omit a protest against this teaching. That crop yields are increased by application of plant-food materials is universally and absolutely known, and this fact is of course admitted by all; but the mere admission of this absolute fact does not relieve in the least the serious menace to American agriculture of the official teaching that such applications are entirely unnecessary, that it is never necessary at any time to introduce fertilizing material into any soil for the purpose of increasing the amount of plant food in that soil.

Under this doctrine farmers are taught to use, and to depend upon, any means or method that will stimulate crop yields, with no purpose or thought of maintaining or increasing the plant food in the soil. It is held that crop rotation is sufficient to maintain the fertility of the soil, and that powerful soil stimulants, such as quicklime and salt, will also accomplish this end. On the other hand, the positive addition of valuable plant food to the soil in systems of permanent soil enrichment is distinctly discouraged, such practise being denounced as wholly unnecessary. Indeed, farmers are strongly encouraged to rob their land of its fertility to the greatest possible extent and to make no return of plant food to the soil.

Furthermore, under this doctrine there is every inducement to sell, for a trifle, not only the million tons of phosphate rock now being annually exported from this country, but still larger and more exhaustive amounts of this tremendously valuable and absolutely necessary natural resource whose conservation is of the gravest importance to the United States, and of the most far-reaching consequence to our national prosperity.

Indeed, this is a matter of such vital concern to this country, and especially to the great agricultural states, that it can not rightly be ignored; for, if these unsupported theories are generally accepted by the farmers of the United States, and if the future, in harmony with all the past, only proves that crop rotation will not permanently maintain the fertility of the soil, and that the use of soil stimulants only leads to ultimate land ruin, then who shall estimate what proportion of the farms that

[6] From page 64 of Bulletin 22 of the Bureau of Soils, published in 1903.

[7] From page 21 of Farmers' Bulletin 257, by Milton Whitney, Chief of the Bureau of Soils, published in 1906.

[8] From the Hearings before the Committee on Agriculture of the House of Representatives, on January 28, 1908, in the committee's discussion with leading members of the Bureau of Soils.

are now prosperous and capable of inaugurating and supporting systems of profitable improvement leading to permanent prosperity, would, under fifty years' struggle to practise this theory, become too completely impoverished ever to redeem themselves from ultimate land ruin?

Surely we should consider the inadequate foundation of this widely promulgated hypothesis, that *practically all soils contain sufficient plant food for good crop yields,* that *this supply will be indefinitely maintained,* that *crop rotation alone will maintain the fertility of the soil,* and that *it is not necessary ever at any time to introduce fertilizing material into any soil for the purpose of increasing the amount of plant food in that soil.*

The one theory advanced in support of this remarkable doctrine is based upon the assumption that sufficient amounts of soluble plant food are brought up from the lower subsoils by the rise of capillary water to constantly replace the plant food removed by the largest crops, and thus to permanently maintain the fertility of the surface soil. (See hearings before the Committee on Agriculture, January 28, 1908.)

It is well known that soluble materials are brought from the subsoil to the surface by capillary moisture in semi-arid countries where the water leaves the soil, not by drainage, but only by evaporation, and also that there is some little tendency in this direction in humid countries, especially in times of partial drouth, but for all normal agricultural conditions this movement is insignificant compared with the actual losses of plant food in drainage water and in crops removed.

This truth is already fully established, not only by the fact that underground drainage waters always carry off some soluble plant food, but also by the fact that in humid regions the surface soils are not richer, but much poorer, than the lower subsoils—in potassium, in magnesium, in lime, and in all other constituents that dissolve in the soil waters and that do not accumulate in the humus from plant residues. Indeed, the surface even of normal virgin soils is almost invariably markedly poorer in such mineral constituents than are the corresponding lower subsoils; so that in all countries the common method employed by geologists for ascertaining the relative age of different soils is to determine the depth of soil to which some mineral constituent, as lime, has been leached out. It is everywhere recognized, both in science and in practise, that more or less of the plant food applied to soils is lost by leaching.

One of the most potent factors in the formation of all residual soils is the process of leaching. Thus, from the leaching of disintegrated rock have soils been formed. Limestone soils were originally impure limestone rock from which a very large percentage of the original rock material has been removed by leaching. No geological fact is better established or more universally recognized. From 75 to 90 per cent. of the original rock formation is not infrequently removed by leaching in the making of residual soils.

Under ordinary circumstances, I would no more think of taking up the valuable time of this society by citing proofs of the marked and continuous losses of plant food by leaching from the surface soil, than I would to cite the proofs that the earth is round, for the one fact is as well established as the other; but under the extraordinary circumstances of the confident promulgation from the position of highest agricultural authority of the theory that the fertility of American soils will be permanently maintained by the rise of plant food in capillary moisture, I feel justified in burdening you with one illustration of the hundreds that might be given.

The soil of the famous Rothamsted Experiment Station is underlain with a bed of calcium carbonate, in the form of chalk, at a depth of eight feet or more. Here, then, is certainly the ideal condition with an immense supply of lime in the lower subsoil, "far below where the roots go," from which there should be an abundance carried up to the surface by capillary moisture, in accordance with the theory that "there is a steady tendency toward an accumulation of dissolved mineral matter at the surface."[9]

Now what do we find the truth to be? Is there a steady tendency toward the accumulation of lime in the surface soil at Rothamsted?

The existing information is very complete on this point. During a period of 40 years, from 1865 to 1905, large numbers of analyses have been made of the Rothamsted soils. During that time, according to Director Hall[10] and Dr. Miller, from nine different plots on Broadbalk Field there have been the following losses of calcium carbonate per acre per annum from the surface 9 inches:

	Pounds
From Plot 2*b*	590
From Plot 3	800
From Plot 5	878
From Plot 6	1,174
From Plot 7	1,010
From Plot 8	1,174
From Plot 9	564
From Plot 10	1,045
From Plot 11	1,429

The truth is that instead of an accumulation at the surface, there has been a large loss of calcium carbonate from every plot, the total loss in 40 years ranging from 11 tons to 28 tons per acre, and varying with the manures applied and the crops produced.

Furthermore, from eight different plots on Hoos Field there have been the following average yearly losses:

	Pounds
From Plot 1*O*	1,185
From Plot 4*O*	723
From Plot 1*A*	793
From Plot 4*A*	750
From Plot 1*N*	772
From Plot 4*N*	554
From Plot 1*C*	750
From Plot 7–2	848

Here, again, every plot reported has sustained a large loss, the average being about the same as for Broadbalk Field. The investigations reported also include Agdell Field and Little Hoos Field, both of which have likewise suffered loss in about the same amount as Broadbalk and Hoos.

Surely with this common knowledge of uncompensated loss by leaching in all normal humid sections, we dare not base our definite plans for systems of permanent agriculture upon a theory that by the rise of capillary water plant food is brought from the lower subsoils sufficient to meet the needs of large crops and to maintain the fertility of the surface soil in all places and for all time; and yet this is the one foundation upon which the teaching of the Bureau of Soils rests concerning permanent supplies of plant food, and is, according to Dr. Cameron, "the most important discovery of the Bureau of Soils in recent years."

In 1839 the following statement was made in Sir Humphry Davy's "Agricultural Chemistry" (p. 343):

> Some effects attributed to exhaustion of soil may be owing to excretions from roots, injurious to the plants which have yielded them, and yet beneficial to other kinds of plants; in one instance acting the part of a poison, in the other of a manure.

[9] Cameron, in "Cyclopedia of American Agriculture" (1907), Vol. I., p. 370.

[10] *Proceedings of the Royal Society* (1905), Vol. 77.

Other literature is also cited in this ancient volume, showing that the investigation of this problem of toxic excreta from plant roots was a live question seventy years ago.

That crop rotation has great value has been recognized for centuries and nowhere has its importance been more clearly shown than on the oldest soil experiment fields at the University of Illinois, where, after 30 years of crop rotation, 58 bushels of corn per acre are still produced as an average of the last three crops, while less than 25 bushels is the average for the same three years on land where corn has been grown every year for 30 years. The value of crop rotation must be attributed to the assistance thus rendered in retarding the development and multiplication of injurious insects and fungous or bacterial diseases and possibly in avoiding injury from poisonous plant excreta, and to the addition of organic matter, which supplies some nitrogen and hastens the liberation of other essential elements; but the effect of crop rotation is always to reduce, and never to augment, the total supply of mineral plant food in the soil and subsoil.

The bank must receive deposits as well as honor checks and drafts; the merchant must purchase stock as well as sell goods; and likewise, if we are to remove continually plant food from the soil in large crops, we must give back to the soil with intelligence based at least upon the mathematical facts.

This is truly the age of science, but science means knowledge; it does not mean theory or hypothesis. One dollar taken from 100 dollars leaves not 100 dollars, but only 99 dollars. This is a scientific fact which no theory or hypothesis can nullify. Likewise when a crop removes 20 pounds of phosphorus from the soil it leaves that soil 20 pounds poorer in phosphorus than before the crop was grown. The rotation of crops or the application of salt or some other stimulant may liberate another 20 pounds of phosphorus from the soil and thus enable us to grow another crop the next year, and possibly this may be repeated for several or many years, but meanwhile the total supply of phosphorus in the soil is growing smaller and smaller year by year, until ultimately neither crop rotation nor soil stimulants can liberate sufficient phosphorus from the remaining meager supply to meet the needs of profitable crops.

It is certainly safe teaching and safe practise to return to the soil as much or more than we remove of such plant-food elements as are contained in the soil in limited amounts when measured by the actual requirements of large crops during one lifetime.

The average prairie soil of more than 20 counties in southern Illinois contains such a limited supply of phosphorus that 60 such crops as we raise on our best treated land in the corn belt would require every pound of phosphorus contained in a 12-inch stratum of the southern Illinois soil; while two centuries of such crops, if they could be grown, would completely exhaust the soil of its phosphorus content to a depth of 40 inches.

These are the oldest prairie soils in the state, both agriculturally and geologically. They are also the poorest prairie soils in the state in the total supply of every valuable plant-food element. In harmony with universal experience, these soils do not improve, but continually deteriorate with time and use where no adequate return of plant food is made. These soils are not renewed by deposits from overflow or by the removal of the depleted surface by erosion, and without the positive addition of deficient plant food the future condition of these soils must be the same as the present condition of much of the level upland plains of populous China, where now exist soil areas hundreds of square miles in extent that are absolutely depopulated, the restoration of which has been called "The Problem of China."

Permanent agriculture is the only structure upon which the future prosperity of the American nation can be secured, and the absolutely essential foundation of permanent agriculture is the fertility of the soil.

Cyril G. Hopkins
University of Illinois

EXTRACTS FROM PRESIDENT ROOSEVELT'S MESSAGE TO THE CONGRESS

If there is any one duty which more than another we owe it to our children and our children's children to perform at once, it is to save the forests of this country, for they constitute the first and most important element in the conservation of the natural resources of the country. There are, of course, two kinds of natural resources. One is the kind which can only be used as part of a process of exhaustion; this is true of mines, natural oil and gas wells and the like. The other, and of course ultimately by far the most important, includes the resources which can be improved in the process of wise use; the soil, the rivers and the forests come under this head. Any really civilized nation will so use all of these three great national assets that the nation will have their benefit in the future.

Just as a farmer, after all his life making his living from his farm, will, if he is an expert farmer, leave it as an asset of increased value to his son, so we should leave our national domain to our children, increased in value and not worn out. There are small sections of our own country, in the east and in the west, in the Adirondacks, the White Mountains and the Appalachians, and in the Rocky Mountains, where we can already see for ourselves the damage in the shape of permanent injury to the soil and the river systems which comes from reckless deforestation. It matters not whether this deforestation is due to the actual reckless cutting of timber, to the fires that inevitably follow such reckless cutting of timber or to reckless and uncontrolled grazing, especially by the great migratory bands of sheep, the unchecked wandering of which over the country means destruction to forests and disaster to the small homemakers, the settlers of limited means.

Shortsighted persons, or persons blinded to the future by desire to make money in every way out of the present, sometimes speak as if no great damage would be done by the reckless destruction of our forests. It is difficult to have patience with the arguments of these persons. Thanks to our own recklessness in the use of our splendid forests, we have already crossed the verge of a timber famine in this country, and no measures that we now take can, at least for many years, undo the mischief that has already been done. But we can prevent further mischief being done, and it would be in the highest degree reprehensible to let any consideration of temporary convenience or temporary cost interfere with such action, especially as regards the national forests which the nation can now, at this very moment, control.

All serious students of the question are aware of the great damage that has been done in the Mediterranean countries of Europe, Asia and Africa by deforestation. The similar damage that has been done in eastern Asia is less well known. A recent investigation into conditions in North China by Mr. Frank N. Meyer, of the Bureau of Plant Industry of the United States Department of Agriculture, has incidentally furnished in very striking fashion proof of the ruin that comes from reckless deforestation of mountains, and of the further fact that the damage once done may prove practically irreparable.

So important are these investigations that I herewith attach as an appendix to my message certain photographs showing present conditions in China. They show in vivid fashion the appalling desolation, taking the shape of barren mountains and gravel and sand covered plains, which immediately follows and depends upon the deforestation of the mountains. Not many centuries ago the country of northern China was one of the most fertile and beautiful spots in the entire world and was heavily forested.

We know this not only from the old Chinese records, but from the accounts given by the traveler Marco Polo. He, for instance, mentions that in visiting the provinces of Shansi and Shensi he observed many plantations of mulberry trees. Now there is hardly a single mulberry tree in either of these provinces, and the culture of the silkworm has moved further south, to regions of atmospheric moisture. As an illustration of the complete change in the rivers, we may take Polo's statement that a certain river, the Hun Ho, was so large and deep that merchants ascended it from the sea with heavily laden boats; to-day this river is simply a broad sandy bed, with shallow, rapid currents wandering hither and thither across it, absolutely unnavigable.

But we do not have to depend upon written records. The dry wells, and the wells with water far below the former water mark, bear testimony to the good days of the past and the evil days of the present. Wherever the native vegetation has been allowed to remain, as, for instance, here and there around a sacred temple or imperial burying ground, there are still huge trees and tangled jungle, fragments of the glorious ancient forests. The thick, matted forest growth formerly covered the mountains to their summits. All natural factors favored this dense forest growth, and as long as it was permitted to exist the plains at the foot of the mountains were among the most fertile on the globe, and the whole country was a garden.

Not the slightest effort was made, however, to prevent the unchecked cutting of the trees or to secure reforestation. Doubtless for many centuries the tree-cutting by the inhabitants of the mountains worked but slowly in bringing about the changes that have now come to pass; doubtless for generations the inroads were scarcely noticeable. But there came a time when the forest had shrunk sufficiently to make each year's cutting a serious matter, and from that time on the destruction proceeded with appalling rapidity; for, of course, each year of destruction rendered the forest less able to recuperate, less able to resist next year's inroad.

Mr. Meyer describes the ceaseless progress of the destruction even now, when there is so little left to destroy. Every morning men and boys go out armed with mattox or axe, scale the steepest mountain sides, and cut down and grub out, root and branch, the small trees and shrubs still to be found. The big trees disappeared centuries ago, so that now one of these is never seen save in the neighborhood of temples, where they are artificially protected; and even here it takes all the watch and care of the tree-loving priests to prevent their destruction.

Each family, each community, where there is no common care exercised in the interest of all of them to prevent deforestation, finds its profit in the immediate use of the fuel which would otherwise be used by some other family or some other community. In the total absence of regulation of the matter in the interest of the whole people, each small group is inevitably pushed into a policy of destruction which can not afford to take thought for the morrow. This is just one of those matters which it is fatal to leave to unsupervised individual control. The forests can only be protected by the state, by the nation; and the liberty of action of individuals must be conditioned upon what the state or nation determines to be necessary for the common safety.

The lesson of deforestation in China is a lesson which mankind should have learned many times already from what has occurred in other places. Denudation leaves naked soil; then gullying cuts down to the bare rock; and meanwhile the rock waste buries the bottom lands. When the soil is gone, men must go; and the process does not take long.

This ruthless destruction of the forests in northern China has brought about, or has aided in bringing about, desolation, just as the destruction of the forests in central Asia aid in bringing ruin to the once rich central Asian cities; just as the destruction of the forests in northern Africa helped toward the ruin of a region that was a fertile granary in Roman days. Short-sighted man, whether barbaric, semi-civilized, or what he mistakenly regards as fully civilized, when he has destroyed the forests, has rendered certain the ultimate destruction of the land itself.

In northern China the mountains are now such as are shown by the accompanying photographs, absolutely barren peaks. Not only have the forests been destroyed, but because of their destruction the soil has been washed off the naked rock. The terrible consequence is that it is impossible now to undo the damage that has been done. Many centuries would have to pass before soil would again collect, or could be made to collect, in sufficient quantity once more to support the old-time forest growth. In consequence the Mongol Desert is practically extending eastward over northern China. The climate has changed and is still changing. It has changed even within the last half century, as the work of tree destruction has been consummated.

The great masses of arboreal vegetation on the mountains formerly absorbed the heat of the sun and sent up currents of cool air which brought the moisture-laden clouds lower and forced them to precipitate in rain a part of their burden of water. Now that there is no vegetation, the barren mountains, scorched by the sun, send up currents of heated air which drive away instead of attracting the rain clouds, and cause their moisture to be disseminated. In consequence, instead of the regular and plentiful rains which existed in these regions of China when the forests were still in evidence, the unfortunate inhabitants of the deforested lands now see their crops wither for lack of rainfall, while the seasons grow more and more irregular; and as the air becomes dryer certain crops refuse longer to grow at all.

That everything dries out faster than formerly is shown by the fact that the level of the wells all over the land has sunk perceptibly, many of them having become totally dry. In addition to the resulting agricultural distress, the watercourses have changed. Formerly they were narrow and deep, with an abundance of clear water the year around; for the roots and humus of the forests caught the rain-water and let it escape by slow, regular seepage. They have now become broad, shallow stream beds, in which muddy water trickles in slender currents during the dry seasons, while when it rains there are freshets, and roaring muddy torrents come tearing down, bringing disaster and destruction everywhere.

Moreover, these floods and freshets, which diversify the general dryness, wash away from the mountain sides, and either wash away or cover in the valleys, the rich fertile soil which it took tens of thousands of years for nature to form; and it is lost forever, and until the forests grow again it can not be replaced. The sand and stones from the mountain sides are washed loose and come rolling down to cover the arable lands, and in consequence, throughout this part of China, many formerly rich districts are now sandy wastes, useless for human cultivation and even for pasture. The cities have been, of course, seriously affected, for the streams have gradually ceased to be navigable. There is testimony that even within the memory of men now living there has been a serious diminution of the rainfall in northeastern China. The level of the Sungari River, in northern Manchuria, has been sensibly lowered during the last fifty years, at least partly as the result of indiscriminate cutting of the forests forming its watershed. Almost all the rivers of northern China have become uncontrollable, and very dangerous to the dwellers along their banks, as a direct result of the destruction of the forests. The journey from Peking to Jehol shows in melancholy fashion how the soil has been washed away from whole valleys, so that they have been converted into deserts.

In northern China this disastrous process has gone on so long and has proceeded so far that no complete remedy could be applied. There are certain mountains in China from which the soil is gone so utterly that only the slow action of the ages could again restore it, although of course much could be done to prevent the still further eastward extension of the Mongolian Desert if the Chinese government would act at once. The accompanying cuts from photographs show the inconceivable desolation of the barren mountains in which certain of these rivers rise—mountains, be it remembered, which formerly supported dense forests of larches and firs, now unable to produce any wood, and because of their condition a source of danger to the whole country.

The photographs also show the same rivers after they have passed through the mountains, the beds having become broad and sandy because of the deforestation of the mountains. One of the photographs shows a caravan passing through a valley. Formerly, when the mountains were forested, it was thickly peopled by prosperous peasants. Now the floods have carried destruction all over the land and the valley is a stony desert. Another photograph shows a mountain road covered with the stones and rocks that are brought down in the rainy season from the mountains, which have already been deforested by human hands. Another shows a pebbly river bed in southern Manchuria, where what was once a great stream has dried up owing to the deforestation in the mountains. Only some scrubwood is left, which will disappear within a half century. Yet another shows the effect of one of the washouts, destroying an arable mountain side, these washouts being due to the removal of all vegetation; yet in this photograph the foreground shows that reforestation is still a possibility in places.

What has thus happened in northern China, what has happened in central Asia, in Palestine, in north Africa, in parts of the Mediterranean countries of Europe, will surely happen to our country if we do not exercise that wise forethought which should be one of the chief marks of any people calling itself civilized. Nothing should be permitted to stand in the way of the preservation of the forests, and it is criminal to permit individuals to purchase a little gain for themselves through the destruction of forests when this destruction is fatal to the well-being of the whole country in the future.

Action should be begun forthwith, during the present session of the congress, for the improvement of our inland waterways—action which will result in giving us not only navigable but navigated rivers. We have spent hundreds of millions of dollars upon these waterways, yet the traffic on nearly all of them is steadily declining. This condition is the direct result of the absence of any comprehensive and far-seeing plan of waterway improvement. Obviously we can not continue thus to expend the revenues of the government without return. It is poor business to spend money for inland navigation unless we get it.

Inquiry into the condition of the Mississippi and its principal tributaries reveals very many instances of the utter waste caused by the methods which have hitherto obtained for the so-called "improvement" of navigation. A striking instance is supplied by the "improvement" of the Ohio, which, begun in 1824, was continued under a single plan for half a century. In 1875 a new plan was adopted and followed for a quarter of a century. In 1902 still a different plan was adopted and has since been pursued at a rate which only promises a navigable river in from twenty to one hundred years longer.

Such short-sighted, vacillating, and futile methods are accompanied by decreasing water-borne commerce and increasing traffic congestion on land, by increasing floods, and by the waste of public money. The remedy lies in abandoning the methods which have so signally failed and adopting new ones in keeping with the needs and demands of our people.

In a report on a measure introduced at the first session of the present congress, the secretary of war said: "The chief defect in the methods hitherto pursued lies in the absence of executive authority for originating comprehensive plans covering the country or natural divisions thereof." In this opinion I heartily concur. The present methods not only fail to give us inland navigation, but they are injurious to the army as well. What is virtually a permanent detail of the corps of engineers to civilian duty necessarily impairs the efficiency of our military establishment.

The military engineers have undoubtedly done efficient work in actual construction, but they are necessarily unsuited by their training and traditions to take the broad view, and to gather and transmit to the congress the commercial and industrial information and forecasts, upon which waterway improvement must always so largely rest. Furthermore, they have failed to grasp the great underlying fact that every stream is a unit from its source to its mouth, and that all its uses are interdependent.

Prominent officers of the engineer corps have recently even gone so far as to assert in print that waterways are not dependent upon the conservation of the forests about their headwaters. This position is opposed to all the recent work of the scientific bureaus of the government and to the general experience of mankind. A physician who disbelieved in vaccination would not be the right man to handle an epidemic of smallpox, nor should we leave a doctor sceptical about the transmission of yellow fever by the *Stegomyia* mosquito in charge of sanitation at Havana or Panama. So with the improvement of our rivers; it is no longer wise or safe to leave this great work in the hands of men who fail to grasp the essential relations between navigation and general development and to assimilate and use the central facts about our streams.

Until the work of river improvement is undertaken in a modern way it can not have results that will meet the needs of this modern nation. These needs should be met without further dilly-dallying or delay. The plan which promises the best and quickest results is that of a permanent commission authorized to coordinate the work of all the government departments relating to waterways, and to frame and supervise the execution of a comprehensive plan. Under such a commission the actual work of construction might be intrusted to the reclamation service or to the military engineers, acting with a sufficient number of civilians to continue the work in time of war; or it might be divided between the reclamation service and the corps of engineers. Funds should be provided from current revenues, if it is deemed wise—otherwise from the sale of bonds. The essential thing is that the work should go forward under the best possible plan and with the least possible delay. We should have a new type of work and a new organization for planning and directing it. The time for playing with our waterways is past. The country demands results.

I urge that all our national parks adjacent to national forests be placed completely under the control of the forest service of the agricultural department, instead of leaving them as they now are, under the interior department and policed by the army. The congress should provide for superintendents, with adequate corps of first-class civilian scouts, or rangers, and, further, place the road construction under the superintendent instead of leaving it with the war department. Such a change in park management would result in economy and avoid the difficulties of administration which now arise from having the responsibility of care and protection divided between different departments. The need for this course is peculiarly great in the Yellowstone Park. This, like the Yosemite, is a great wonderland, and should be kept as a national playground. In both all wild things should be protected and the scenery kept wholly unmarred.

I am happy to say that I have been able to set aside in various parts of the country small, well-chosen tracts of ground to serve as sanctuaries and nurseries for wild creatures.

I had occasion in my message of May 4, 1906, to urge the passage of some law putting alcohol, used in the arts, industries, and manufactures, upon the free list; that is, to provide for the withdrawal free of tax of alcohol which is to be denatured for those purposes. The law of June 7, 1906, and its amendment of March 2, 1907, accomplished what was desired in that respect, and the use of denatured alcohol, as intended, is making a fair degree of progress and is entitled to further encouragement and support from the congress.

The pure-food legislation has already worked a benefit difficult to overestimate.

. . . .

The share that the national government should take in the broad work of education has not received the attention and the care it rightly deserves. The immediate responsibility for the support and improvement of our educational systems and institutions rests and should always rest with the people of the several states acting through their state and local governments, but the nation has an opportunity in educational work which must not be lost and a duty which should no longer be neglected.

The National Bureau of Education was established more than forty years ago. Its purpose is to collect and diffuse such information "as shall aid the people of the United States in the establishment and maintenance of efficient school systems and otherwise promote the cause of education throughout the country." This purpose in no way conflicts with the educational work of the states, but may be made of great advantage to the states by giving them the fullest, most accurate, and hence the most helpful information and suggestion regarding the best educational systems. The nation, through its broader field of activities, its wider opportunity for obtaining information from all the states and from foreign countries, is able to do that which not even the richest states can do, and with the distinct additional advantage that the information thus obtained is used for the immediate benefit of all our people.

With the limited means hitherto provided the Bureau of Education has rendered efficient service, but the congress has neglected to adequately supply the bureau with means to meet the educational growth of the country. The appropriations for the general work of the bureau, outside education in Alaska, for the year 1909 are but $87,500—an amount less than they were ten years ago, and some of the important items in these appropriations are less than they were thirty years ago. It is an inexcusable waste of public money to appropriate an amount which is so inadequate as to make it impossible properly to do the work authorized, and it is unfair to the great educational interests of the country to deprive them of the value of the results which can be obtained by proper appropriations.

I earnestly recommend that this unfortunate state of affairs as regards the national education office be remedied by adequate appropriations. This recommendation is urged by the representatives of our common schools and great state universities and the leading educators, who all unite in requesting favorable consideration and action by the congress upon this subject.

I strongly urge that the request of the director of the census in connection with the decennial work so soon to be begun, be complied with, and that the appointments to the census force be placed under the civil-service law, waiving the geographical requirements as requested by the director of the census. The supervisors and enumerators should not be appointed under the civil-service law, for the reasons given by the director. I commend to the congress the careful consideration of the admirable report of the director of the census, and I trust that his recommendations will be adopted and immediate action thereon taken.

It is highly advisable that there should be intelligent action on the part of the nation on the question of preserving the health of the country. Through the practical extermination in San Francisco of disease-bearing rodents our country has thus far escaped the bubonic plague. This is but one of the many achievements of American health officers; and it shows what can be accomplished with a better organization than at present exists. The dangers to public health from food adulteration and from many other sources, such as the menace to the physical, mental and moral development of children from child labor, should be met and overcome. There are numerous diseases, which are now known to be preventable, which are, nevertheless, not prevented. The recent International Congress on Tuberculosis has made us painfully aware of the inadequacy of American public health legislation.

This nation can not afford to lag behind in the world-wide battle now being waged by all civilized people with the microscopic foes of mankind, nor ought we longer to ignore the reproach that this government takes more pains to protect the lives of hogs and of cattle than of human beings. The first legislative step to be taken is that for the concentration of the proper bureaus into one of the existing departments. I therefore urgently recommend the passage of a bill which shall authorize a redistribution of the bureaus which shall best accomplish this end.

WOLCOTT GIBBS

DR. OLIVER WOLCOTT GIBBS, from 1863 to 1887 Rumford professor of applied science and later emeritus professor in Harvard University, past president of the National Academy of Sciences and of the American Association for the Advancement of Science, died at his home in Newport, R. I., on December 9, in his eighty-seventh year. We hope to print later an adequate appreciation of Professor Gibbs's contributions to chemistry. A biographical note, prepared by him about two years ago and given to his nephew, Dr. Alfred Tuckermann, with the request that it be published after his death, is as follows:

Oliver Wolcott Gibbs was born in New York, February 21, 1822. He was the second son of George and Laura Wolcott Gibbs and grandson of Oliver Wolcott, secretary of the treasury during part of the presidency of Washington and of John Adams. His father, Colonel George Gibbs, owned a large estate on Long Island known as Sunswick, a few miles from the then small city of New York. He was one of the earliest American mineralogists, devoted to that branch of science, and an active and successful horticulturist. Wolcott, like his elder brother, inherited his father's tastes: He was often occupied with making volcanoes with such materials as he could obtain and in searching the stone walls on the estate for minerals, and the gardens and fields for flowers. His mother was an artist of no mean ability, and often won the praises of Gilbert Stuart by her work. At the age of seven, Wolcott went to reside in Boston with his aunt, Miss Sarah Gibbs, who, at that time, with her brother-in-law, Dr. Channing, and her sister, occupied a fine mansion in Mount Vernon Street during the early spring and winter months. The boy was sent to a school kept by Mr. Leverett, a prominent Latin scholar. Among his fellow pupils were William M. Evarts, the two brothers Perkins, Greenough, Samuel Eliot and others who in time became distinguished. Miss Gibbs and the Channings spent the summers and autumns at Oakland, a large estate about five miles from Newport, Rhode Island, which, under their care, became, as it still is, very attractive. The summer home was a most hospitable one and Dr. Channing's fame brought many foreign visitors. When about twelve years of age, Wolcott, whose father had died in 1833 at Sunswick, was sent to a celebrated school at Flushing, Long Island, kept by the Rev. Dr. Muhlenberg. He was two years at this school of which he entertained always an affectionate remembrance. In 1835 the estate at Sunswick was sold and the family moved to New York. Wolcott was sent to the grammar school of Columbia College and in 1837 he entered Columbia College as a freshman.

In 1841 he graduated and later became assistant to Dr. Robert Hare who held the chair of chemistry in the medical school of the University of Pennsylvania. After some months in the laboratory, Wolcott commenced the study of medicine with the view of qualifying himself to hold the chair of chemistry in a medical school. After two years of study at the College of Physicians and Surgeons in New York, he received the degree of Doctor of Medicine in 1845, and shortly after sailed for Hamburg. He took up his residence in Berlin and entered, as a student, the laboratory of Professor Carl Rammelsberg. After some months with him, he entered the laboratory of Heinrich Rose, where he remained about a year. He then went to Giessen where he spent one semester with Liebig. Thence to Paris, where he attended lectures by Laurent and Dumas, and especially by Regnault. He returned to New York in the fall of 1848, having received from the College of Physicians and Surgeons an offer of an assistant professorship of chemistry, Dr. John Torrey being full professor. In 1849 he was elected professor of chemistry and physics in the newly created Free Academy, now the College of the City of New York, and in 1853 married Josephine, daughter of Oroondates and Martha Eddy Mauran. He remained professor for fourteen years, when he was elected Rumford professor in Harvard University, to fill the vacancy occasioned by the resignation of Professor E. N. Horsford and removed to Cambridge in August, 1863. At the outbreak of the civil war, he took an active part in the creation of the Union League Club. In 1887 he resigned the Rumford professorship in Harvard University and built and equipped a laboratory near his residence at Newport, Rhode Island. Dr. Gibbs received the degree of LL.D. from Columbia College, Harvard University, the University of Pennsylvania and the Columbian University of Washington. He was an honorary member of the German, English and American Chemical Societies, of the Royal Society of Berlin and of the Philosophical Society of Philadelphia.

PRESIDENT ROOSEVELT'S AFRICAN TRIP

In March, 1909, Mr. Roosevelt will head a scientific expedition to Africa, outfitted by the Smithsonian Institution and starting from New York City. This expedition will gather natural history materials for the government collections, to be deposited by the Smithsonian Institution in the new United States National Museum, at Washington, D. C.

Besides the president and his son, Kermit Roosevelt, who will defray their own expenses, the personnel of the party, on leaving New York, will consist of three representatives of the Smithsonian Institution: Major Edgar A. Mearns, Medical Corps, U. S. Army (retired), Mr. Edmund Heller and Mr. J. Alden Loring. On arriving in Africa, the party will be enlarged by the addition of Mr. R. J. Cuninghame, who is now in Africa preparing the president's outfit. He will have charge of a number of native porters, who, with necessary animals, will be formed into a small caravan.

Mr. Roosevelt and his son will kill the big game, the skins and skeletons of which will be prepared and shipped to the United States by other members of the party. Mr. Kermit Roosevelt is to be the official photographer of the expedition.

The national collections are very deficient in natural history materials from the Dark Continent; and an effort will be made by the expedition to gather general collections in zoology and botany to supply some of its deficiencies; but the main effort will be to collect the large and vanishing African animals.

Mr. R. J. Cuninghame, who is now engaged in assembling the materials for Mr. Roosevelt's use, has been employed to act as guide and manager of the caravan. Mr. Cuninghame is also an experienced collector of natural history specimens, having made collections for the British Museum in Norway and Africa. He is an English field man, who has guided numerous hunting parties in Africa and who was chief hunter for the Field Columbian Exposition.

Mr. Edmund Heller, a graduate of Stanford University, class of 1901, is a thoroughly trained naturalist, whose special work will be the preparation and preservation of specimens of large animals. Mr. Heller is about thirty years of age. His former experience, when associated with Mr. D. G. Eliot and Mr. Ackley, of the Field Columbian Museum, in collecting big game animals in the same portions of Africa which Mr. Roosevelt will visit, will be a valuable asset to the expedition. Mr. Heller has had large experiences in animal collecting in Alaska, British Columbia, United States, Mexico, Central America and South America. In the year 1898 he made a collecting trip of eleven months to Gallapagos Islands, starting from San Francisco. He is the author of scientific papers on mammals, birds, reptiles and fishes. At present he is assistant curator of the Museum of Vertebrate Zoology of the University of California.

Mr. J. Alden Loring is a field naturalist, whose training comprises service in the Biological Survey of the Department of Agriculture, and in the Bronx Zoological Park, New York City, as well as on numerous collecting trips through British America, Mexico and the United States. He is about thirty-eight years old. In August, September and October, 1898, he made the highest record for a traveling collector, having sent in to the United States National Museum 900 well-prepared specimens of small mammals in the three months' journey from London through Sweden, Germany, Switzerland and Belgium.

Major Edgar A. Mearns, a retired officer of the medical corps of the army, about fifty-three years of age, will be the physician of the trip and have charge of the Smithsonian portion of the party. He has had twenty-five years' experience as an army doctor, and is also well known as a naturalist and collector of natural history specimens.

The party will reach Mombasa in April, 1909. No detailed itinerary has been decided upon; but the general route will be up the Uganda Railway to Nairobi and Lake Victoria Nyanza, a distance of about 650 miles by rail, thence crossing into Uganda, and, finally, passing down the Nile to Cairo. Much of the hunting will be done in British East Africa, where the Uganda Railroad can be used as a base of supplies and means of ready transportation. At least one great mountain, possibly Mount Kenia, will be visited.

Khartum will be reached, if all goes well, about April, 1910. The expedition may be expected to spend about one year on African soil.

FRENCH VITAL STATISTICS

The *Journal Officiel* has recently published the vital statistics of France for the year 1907, and these are summarized in the *British Medical Journal.* The excess of deaths over births during the year reached the unprecedented number of 19,920. There were 32,878 fewer births and 13,693 more deaths than in 1906. In 1907, 773,969 births were registered of infants alive at the time of the declaration; there were also 36,760 stillbirths or infants who died before the declaration of the birth—a total of 810,729 births. The proportion, calculated on the census of 1906, is 207 per 10,000 inhabitants; lower than 1906, when it was 215; in 1905 it was 216; in 1904 it was 219; in 1903 it was 221; in 1902 it was 226; in 1901 it was 230 per 10,000 inhabitants. This dimunition of the natality is general throughout the country, for in comparison with 1906 the number of living births fell in 82 departments, and only showed an increase in 5 departments. The following departments show the largest diminution in the absolute number of births: Dordogne, 1,434 fewer births; Finistère, 1,067; Côtes-de-Nord, 978; Ardèche, 972; Hérault, 928; Aveyron, 893; Isère, 773; Rhône, 732; Loire, 701. The departments which showed in 1907 the largest number of living birth per 10,000 inhabitants were: Finistère, 287; Pas-de-Calais, 285; Seine Inférieure, 258; Morbihan, 253; Côtes-du-Nord, 242; Nord, 239; Meurthe-et-Moselle, 238; Vosges, 230; Lozère, Territory of Belfort, 226; Doubs, 221. The smallest proportion was in the departments of Gers, 131; Lot-et-Garonne, 132; Yonne, 142; Lot, 143; Tarn-et-Garonne, 145; Haute-Garonne, 151; Nièvre, 155; Gironde, 156; all of which show a progressive decrease as compared with previous years.

During the year 1907 793,889 deaths were registered. This gives 13,693 more deaths than in 1906, and 10,510 more than the annual mean for the decennial period 1896–1905. The increase in the number of deaths as compared with 1906 includes 55 departments: Seine, 3,316 more than in 1906; Morbihan, 1,084; Manche, 1,070; Isère, 996; Gard, 721; Indre-et-Loire, 719; Nord, 695, etc. In 32 departments the number of deaths in 1907 was less than in 1906. Of these, the following show the largest decrease: Seine-Inférieure, 777; Pas-de-Calais, 619; Doubs, 579; Vosges, 558; Rhône, 498; Haute-Saône, 453; Somme, 294; Meuse, 291; Finistère, 682. The departments giving the largest number of deaths per 100,000 of the population are: Lot, 244; Tarn-et-Garonne, 240; Bouches-du-Rhône, 238; Manche, 237; Orne, 236; Ardèche, 234; Vaucluse, 233; Calvados, Gard, 232; Aveyron, 224. The following show the lowest mortality: Cher, 161 per 10,000 inhabitants; Creuse, 163; Indre, 165; Landes, 167; Allier, 169.

The relative increase in the population per 10,000 inhabitants reached the mean of 18 in 1901 to 1905; it fell to 7 in 1906, and in 1907 fell to *minus* 5 per 10,000.

In 1907 there was an excess of births in only 29 departments, as compared with 42 in 1906 and 43 in 1905, the departments showing this excess most markedly being: Pas-de-Calais, 103 per 10,000 inhabitants; Finistère, 89; Nord, 57; Morbihan, 51; Territorie de Belfort, 49; Haute-Vienne, 44; Seine-Inferièure, 37; Vosges, 36; Meurthe-et-Moselle, 35; Lozère, 34; Vendée, 33; Doubs, 26; Côtes du Nord and Corsica, 23. It will thus be seen that the regions which show an excess of births are the North, Britanny, the Eastern frontiers, Limousin, and Corsica, the departments inhabited by the Celtic, Flemish, and Basque races. In the basins of the Garonne and the Rhone each year the proportion of deaths over births increases, and thus Gascony and Provence are rapidly losing their characteristic population.

THE AMERICAN SOCIETY OF ANIMAL NUTRITION

In connection with the International Live Stock Exposition at Chicago, there was held on November 28, 1908, a meeting of those college and experiment station workers more especially interested in investigation in stock feeding. About thirty were present, representing experiment stations from Massachusetts to California and from Minnesota to Alabama. The meeting grew out of a conference of investigators in this subject, held at Cornell University last summer during the graduate summer school of agriculture, and resulted in the formation of The American Society of Animal Nutrition.

The objects of the society, as stated in the constitution which was adopted, are "To improve the quality of investigation in animal nutrition, to promote more systematic and better correlated study of feeding problems, and to facilitate personal intercourse between investigators in this field." In addition to holding an annual meeting, the society proposes to take up actively the consideration of methods of investigation and later to enter upon cooperative study of important problems of stock feeding. To this end, a standing committee on experiments and two special committees on methods were provided for and the committee appointed at the Cornell conference presented a full report outlining the work to be undertaken.

The officers of the new society are: *President,* H. P. Armsby, of Pennsylvania; *Vice-president,* C. F. Curtiss, of Iowa; *Secretary-treasurer,* D. H. Otis, of Wisconsin; *Registrar,* J. T. Willard, of Kansas. *Committee on Experiments:* H. J. Waters, of Missouri; H. W. Mumford, of Illinois; T. L. Haecker, of Minnesota; E. B. Forbes, of Ohio; W. H. Jordan, of New York.

SYMPOSIUM ON CORRELATION

SECTION E, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AND GEOLOGICAL SOCIETY OF AMERICA

The program for a Symposium on the Principles and Criteria of Correlation is now completed, the following scientists having stated their readiness to discuss the several subjects opposite their names. The symposium will begin on Monday, December 28, under the auspices of Section E, and be carried as far as the time at the disposal of that section on Monday permits. On Tuesday and the following days, until completed, it will form a part of the program of the Geological Society of America, under a special subsection on correlation. The presentation and discussion of papers will be conducted strictly according to a definite time schedule, which will be stated in the program of the meeting.

C. R. Van Hise or C. K. Leith: "Principles of pre-Cambrian Correlation."

F. D. Adams: "The Basis of pre-Cambrian Correlation."

C. D. Walcott: "Evolution of Early Paleozoic Faunas in Relation to their Environment."

A. W. Grabau: "Physical and Faunal Evolution of North America in the Late Ordovicic, Siluric and Early Devonic Time."

Stuart Weller: "Correlation of Middle and Upper Devonian and Mississippian Faunas of North America."

G. H. Girty: "Physical and Faunal Changes of Pennsylvanian and Permian in North America."

David White: "The Upper Paleozoic Floras, their Succession and Range."

S. W. Williston: "Environmental Relations of the Early Vertebrates."

H. F. Osborn: "Environment and Relations of the Tertiary Mammalia."

T. W. Stanton: "Succession and Distribution of Later Mesozoic Invertebrate Faunas."

W. H. Dall: "Conditions governing the Evolution and Distribution of Tertiary Faunas."

Ralph Arnold: "Environment of the Tertiary Faunas of the Pacific Coast."

F. H. Knowlton: "Succession and Range of Mesozoic and Tertiary Floras."

R. D. Salisbury: "Physical Geography of the Pleistocene with Special Reference to Conditions Bearing on Correlation."

D. T. MacDougal: "Relation of Plants to Climate with Special Reference to Pleistocene Conditions."

T. C. Chamberlin: "Diastrophism as the Ultimate Basis of Correlation."

Bailey Willis,
Vice-president of Section E
E. O. Hovey,
Secretary of the Geological Society of America

THE AMERICAN SOCIETY OF NATURALISTS

The following circular, prepared for members of the American Society of Naturalists, is published in Science, in the hope of reaching many members of the affiliated societies who are not now members of the Society of Naturalists. It is hoped that all who are interested in the scientific study of evolution will join the naturalists in making a systematic effort to present the results of modern investigation in this field. Many who have not hitherto attended to the matter will also now appreciate the other advantages to be accomplished by strengthening this association of the special scientific societies to which they belong. Candidates are requested to apply directly to the secretary of the society, in accordance with the article of the constitution printed below.

REORGANIZATION AND ANNUAL MEETING

In view of the opinion, apparently so wide spread, that the American Society of Naturalists has no important function, and is not meeting the requirements of a proper cooperation between its affiliated societies and others, the following plan of reorganization is presented by the president and executive committee. (Attention is especially called to paragraph 5.)

1. The Society of Naturalists shall remain independent of other general societies.

2. The Society shall continue to represent the natural affiliation between its group of technical societies composed of scientific specialists.

3. Cooperation with other organizations shall be accomplished through the executive committee, which shall be selected with a view to the establishment of such external relations.

4. The policy of the Society shall be redefined, so as to adjust it more definitely to exert an influence for the encouragement of research in the larger field of science which it has cultivated from the start.

5. It is suggested that the main object of the society be considered the study of evolution in all of its many-sided aspects (historical, environmental, experimental, etc.). There is no subject which would so well hold together all the present members (including botanists, zoologists, physiologists, anatomists, paleontologists, anthropologists, etc.). It is suggested, therefore, that each year original contributions dealing with evolutionary matters be presented at one or more of the sessions of the American Society of Naturalists. It may also prove desirable to have reports each year of the most important recent work in evolution, in several of its different aspects (botany, zoology, paleontology, etc.). In this way members could be kept in touch with the most important advances in different departments. Such reviews should be given by men eminent in their respective fields.

This year the Darwin Memorial Celebration of the American Association will be conducted along the lines sketched above. The Society of Naturalists will, therefore, not attempt, at this meeting, to present a similar program; but, after the presidential address, will devote its session to the consideration of other problems.

New Members

The above plan will doubtless attract a considerable number of investigators interested in the general problems of evolution, and it is hoped that all available candidates will be induced to join the Society at this time, and will have their names sent in.

Article II.—Section 1. Membership in this Society shall be limited to persons professionally engaged in some branch of Natural History, as, Instructors in Natural History, Officers of Museums and other Scientific Institutions, Physicians and others, who have essentially promoted the Natural History Sciences by original contributions of any kind. Any member may present to the Executive Committee of the Society or of the Branch to which he belongs names of candidates for membership, and those candidates who are approved by the Committee may be elected to membership in the Society by a majority of the members present at any meeting of the Branch.

Annual dues, $1.00.

This December Meeting—December 31, 1908

The next meeting of the American Society of Naturalists will be held in Baltimore, Md., at Johns Hopkins Medical School, in the auditorium of the Physiological Building, Thursday, December 31, 1908, at 3 P.M. The address of the President, Professor D. P. Penhallow, of McGill University, will be on "The Functions of the American Society of Naturalists." There will then be a brief discussion in which matters of much importance to the Society will be brought up. Speakers will be limited to ten minutes. Several prominent investigators have already agreed to take part. The annual business meeting will follow.

The coming meeting is important. It has become necessary to secure positive action from its members if the integrity of the society is to be maintained. Shall the Society be permitted to dissolve? No other association emphasizes so well the distinctively scientific interests of this group of special societies as does the Society of Naturalists. It should, therefore, be made more representative of those societies for which it stands. Its affiliated societies should always retain complete independence, and yet will be able to accomplish more for science by establishing more practical machinery for cooperation. The Naturalists will then be able to act together effectively in dealing with general problems or with other more general societies.

The usual annual dinner will this year be merged with the Darwin dinner of the American Association for the Advancement of Science, to be held on the evening of January 1, 1909. This Society has also been invited to attend the Darwin Memorial Exercises on January 1, organized under the auspices of the American Association.

Members are requested to send their correct addresses, etc., to the secretary at once, so that an accurate membership list may be printed.

For particulars of the arrangements of rates, hotels, etc., for the Baltimore meeting consult the Announcement of the American Association, or Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

By order of the Executive Committee:

D. P. Penhallow, *President.*
T. H. Morgan, *Vice-President and Chairman of the Eastern Branch.*
R. A. Harper, *Vice-President and Chairman of the Central Branch.*
Thos. G. Lee, *Secretary of Central Branch.*
H. von Schrenk, *Treasurer.*
O. W. Caldwell, W. R. Coe, } *Members of Executive Committee.*
H. McE. Knower, *Secretary,*
Johns Hopkins Medical School, Baltimore, Md.

December 1, 1908

SCIENTIFIC NOTES AND NEWS

According to a cablegram to the daily papers from Stockholm, King Gustaf distributed the Nobel prizes on December 10. The awards, not identical in the cases of physics and literature with those cabled to this country last week, are as follows: Literature, Dr. Rudolf Eucken, professor of philosophy at Jena; physics, Professor Gabriel Lippman, of the University of Paris; chemistry, Professor Ernest Rutherford, director of the physical laboratory of the University of Manchester, England; medicine, divided between Dr. Paul Ehrlich, of Berlin, and Professor Elie Metchnikoff, of the Pasteur Institute, Paris; the promotion of peace, K. P. Arnoldson, of Sweden, and M. F. Bajer, of Denmark.

The Paris Academy of Sciences has divided the LaLande prize between Professor W. L. Elkin, director of the Yale Observatory, and Dr. F. L. Chase, assistant astronomer in the observatory, for their papers on "The Parallaxes of 163 Stars." Mr. M. F. Smith, assistant in the observatory, was given honorable mention in the award.

Professor George Davidson, head of the geographical department of the University of California, has been presented with the Charles P. Daly medal of the American Geographical Society.

Dr. John G. Curtis, professor of physiology in the College of Physicians and Surgeons of

Columbia University since 1875, and Dr. T. Mitchell Prudden, professor of pathology since 1891, will retire on June 30, next.

Dr. E. Benjamin Andrews has been compelled by failing health to resign the chancellorship of the University of Nebraska, and will retire from the office December 31, 1908. On December 8 a special convocation was held of students and faculties in honor of the retiring chancellor, at which somewhat extended addresses were made by Honorable William G. Whitmore of the board of regents, Judge E. P. Holmes of the alumni, and Professor C. E. Bessey of the university faculties. On the evening of the same day, the Faculty Dinner Club gave a complimentary banquet at which distinguished men from all parts of the state were present to do him honor. Many short addresses were made by representatives of the professors, regents, alumni and citizens of the state, as well as by the governor and the governor-elect. The banquet was closed by a farewell address by Dr. Andrews.

In addition to the program of addresses to be given at the Darwin celebration already published in Science on October 30, page 602, certain brief addresses have been arranged for at the time of the dinner as follows: Professor W. H. Welch, "On the Debt of Medicine to Darwinism"; Professor Edward Poulton, and Professor Albrecht Penck, "On the Geographical Factor in Evolution." The details of the dinner arrangements will be published at the time of the meeting. The dinner will be a memorable occasion and all will wish to attend. In order that proper accommodations may be supplied, it will be necessary to obtain tickets for the dinner as early as possible during convocation week.

Mr. Charles H. Townsend, director of the New York Aquarium, has been made a life member of the American Museum of Natural History, in recognition of his gift of mounted specimens of birds from Alaska and ethnological material from the South Sea Islands.

Dr. Bashford Dean, professor of vertebrate zoology in Columbia University, has been elected an honorary fellow because of gratuitous services during the past five years to the department of vertebrate paleontology, especially in respect to the collection of fossil fishes.

The Rev. Thomas Roscoe Reid Stebbing, M.A., F.R.S., F.L.S., gold medalist of the Linnean Society, formerly fellow and tutor of Worcester College, Oxford, has been elected an honorary fellow of the college.

President Charles F. Cox has been appointed the delegate of the New York Academy of Sciences to the Darwin centennial anniversary exercises at the University of Cambridge.

Professor Edward E. Prince, fish commissioner of Canada, has been appointed, in place of Mr. Samuel T. Bastedo, resigned, the British representative on the International Fisheries Commission having in charge the preparation of joint statutes to govern the fisheries of the international boundary waters. President David Starr Jordan is the American Commissioner.

An investigation into the cause of cancer and its possible prevention and cure has been begun in the College of Physicians and Surgeons, Columbia University, under the direction of a committee consisting of Dr. Samuel W. Lambert, dean; Dr. William J. Gies, professor of biological chemistry; Dr. Philip Hanson Hiss, Jr., professor of bacteriology; Dr. Francis Carter Wood, professor of clinical pathology; Dr. Gary N. Calkins, professor of protozoology, and Dr. Eugene H. Pool, instructor in the department of surgery.

The field parties of the U. S. Biological Survey have now returned to Washington for the winter. The biological survey of New Mexico under Vernon Bailey, assisted by E. A. Goldman and Clarence Birdseye, is nearly completed. Field work in southern Utah, discontinued several years ago, has been resumed under W. H. Osgood. Field work in Colorado, under Merritt Cary, has been finished, and the report is now nearly ready for publication. In the southern states work on geographic distribution has been continued by A. H. Howell in Alabama, Georgia, Kentucky, Louisiana, Mississippi, Tennessee and Virginia.

Offprints of articles on genetics for notice in the *Zeitschrift für induktive Abstammungs- und Vererbungslehre* should be sent to Dr. E. M. East, Agricultural Experiment Station, New Haven, Conn.

President-designate Taft will deliver the oration at the University of Pennsylvania at the annual celebration on Washington's birthday.

Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution at Boston, will give the first of a series of special lectures on hygiene to the students of the University of Wisconsin. Dr. Benedict will speak on "The Influence of Mental and Muscular Work on the Assimilation of Food."

The regular meeting of the Columbia Chapter of the Society of Sigma Xi was held on December 10, when Professor William H. Burr, of the department of civil engineering, addressed the society on the topic "The Quebec and Blackwells Island Cantilever Bridges." The lecturer discussed the cause of the failure of the former and the recent criticisms of the latter and the reports of the investigations of that structure recently made public.

At the first meeting of the Cornell Chapter of Sigma Xi for the present year, held on November 21, President Edmund A. Engler, of the Worcester Polytechnic Institute, gave an address on "The Reign of Law." About forty members of the chapter were present.

Dr. J. Paul Goode, of the University of Chicago, gave an address before the Geographical Society of Chicago, on December 11, on the subject "The Great Seaports of Europe."

Professor S. A. Mitchell, of Columbia University, has been delivering courses of lectures on astronomy at Asbury Park, N. J., Totterville, N. Y., and Newark, N. J.

The Vienna College of Physicians will celebrate the centenary of the death of Auenbrugger, the inventor of percussion, on May 18, 1909. A marble memorial tablet will be placed on the house in which he died.

A medallion of M. Laveran has been placed in the military hospital of Constantine, Algiers, where he discovered the parasite of malaria in 1880.

Mrs. Frederick F. Thompson has given to the New York State Museum as a memorial of her father, former Governor Myron H. Clark, the sum of fifteen thousand dollars, for a representation of the culture of the Six Nations of New York, to be known as the Clark Museum of Iroquois Culture.

A press despatch from Washington, dated December 8, says: "Appropriations aggregating $636,300 were made to-day at the annual meeting of the board of trustees of the Carnegie Institution of Washington. This amount is not intended to cover any new work, but will cover the operations of the institution planned for 1909. Dr. Carroll D. Wright, president of Clark College, presented his resignation as trustee, but indicated a desire to continue his work as director of the department of economics and sociology of the institution. Dr. Charles W. Eliot, president of Harvard University, and Mr. Martin A. Ryerson, of Chicago, were elected trustees of the institution to fill vacancies in the board."

The graduate clubs of the departments of philosophy, history, political economy, political science and sociology of the University of Chicago have formed an interdepartmental organization known as the Social Science Clubs Union with Mr. L. L. Bernard, of the department of sociology, as president. The union plans to have during the year a number of meetings and four lectures, by distinguished men from outside the university, on topics of interest to all the departments. The meeting of December 17 will be addressed by Professor Roscoe Pound, of Northwestern University Law School, on "Freedom of Contract—the notion of an inviolable right of contracting as one pleases which is one of the chief legal obstacles in the way of modern social legislation." The union has the financial backing of the university.

Portraits, given by various persons, of the following distinguished men have been framed and hung in the seminary room of the social sciences and history in Linsly Hall, Yale University: Christopher Columbus, William Patterson, Adam Smith, John Law, Arthur Young, the Earl of Shaftesbury, Herbert Spencer, Jean Jacques Rousseau, Jeremy Bentham, P. J. Proudhon, Charles Fourier, Sir William Petty, Robert Owen.

The necessary appropriation having been made by the trustees of the Carnegie Institution of Washington, on December 8, 1908, the contract for the construction of the magnetic survey yacht *Carnegie* was awarded on December 9, as the result of competition, to the Tobe Yacht Basin Company, of Brooklyn, N. Y. The vice-president and manager of this firm, Mr. Wallace Downey, has had charge of the building of several well-known yachts, *e. g.*, the *Meteor* (Kaiser Wilhelm's yacht) and the *Atlantic,* which won the Atlantic cup race of 1906. The vessel is to be completed by July 1, 1909. Mr. Henry J. Gielow, of New York City, is the naval architect and engineer-in-charge; he will be assisted in the work of inspection by Mr. W. J. Peters, formerly in command of the *Galilee* and to have charge of the *Carnegie.* The general dimensions of the *Carnegie* will be: length over all, 155½ feet; length on load water line, 128½ feet; beam molded, 33 feet; draught, 12 feet 7 inches.

According to despatches to the London papers from New Zealand, the *Nimrod* sailed on December 1 from Lyttelton for King Edward VII. Land, to take on board Lieutenant E. H. Shackleton, R.N.R., and his party of explorers, who, for the best part of the year, have been engaged in an attempt to reach the South Pole. The *Nimrod* left England in August, 1907, and arrived at New Zealand on November 23, 1907. After embarking Lieutenant Shackleton and the other scientific men and explorers, the *Nimrod* left Lyttelton on January 1, 1908, and made her way southward to the ice-pack. The explorers landed and the *Nimrod* came back to Lyttelton. Since then she has undergone a thorough overhaul, and the scientists' quarters on deck have been enlarged to nearly twice their original size, so that in the event of any of the shore party being ill they would have some place to use as a hospital. It is anticipated that six weeks will be taken in the passage from Lyttelton to the landing place in the far south. Lieutenant Shackleton and his party will, it is hoped, put in an appearance before the end of February, after which the *Nimrod* would make her way back to Lyttelton. It appears improbable that the ship will have to winter in the Antarctic. The vessel takes with her from Lyttelton to the Antarctic 280 tons of coal, and stores sufficient to last thirty-eight men for one year. She is now commanded by Lieutenant F. P. Evans, R.N.R., who was master of the steamer which towed the *Nimrod* from Lyttelton to the ice-pack at the beginning of the present year.

The third series of Norman W. Harris lectures at Northwestern University, given by Dr. Henry Fairfield Osborn, from December 3 to 8 on "The Age of the Mammals of Europe and America," was as follows:

Lecture I. Rise and Progress of Paleontological Discovery in Europe and America. Relations of Exploration, Research and Theory of Interpretation. Leaders in American Discoveries and Paleontological Methods.

Lecture II. General Comparison of the Physiography of America and Europe during the Age of Mammals and the Close of the Reptilian Age. Principals of Paleogeography. Sources of the World Stock of Mammals and of Successive Migrations.

Lecture III. Decline of the Archaic or Mesozoic Mammals, and Rise of the Modernized Mammals in America and Europe during the Eocene and Oligocene Periods. The Common and Independent Evolution on the Two Continents. Principles of Adaptive Radiation or Divergence.

Lecture IV. The Middle or Miocene Period. Invasion and Prevalence of African Types and Conditions of Life.

Lecture V. The Pliocene Period, Invasion and Intermingling of South American Forms. Contrasts and Resemblances between American and European Conditions.

Lecture VI. The Early and Mid-Pleistocene Periods. Extinction of the Large American Native Animals, and Repopulation from Europe and Asia. Causes of Extinction. Conclusions as to the Nature and Causes of Evolution of the Mammals.

A correspondent of the *Transcript* writes that simplified phonetic spelling is to be introduced in the public schools of France by

M. Dougmergue, the minister of public instruction. This reform received the approval of the French Academy as long ago as 1893, but has not heretofore received government sanction. It provides for the suppression of the "h" in the Greek group of words like "rhetorique," "rhinoceros," etc., the substitution of "i" for "y" in "analyse," "style," etc., the substitution of "c" for the sibilant "t" in words like "confidential," etc., and the extension of the "s" as a sign of the plural in words ending in "ou," "eau" and "au." It also provides for the suppression of the "h" in words like "theatre," the substitution of "f" for "ph" in words like "phenomene" and the elimination of the double "n" in words like "paysanne."

Since 1890 there has existed in Paris a little museum of hygiene, containing among other things, the exhibits which figured in the Paris pavilion of hygiene at the exposition of 1900, and which have to do especially with the sanitation of dwellings, the emptying of latrines and sewers, etc. According to the *Journal* of the American Medical Association there is now a plan to complete and to install the collections so as to make of them a real model museum of hygiene and sanitation. It will comprise the twelve following sections: Air and light (composition, meteorology; lighting of the city; lighting, heating and ventilation of the house); water (composition and bacteriology; flowing waters of rivers and springs, ozonation; distribution, filters, private baths, etc.); food and clothing (composition of foods, nutritive value, adulteration, sterilization of milk; hygiene of clothing, impermeability, etc.); preventive hygiene (disinfection, measures against fire, materials of construction); hygiene of infancy (feeding of infants, gymnastics); establishments such as hospitals, asylums, soup-kitchens; hygiene of special establishments (arrangement, heating, etc., of barracks, prisons, schools, cheap houses); residues of life (cemeteries and cremation; household refuse; rain-water and slops, night soil; sewers; emptying of used waters); public conveyances (omnibuses and fiacres; neatness, ventilation, disinfection, cleaning, etc.); smoke; demography; library.

UNIVERSITY AND EDUCATIONAL NEWS

We regret to learn that the will of Frederick Cooper Hewitt, which made large bequests for public purposes, including $500,000 to Yale University, is being contested by a sister.

Governor John J. Johnson, of Minnesota, went to Washington on December 12, to invite President Roosevelt on behalf of the regents to accept the presidency of the University of Minnesota, but he declined this invitation.

Dr. Samuel Avery, head professor of chemistry in the University of Nebraska, was elected acting chancellor at a recent meeting of the regents, on account of the resignation of Chancellor Andrews. Dr. Avery will assume the duties of the office on January 1.

Hon. Timothy Hopkins, of Menlo Park, California, well known as a patron of zoological research, and for whom the nudibranch genus of *Hopkinsia* has been named, has been elected president of the board of trustees of Stanford University.

Dr. Hochstetter, professor of anatomy at Innsbruck, has been appointed to the chair of anatomy in the University of Vienna.

DISCUSSION AND CORRESPONDENCE

THE FIVE HUNDREDTH ANNIVERSARY OF THE UNIVERSITY OF LEIPZIG

During August, 1909, the University of Leipzig is to celebrate its Five Hundredth Anniversary. It would be eminently fitting for the Americans who have taken their doctor's degrees at Leipzig to send to the university on that occasion some formal address of congratulation. A list of about one hundred Americans who have taken their degrees at Leipzig has been prepared, including all of the names of American scientists mentioned in "American Men of Science" and such others as could be secured from a few former Leipzig students in the vicinity of New York and New Haven.

A small committee has organized itself in an informal way for the purpose of collecting suggestions and information. If the movement seems to be of interest to those who are reached by this letter, a more formal organization can be perfected later and the congratulatory message can be issued by a representative committee.

The undersigned, acting as secretary for the preliminary informal committee, begs leave to request (1) suggestions with regard to the mode of procedure which would be most effective in presenting to Leipzig University the expression of congratulation from former American students; (2) information with regard to Americans in all departments who have received their degrees at Leipzig. The present list is complete for all names included in "American Men of Science"; it is otherwise very fragmentary and should be supplemented even at the risk of duplicating names from various sources.

It is requested that replies be sent at the earliest possible moment in order that the organization may be completed before January.

For the Committee,

Charles H. Judd

Yale University,
New Haven, Conn.,
December 2, 1908

MALARIA IN THE WEST INDIES

To the Editor of Science: In Science for August 28, 1908, p. 273, a note taken from the London *Times* appears in which it is stated that "Malaria is very much less common in Barbados than in other West Indian islands" and that the small fish known as "millions" (*Girardinus pœciloides*) "destroys large numbers of the larvæ of mosquitos that spread malaria."

These are the usual newspaper statements regarding the habits of these very interesting little fish, and they have frequently appeared recently in different papers. They are, however, not quite correct, in that the malaria-bearing mosquito (*Anopheles*) does not occur in Barbados and it is generally believed that no case of malaria has ever originated in this island.

"Millions" eat the larvæ of mosquitos and many forms of aquatic animal life. The permanent pools and small streams which would be the natural breeding places of the *Anopheles* mosquito are inhabited by "millions." Other mosquitos are able to maintain themselves in Barbados because they naturally breed in water which is not inhabited by "millions," but there is a possibility that the absence of *Anopheles* in this island may be due, wholly or in part to the presence of enormous numbers of these small fish.

The Imperial Department of Agriculture has introduced "millions" into Antigua, St. Kitts-Nevis and Jamaica and they have been taken to British Guiana and Colon. "Millions" are among the most active natural enemies of mosquitos and in any malarial country where they become established they will be almost certain to exert a very considerable effect on the prevalence of the malarial mosquitos, because they naturally inhabit the breeding places of *Anopheles*. In any locality where it is possible to establish "millions" in rain-water tanks, reservoirs, fountains, etc., much relief may be had from the mosquito nuisance.

The "millions" of Barbados are closely related to the top-minnows found in different parts of the United States, certain species of which are well known as natural enemies of mosquitos. Top-minnows from Texas have been introduced into the Hawaiian Islands, and similar fish have frequently been used in stocking streams and ponds for the purpose of reducing the numbers of mosquitos in certain localities.

H. A. Ballon

Imperial Department of Agriculture
for the West Indies

THE ODONATA OF MEXICO

To the Editor of Science: In my article on "The Present State of our Knowledge of the Odonata of Mexico and Central America," published in Science for November 13, 1908, I have unintentionally omitted the Ohio State University from the list of cooperating institutions on page 692. Regretting the oversight, this note is offered in correction.

Philip P. Calvert

QUOTATIONS

CLERICAL HEALING

The announcement made a few weeks ago by the rector of an Episcopal church in this city, that he was going to take up the practise of medicine as a part of his clerical work, calls renewed attention to this curious movement. While it was confined to the Emmanuel Church people in Boston it was generally regarded as a sort of Neo-Eddyism, one more of the many queer fads with which the citizens of that town are wont to amuse themselves, and little more was thought of it. Now, however, two at least of the Episcopal churches in New York are going to adopt the Emmanuel plan of treating disease, and doubtless some of the rectors of other churches in that denomination will be ready to join the ranks of irregular practitioners. It is time therefore to ask what the movement means, and why physicians, even trained neurologists, are to be found lending themselves to the movement and supporting it by voice and pen.

The first question raised by a perusal of the official book of the Emmanuel movement, is, why? Why clerical healing, and why the limitation of clerical healing to functional diseases? We do not find either question answered satisfactorily in this book and we do not see how they can be answered. If the physician is to entrust the care of his patients to the clergymen why not to the lawyer? The latter is as much the confidant of his clients as the minister of his parishioners, and could speak just as authoritatively to the subliminal self of the sick. But the physician ought to be able to speak with much greater effect. When he can not, the explanation must be found in that curious state of mind which leads the ignorant to trust the confident amateur rather than the professional, to pin greater faith to quack remedies or grandmother's simples than to the prescription of the physician. The skilful physician despises no remedy which may benefit his patient, and if he believes a word from a sincere and tactful minister of the gospel will help, he is glad to send, and often does send, the sick man to the clergyman. As physicians we should regret indeed to lose the powerful therapeutic force that resides in religion, but it does not follow from this that we are ready to welcome the priest as a fellow practitioner of medicine, or even to acknowledge that he can exercise that function in the public and wholesale way of the Emmanuel rectors without the danger of doing far more harm than good.—*Medical Record.*

SCIENTIFIC BOOKS

Traité de Géologie: I. Les Phénomènes géologiques. By Mons. Emile Haug, Professeur a la Faculté des Sciences de l'Université de Paris. Pp. 536. Libraire Armand Colin, 5 rue de Mézières, Paris, France. 1907. Price, 12 fr. 50.

Though primarily intended for the use of French students, Mons. Haug's excellent volume, recently published, is worthy of study by American geologists. A text-book or treatise dealing with the whole subject of geology should be a sort of clearing-house wherein is struck the true balance of competing ideas, suggestions and hypotheses, so far as that is possible in the progressive science. Only the first part of this newest treatise, that relating to the geological processes, has been issued, but it is fair to suppose that the author's conception of the principles of geology is rather fully presented. At the very first one is struck with the compactness of thought and expression throughout the work; Mons. Haug is to be congratulated on his success in preserving a very readable style while packing into his chapters a truly remarkable amount of fundamental material. The author has not followed the beaten track and the pages are full of valuable new thoughts.

The work is unusual in its order of treatment. The complex is considered before the relatively simple; geosynclinals, metamorphism, orogeny, epeirogeny and igneous intrusion are discussed before underground water, weathering, and river, glacial and marine erosion. It is not clear why chapter 28 on displacements of the shore-line is so far removed from chapter 16 on the vertical movements of the earth's crust.

As was to be expected, the author lays principal stress on the conception of the geosyncline. For the first time a European text-book states this idea at length sufficient to impress the student with its great importance. The statement is, however, charged with details which must lead to debate. For example, the diagram of a typical geosyncline in cross-section (p. 159) indicates a more or less perfect symmetry in the lithological composition of the sedimentary prism filling the down-warp. Yet is not the world's average geosynclinal prism lithologically unsymmetric in cross-section? The reviewer believes that the rule is to find the sediments on one side of a geosynclinal prism relatively coarse-grained because near the main region of erosion, the sediments growing finer-grained toward the opposite side of the prism. The idea of symmetry is probably suggested by Mons. Haug as a by-product of his hypothesis concerning the location of geosynclinal down-warps. He writes (p. 166): "loin de prendre naissance sur le bord des océans, les géosynclinaux sont toujours situés entre deux masses continentales et constituent des zones essentiellement mobiles, comprises entre deux masses relativement stables." Can this be correct? Is it safe to generalize from the geosynclinals[1] situated in the subequatorial zone of down-warps, Mediterranean seas and mountain-ranges? It is clear that the Alps and the Himalaya appear to follow the law as stated; but for most of the other "Mesozoic" geosynclinals the author has allowed his fancy to run very far. On page 162 a world-map is inserted, showing a wholesale "restoration" of the earth in Mesozoic times and a zone of Mesozoic geosynclines almost completely surrounding the area of the present Pacific Ocean. To make this ancestor of the mountain-built "circle of fire" obey the law, Mons. Haug hypothecates a Mesozoic Pacific continent some 75,000,000 square miles in area. He similarly "restores" a "continent nordatlantique," a "continent Sino-Sibérien," a "continent Africano-Brésilien," and a "continent Australe-Indo-Malgache." The obvious objection to this vast restoration of land-areas over the sites of the present ocean-basins is most inadequately discussed. In fact, almost the only words bearing on the fundamental matter are the following:

> On a cependant objecté aux conclusions qui viennent d'être exposées, la difficulté de loger toute l'eau des mers qui remplit actuellement de profondes dépressions auxquelles nous attribuons une origine récente. On oublie que les continents étaient beaucoup moins étendues qu'aujourd'hui et que des fosses profondes occupaient des emplacements où se dressent maintenant de hautes chaines de montagnes. L'océan Arctique semble avoir toujours existé et il a pu avoir une profondeur bieu superieure à sa profondeur actuelle. De plus, nous ne savons pas si entre Madagascar, l'Australie et le continent Antarctique ne se trouvait pas également une très profonde dépression (pp. 532–3).

But the simplest computation shows that these Arctic and South Indian oceanic basins, together with all the possible volume of the seas of transgression in the Mesozoic, are utterly incompetent to receive the 150,000,000 cubic miles of water which must be displaced to make room for the "restored" continents. It may be added that the facts of plant and animal distribution in no wise necessitate such drastic "restoration" of land-areas for the Mesozoic.

The chapters devoted to petrographic geology can hardly be regarded as satisfactory. Much emphasis is placed on the theoretical views of a few French authors, but the constructive work of men like Loewinson-Lessing, Vogt, Teall and Doelter is not discussed and, in general, not even mentioned. The view that granite is the final term of the metamorphism of geosynclinal sediments is presented, but no mention is made of the enormous physical and geological difficulties confronting this seductive hypothesis. The heat of fusion is attributed to the "rise of the

[1] The reviewer here uses this word to mean the sedimentary prism formed in the down-warp or "geosyncline."

isogeotherms" (with normal temperature gradient) into the lower beds of a sinking geosynclinal prism—a demonstrably inadequate source of the required heat. On page 174 we have:

Le granite est formé des mêmes éléments caractéristiques que le gneiss. Plusieurs auteurs l'envisagaient, probablement avec raison, comme le terme ultime du métamorphisme, et il convient peut-être d'attribuer la même origine aux roches granitoïdes basiques, à la syenite, à la diorite, au gabbro, etc. (!)

In the table of geological periods we find the traditional but inaccurate names "ère Primaire" and "ère Secondaire" used as synonyms for "ère Paléozoïque" and "ère Mésozoïque." The "période Algonkienne" enters the table; it will be interesting to see, in the second volume, what definition a French author can give this expression. For the North American geologist "Algonkian" is hard enough to define; "Algonkian period" is harder to define.

In form of publication the book marks a distinct advance over its only rival in the French language—A. de Lapparent's "Traité de Géologie." The improvement is notable in the style of the letter-press and in the introduction of many attractive illustrations. The book is marred by the lack of an index—a lack which can not be made up by the insertion of a general index in a succeeding volume, for the present thick one should be bound alone. The "Table des Matières" is placed at the end of the volume, where the index would also be placed if it had been printed. One may hope that some day the French will change their tradition and place the table of contents in the front of the book. Who of us has not wasted precious time searching out the "Table des Matières" among the appendixes, plates and index sheets of French texts!

Reginald A. Daly
Massachusetts Institute of Technology

A Text-Book on Sound. By Edwin H. Barton, Professor of Experimental Physics, University College, Nottingham. London, Macmillan and Co., Limited. 1908.

There was need of a treatise on sound, which would neither be taken up wholly with a mathematical discussion of dynamical principles, nor consist merely of experiments, and yet which would so combine these features and so fully cover the subject as to deserve the attention and meet the needs of the serious student of acoustics. Barton's "Text-Book of Sound" occupies such a place.

It is forty-five years since Helmholtz's classic, "Tonempfindungen," appeared, and thirty-one since the publication of Lord Rayleigh's masterly treatise, and in that time no work worthy to rank with these has been produced. The first volume of such a treatise by the late Professor Donkin was published in 1870, and this was of the same order as the two works mentioned, but it is doubtful whether it could have appealed to a large number of readers or to any but most accomplished mathematicians if it had been completed on the lines upon which the initial volume proceeded.

In the past forty years admirable treatises on heat have appeared, keeping pace with the development of the subject, still more on light; while those on electricity have been numerous enough and varied enough to satisfy almost every want; but sound as a branch of physics seems to have been side-tracked. Of course, the subject has been included in all compendiums or treatises on general physics, and to these the author acknowledges his indebtedness.

Barton's "Text-Book of Sound" is admirable on many accounts and has little to object to. Indeed all the material in it is excellent, the principal question in regard to some of it being one as to its relevancy. Unless one admits the propriety of including all wave phenomena in the theory of sound it would seem as if some things here were superfluous. Following approved precedents in defining "Acoustics, or the study of sound, as that branch of physics which deals with vibratory motion as perceived by the sense of hearing," an adherence to this definition might save the author from the necessity of discussing all the causes and peculiarities of wave motion. Possibly, a full presentation of simple harmonic motion might be appropriate, since all waves, transverse or longitudinal, which result in sound are of that form of motion, but it could hardly be necessary to go into any considerable discussion of elasticity or the determination of elastic constants. It should be sufficient, it would seem, to point out that in accordance with Hooke's law all vibrations due to elasticity are simple harmonic motions. In America, at least, a student capable of reading a work like this intelligently would very probably be so far familiar with the principles of elasticity as to make chapter III. superfluous, and the like would be true regarding some other portions that are not obviously of an acoustic nature. Even if their connection with acoustics is ultimately fundamental, it is so remote as to suggest comparison with the works of a watch which have nothing to do with the case. Their presence, however, is not a serious fault if it secures better treatment of other parts that could not be omitted. It is a question whether simple harmonic motion in connection with sound is not overdone. It is true that elastic vibrations are simple harmonic motions, but so far as sound is concerned its reception by or transmission to the ear is always due to longitudinal vibration, and the intricate composition of transverse vibrations helps very little in interpreting the superposition or interference of longitudinal waves in the medium through which the sound is transmitted. Still, the phonograph and the telephone have of necessity forced the study of acoustics along the line of vibrating plates. It is interesting to note how the very delicate points in acoustics are best appreciated by seeing instead of hearing.

The last chapter, devoted to recorders and reproducers, is most interesting and important, although some of it goes pretty far afield for sound. A good instance is given of rhythm resulting from sound vibrations and, without being itself sound, transmitted electrically as rhythm and perceived by dipping fingers into a conducting liquid. This may illustrate the vibrations of a plate as a source of sound, but they are neither transmitted nor perceived as sound at all, there being no evidence of any material vibration in the transmitting media or in the organ of perception. Of course this is very different from telephonic reproduction, where there is distinctly a sounding disk at the receiving as well as at the sending terminal. This chapter serves to show how greatly the domain of acoustics has widened since the earlier work of Donkin and Helmholtz, and it also points out how the theory of sound is connected with that of electricity through wave motion. The value of the chapter is heightened by the original work of the author upon electric oscillations.

We notice the introduction of the term sound-rays. Although this is unusual, the use of the term ray to designate a normal to a wave front is becoming so common in text-books as to justify it in connection with sound, even though the conception of a material ray of sound has never had any favor.

In enumerating several forms of sensitive flames the Govi-Barry flame, which is so easy to produce and so wide in its range of sensibility might well have been included.

A few errors have escaped the proof-reader, but probably not more than are to be expected in a first edition. Such are the omission of an exponent after equation (1) on page 225, and an uncompleted sentence at the top of page 371. But when the few points have been mentioned to which exception might be taken, there remain so many more to be commended that the balance is greatly in favor of the work. The admirable choice and distribution of experiments, the masterly character of the discussions, the ample scope of the work and its attractive typography and make-up, constitute it a welcome addition to the text-books of this division of physics.

D. W. Hering

The Nature and Development of Plants, by Carlton C. Curtis, instructor in botany in Columbia University. Henry Holt & Company, publishers.

Though published last year, the book has not yet received, in the way of review, the notice which it deserves. Though not purporting to be a text-book, it nevertheless is a book which may well serve the purpose in the real sense of the word. In the first place are set forth in simple language and lucid style the fundamental facts of plant physiology and morphology. Although not elementary in its treatment, the book is one which the beginner may read with interest and profit. In the second place the general order in which the subjects are taken is the logical one from the teacher's standpoint.

In Part I. the author discusses the structures and functions of typical plant organs as found in the leaf, root, stem, flower, etc. Though the order of subjects in the first part is not the most advantageous, from the reviewer's standpoint, the relations of structure and function and the relation of the work of one organ to that of another is made clear, and one is acquainted with the business of a vegetable organism, and the nature of plant life, before taking up the study of the structure and relationships of the groups which form the substance of Part II.

In the second part we are introduced to the principal divisions of the vegetable kingdom in ascending order, typical examples being discussed with sufficient fullness and clearness to set forth the salient features of their kind. Due emphasis is laid upon phylogeny and discussions of points of biological interest are plentiful. One feature of the book which adds to its interest, and which will commend it to many readers, is the repeated reference to the practical application of botanical knowledge and the relation of certain plants to economic operations.

One is pleased to observe the excellent character of the illustrations. It is a relief to see illustrations that illustrate, after some of the wretched sketches and meaningless figures that characterize several of the recent text-books of botany.

J. E. Kirkwood
Desert Botanical Laboratory,
Tucson, Arizona

India Rubber and its Manufacture, with Chapters on Gutta-percha and Balata. By Hubert L. Terry. 8vo, pp. v + 291, illustrated. New York, Van Nostrand Company. 1907. $2.00.

One may fairly say that, next to mining, the growing of rubber has of recent years been increasingly regarded as a golden path to material ease. In common with mining, the project has its risks and drawbacks, and the only safe guide to intelligent investment in both is knowledge. This the general public does not have, but many individuals desire specific information, either for the reason observed, or for the sake of general enlightenment. With regard to rubber and its manufacture, Terry's book fairly meets this need; it is for such that it has been written. Though dealing with a distinctly technical field, the author has succeeded in making a very readable book, and this is due not a little to his pleasing style, occasional prolixity to the contrary notwithstanding.

One experiences a slight feeling of disappointment in reading the first two chapters, those dealing with the history of the matter and with the botanical origin of crude rubber. It would have been justifiable to have dealt with these topics with greater liberality, and the addition of treatment at greater length of the cultural aspects of the industry would have heightened the value of the book in a marked degree. It seems to the reviewer a fair criticism that the chapter on India-rubber Plantations is a trifle pessimistic. Mr. Terry's attitude is safe, because negative. A more just statement of the legitimate attempts which are being made in Mexico to cultivate rubber trees (*Castilloa*) would have had greater merit. Sharp practises do great damage to infant industries. So much more therefore do these demand proper representation at the hands of the critic.

To be commended in this connection is the effort to point out the need for adequate conservation of the natural forests of rubber-producing trees, a problem to which our modern forestry methods have not yet reached. Science will be needed in meeting this aspect of the industry quite as much as any other. Already her face has been turned toward plantation culture, with no little success, but the inevitable struggle of man with nature has already discovered a quite handsome array of parasitic enemies, whose energies appear to be largely concentrated upon cultivated rubber-trees. The general criticism applied to the treatment of the botanical aspect of the case appears to be justified especially, for example, to the discussion of guayule, a rubber-producing plant with which Americans are more familiar (or perhaps one should say less ignorant). This plant is of peculiar interest because of its preference for the arid conditions of the central plateau of Mexico and adjacent Texas. Indeed, any plant which offers the possibility of using the desert with economic intent may well be thought worthy of special regard. With regard to the process of manufacture of crude guayule rubber the author appears not to be fully informed, but, as the industry is comparatively new, and as a number of methods have had more or less vogue, it is naturally difficult to get exact knowledge, especially at a distance, a difficulty not reduced by the natural effort at secrecy on the part of the manufacturers.

In the discussion of the technical aspects of the rubber industry the author is distinctly at home. Though often brief and summary, he gives the gist of the matter in a very satisfactory way, and this despite the very abstruse nature of the subject. Among the topics presented, to give a brief impression of the scope of the book, are the chemical and physical properties of rubber, its vulcanization, substitutes, reclamation, and the methods of manufacture of various classes of articles from it. It will suffice here to heartily commend the way in which the numerous pertinent details have been handled, since more than a very general criticism would occupy the time of the inquirer better spent in reading the original. As to the orthography, it may be captious to say anything, especially as we (speaking as Americans) have the sympathy of Mr. Terry himself, if we take exception to the English spelling of "tyre."

We may regret that the book is but poorly illustrated, more especially in the pen-drawings of rubber plants. These are hopelessly crude, and behind the times.

Francis E. Lloyd

Auburn, Ala.

SPECIAL ARTICLES

THE ACCLIMATIZATION OF AN ALFALFA VARIETY IN MINNESOTA

That practically none of our many crop plants are indigenous is a matter of common knowledge. Among the numerous agencies that have been instrumental in their introduction immigrants from agricultural areas of the old world deserve more credit than they have hitherto received. Although it is likely that many introductions have been made in this manner, it is rarely possible to trace clearly the history of an individual case. The successful introduction of South American alfalfa into California, to which we owe almost exclusively the present extension of alfalfa growing in the United States, took place about 1855.

In the spring of 1857 another strain found its way into the United States, this time from Europe. In that year there came to this country from the little village of Külsheim, near Wertheim, in the Grand Duchy of Baden, a German farmer named Wendelin Grimm. Like many of his countrymen, Grimm went west, taking up a farm in Carver County, Minn.

Among the few possessions that he brought with him from his old home was a small bag containing less than twenty pounds of seed of the alfalfa or lucerne commonly cultivated in Baden. Grimm applied numerous local names to this alfalfa, but most commonly he called it "ewiger Klee" (everlasting clover) referring to its perennial nature.

This small lot of seed was the progenitor of an alfalfa industry that has existed in Carver County, Minn., for more than a generation and which is now being extended into other parts of the cold northwest.

The South American seed found a congenial soil and climate and became the basis of a farming industry whose annual product has in half a century attained a value of about $150,000,000. The European seed, on the other hand, encountered a favorable soil but a very unfavorable climate, with the result that a long period of years was required for it to become finally established. The original

Grimm alfalfa came from the valley region of Baden, which is said to be one of the warmest and most fruitful districts, not only of Germany, but of Europe; a section in which the almond, walnut and vine flourish. Hence we have in the latter case an instance of the introduction of a valuable crop by an immigrant and also an undoubted example of a high degree of acclimatization brought about by natural selection unconsciously aided by man.

The Minnesota climate is exceedingly severe and during the early years Grimm alfalfa suffered many vicissitudes. Several years ago a member of the Minnesota Agricultural Society, discussing this valuable strain, said:

> When they first commenced to plant it some of them were badly discouraged . . . but finally they made a success of it, and I attribute that success to its having acclimated itself to the country. I can remember that clover growing in this county (Carver), well I should say pretty close to forty years.

Fields between twenty and thirty years old visited by the writer during the past summer have from 10 to 50 per cent. of a stand. Hardy as the strain has become, winters of unusual severity in any particular respect carry the selective acclimatization still farther. Fields examined in the summer of 1905 had suffered considerable losses in stand from the previous winter; fully 50 per cent. of the selected Grimm plants in the nursery at the Minnesota Experiment Station were winter-killed during the same winter (1904–5), while common alfalfa was killed out almost completely.

Wendelin Grimm died eighteen years ago, hence exact details as to his experiences are lacking. Nevertheless, it is apparent that in the early years of his attempt to grow alfalfa in Minnesota he suffered many setbacks. With characteristic German persistence, realizing neither the practical nor the scientific importance of his unconscious experiment in acclimatization, he patiently saved generation after generation of seed from the plants that survived each successive winter, planting new fields to replace the deteriorated ones on his own farm, and selling his surplus seed to his neighbors. He was probably oblivious both to the difficulty of the task he had undertaken and to the great value of the result, and took as a matter of course the yearly degeneration of his stands.

The fact that in its original home in Germany this variety was called upon to bear minimum temperatures less severe than those observed at Albuquerque, N. M., shows what this German immigrant accomplished in the way of acclimatization of alfalfa in Minnesota.

The Grimm strain is one of the hardiest of which we have knowledge. A six-year-old field at Fargo, N. D., has repeatedly endured temperatures lower than 30° F. below zero. It is for this quality that it is so highly prized. It came from a climate little calculated to develop resistance to cold, and as it stands to-day it is undoubtedly the direct product of fifty-one years of perpetuation of fit and elimination of unfit individuals under climatic conditions whose rigors are unknown in Germany.

Charles J. Brand

Bureau of Plant Industry,
U. S. Department of Agriculture,
November 13, 1907

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at the Johns Hopkins University, at Baltimore, during convocation week, beginning on December 28, 1908.

American Association for the Advancement of Science.—Retiring president, Professor E. L. Nichols, Cornell University; president-elect, Professor T. C. Chamberlin, University of Chicago; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. J. Paul Goode, University of Chicago.

Local Executive Committee.—William H. Welch, M.D., chairman local committee; Henry Barton Jacobs, M.D., chairman executive committee; William J. A. Bliss, secretary, Joseph S. Ames, William B. Clark, R. Brent Keyser, Eugene A. Noble, Ira Remsen, John E. Semmes, Francis A. Soper, Hugh H. Young.

Section A, Mathematics and Astronomy.—Vice-president, C. J. Keyser, Columbia University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Carl E. Guthe, State University of Iowa; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor Louis Kahlenberg, University of Wisconsin; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Geo. F. Swain, Massachusetts Institute of Technology; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Bailey Willis, U. S. Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor C. Judson Herrick, University of Chicago; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor H. M. Richards, Columbia University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Professor R. S. Woodworth, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Professor W. G. Sumner, Yale University; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. H. Howell, Johns Hopkins University; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Professor John Dewey, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 31. President, Professor D. P. Penhallow, McGill University; secretary, Dr. H. McE. Knower, The Johns Hopkins Medical School, Baltimore, Md. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 30, 31. President, Professor H. S. White, Vassar College; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28, 29. President, H. W. Tyler, Boston, Mass.; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor E. L. Nichols, Cornell University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 29–January 1. President, Professor Marston T. Bogert, Columbia University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Professor Samuel Calvin, University of Iowa; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—January 1, 2. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor Richard Swan Lull, Yale University; secretary, Dr. W. D. Matthew, American Museum of Natural History, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor John J. Abel, The Johns Hopkins University; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 29–31. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 29–31. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–January 2. Vice-president, Professor H. L. Russell, University of Wisconsin; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 29–31. President, Professor William Morton Wheeler, Harvard University;

secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn. *Central Branch*, December 28–30. President, Professor E. A. Birge, University of Wisconsin; acting secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The Entomological Society of America.—December 29, 30. President, Professor W. M. Wheeler, Harvard University; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor S. A. Forbes, University of Illinois; secretary, A. F. Burgess, Washington, D. C.

The Botanical Society of America.—December 29–31. President, Professor W. F. Ganong, Smith College, Northampton, Mass.; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—December 30, 31. President, Professor L. H. Bailey, Cornell University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Chapter.—President, Dr. T. C. Frye, Seattle, Wash.; secretary, Mr. N. L. T. Nelson, St. Louis, Mo. Address: Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor G. M. Stratton, University of California; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Philosophical Association.—December 29–31. President, Professor Hugo Münsterberg, Harvard University; secretary, Professor Frank Thilly, Cornell University, Ithaca, N. Y.

Southern Society for Philosophy and Psychology.—Convocation week. President, Professor J. MacBride Sterrett, The George Washington University; secretary, Professor Edward Franklin Buchner, The Johns Hopkins University, Baltimore, Md.

The American Anthropological Association.—December 28–January 2. President, Professor Franz Boas, Columbia University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 28. President, Professor Roland B. Dixon, Harvard University; secretary, Dr. Alfred M. Tozzer, Harvard University, Cambridge, Mass.

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 446th meeting was held October 17, 1908, with President Stejneger in the chair. A paper on "The Pear Thrips Problem in California" was read by Mr. A. L. Quaintance. The so-called pear thrips (*Euthrips pyri* Daniel) first came to notice in the spring of 1904 in the Santa Clara Valley in California. Since its first appearance, its injuries have constantly increased, and it has now spread to the principal deciduous-fruit growing regions in the San Francisco Bay region. The losses brought about by the pear thrips the past year have been perhaps not less than half a million dollars.

The insect was first investigated by Mr. Dudley Moulton, beginning in 1904, at that time Santa Clara County entomologist, and a fairly complete account of it was published in a bulletin from the office of the state commissioner of horticulture. The increased destructiveness of the thrips led to provision by congress for an investigation of the insect by the Bureau of Entomology, and Mr. Moulton, who in the meantime had been employed by the bureau, was assigned to the work beginning July 1, 1907, with headquarters at San José, Cal.

The pear thrips attacks various deciduous fruits, as almond, apricot, peach, prune, cherry, pear, apple, etc. The life history is briefly as follows: Early in the spring, as in late February or early March, the adult thrips begin to make their appearance from the soil, at once attacking the opening buds or blossoms, and by their feeding soon cause these to blight, literally nipping the fruit crop in the bud. Oviposition occurs soon after emergence, the eggs being placed in soft tissues, especially fruit and leaf stems or in the midribs of leaves. The young larvæ feed upon the tender tissues of the leaf or flower, requiring some three or four weeks to reach their full size. They then leave the plants and work their way below the soil from three to four or even ten to twelve inches, depending upon whether this is hard or soft, as resulting from frequent cultivations. In the soil, the thrips larvæ construct small oblong cells where they remain the balance of the season. In late fall and early winter, transformation to the pupa stage occurs, from which the adults develop, to appear above ground about the time fruit trees are beginning to bloom in the spring. There is thus but one generation each year, and the insect spends practically ten months in the ground.

The pear thrips has proved to be a very difficult insect to combat, and its practical control has not yet been determined. The Bureau of Entomology is carrying out extensive experiments and demonstrations in spraying in the infested territory and also testing over large areas the possibility of destroying the larvæ or pupæ in the ground by cultivation or other methods of soil treatment. Of many sprays tested, a proprietary tobacco extract and a distillate emulsion have proved most efficient. Spraying must be directed largely against the larvæ feeding on the more exposed portions of the plant. Of the various fruits attacked, pears and prunes suffer worst, from the fact that the thrips are out in large numbers just when the buds of these fruits are beginning to swell, and these are promptly infested and destroyed, usually before the blossoms expand.

An abstract of a paper on "Recent Discoveries in the Natural History of Eels," by Dr. T. N. Gill, appeared in Science for December 11.

The 447th meeting was held October 31, 1908, with President Stejneger in the chair. The evening was taken up with a discussion of the necessity for an immediate biological survey of the Isthmus of Panama, the following members taking part: The chair, Gill, Dall, Howard, Coville, Pittier, Nelson, Safford, C. D. Marsh, Bartsch and Schwartz. Insistence was made on the desirability of a survey, and since the fresh waters of the two sides of the isthmus will mingle within a year, permitting the mixture of forms from the two sides, a fresh-water survey should be begun immediately. The plan favored was that of united action on the part of the heads of governmental departments rather than dependence upon congress. The following resolution was adopted:

Realizing that the work on the Panama Canal is changing biological conditions in Panama and that the completion of the canal will enable the fresh-water faunas of the two slopes to mingle freely and that many marine animals will succeed in passing the completed canal, the Biological Society of Washington urges upon the government of the United States to make provision for a biological survey of the Isthmus of Panama.

Since the conditions will be permanently changed as soon as the canal is completed and the work can not be satisfactorily done after the completion of the canal, there is great urgency that provision for the work be made at once. Therefore be it

Resolved, That copies of this resolution, signed by the president of the society and the recording secretary, be sent to the president of the United States, the heads of the several departments concerned and the secretary of the Smithsonian Institution.

The 448th meeting was held November 14, 1908, with President Stejneger in the chair. Dr. Hugh M. Smith exhibited a series of colored lantern slides of living fishes photographed in the wild state and in aquaria by the well-known photographer, Mr. A. Radclyffe Dugmore.

Mr. Henry Oldys presented a paper entitled "Some Deductions from the Nesting of Birds," in which he called attention to the identity of construction of the nests of closely related birds in widely separated parts of the world. Thus the American robin (*Merula migratoria*), the European blackbird (*Merula merula*) and *Merula mandarina* of China all use mud in the composition of their structures; the American kinglets and the European goldcrest build suspended nests stuccoed with lichens; and the Caprimulgidæ of America, Europe and Australia construct no nests, but lay their eggs on the bare ground. These are merely random examples; many others might be cited, such as titmice, wrens, doves, etc. The components of these different groups of birds must have been separated for thousands of years, and the fact of this resemblance of their nests indicates how little they have departed from the habits of their common ancestor. This seems on its face a strong justification of the inference that nest-building is instinctive. But various instances are recorded of radical departure from the type. The American herring gull (*Larus argentatus smithsonianus*), when the usual flimsy nests of seaweeds carelessly thrown together on the beach were persistently robbed by fishermen, abandoned their custom of ages and built substantial structures in trees forty or fifty feet from the ground; and the herons near Redwood City, Cal., from a similar cause deserted their rookery with its nests in eucalyptus trees and built on the ground far out in the marsh. Other instances of radical departure from custom were instanced by Mr. Oldys, who deduced from these examples that since birds can change their architectural customs when necessity arises, we must attribute their adherence to the ancestral type of nest to conservation rather than the mechanical operation of instinct, and hence conclude that the building of a nest is an intelligent action. In support of this contention Mr. Oldys adverted to like adherence to architectural forms on the part of man, particularly shown by less developed types. The round huts of African savages, the wigwams of Indians, and various other examples were enumerated by the speaker as evidence that man's house building runs also in architectural grooves. Lower types of man are less capable of invention and innovation than those of greater development; and as birds are still lower in the scale, the persistence of avian architectural types for ages is not incompatible with the idea that birds' labors are not automatic, but are governed by intelligence.

Mr. Wells W. Cooke read the third paper of the program, on "The Earliest Migration Records in the United States." This will be published in *The Auk*.

M. C. Marsh,
Recording Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 654th meeting of the society was held on November 7, 1908, Secretary Burgess presiding. The following papers were read:

An Electrical Resistance Method for the Rapid Determination of Moisture in Grain: Dr. L. J. Briggs.

The speaker briefly reviewed the lack of uniformity in grain grading due to the moisture content of the grain, and the effect of moisture upon the method of grain shipment. The methods heretofore used in ascertaining moisture content of grain were briefly described and the importance of a rapid method was pointed out. The speaker had recently applied the electric resistance method to the problem. It was found that the same specific resistance gave the same per cent. of moisture within a limit of error of 0.3 per cent. A curve was exhibited showing the relation of the percentage of moisture content to the logarithm of the electric resistance. The results showed three noteworthy things: (1) all the varieties of wheat tested in the investigation gave about the same amount of moisture for the same specific resistance; (2) the high temperature coefficient; (3) the relation of moisture content to the logarithm of the resistance.

By this method the moisture content can be ascertained in about one half hour, whereas by the methods heretofore usually employed three days were required.

The paper was published in the issue of Science for December 4.

Some New Measurements with the Gas Thermometer: Dr. A. L. Day.

This paper will be found published in full in the *American Journal of Science* for November, 1908.

R. L. Faris,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The eighty-seventh regular meeting of the Northeastern Section of the American Chemical Society was held on Friday, November 20, 1908, at the Technology Union, Boston. Reports of the treasurer and secretary for the year just closed showed the section to be in prosperous condition. The annual election was held and the following officers chosen for next year:

President—G. N. Lewis.

Vice-president—Franklin C. Robinson.

Secretary—Kenneth L. Mark.

Treasurer—Hermann C. Lythgoe.

Councilors—J. F. Norris, W. H. Walker, L. A. Olney.

Executive Committee—S. W. Wilder, Karl Langenbeck, W. L. Jennings, F. E. Gallagher, A. G. Woodman.

Professor Henry Fay, of the Massachusetts Institute of Technology, addressed the section upon "The Effect of Manganese Sulphide upon Steel," having particular reference to the failure of steel rails. The appearance and properties of manganese sulphide in steel were discussed and it was shown that under certain conditions this substance may cause dangerous weakening of the finished rail. The relation of this material to fractures which had occurred in rails in use was clearly shown by an interesting set of lantern-slide photographs. The properties of manganese sulphide were studied and its melting point found to be 1,162° C., and its specific gravity after fusion, 3.966. It was suggested that in consequence of the difference of its specific gravity, and that of steel, better separation of the sulphide may be obtained by keeping the melted metal in the ladle for a longer time after adding the ferromanganese, and before pouring the ingot.

Professor Franklin C. Robinson, of Bowdoin College, addressed the section upon "Some Chemical Facts and Fancies." The speaker related numerous personal experiences as an expert on the witness stand, and advanced certain views as to the proper attitude of the expert in court trials, particularly in criminal cases. He especially deprecated the theatrical or pompous attitude, sometimes assumed by the expert, and asserted that usually a better impression is made upon the court and the jury if the witness keeps himself somewhat in the background.

Frank H. Thorp,
Secretary

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 25, 1908

CONTENTS

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

EARLY TERRESTRIAL CONDITIONS THAT MAY HAVE FAVORED ORGANIC SYNTHESIS

THERE is a wide gap between the inorganic carbon compounds, as we now know them in nature, and the much more highly complex carbon compounds which are the material basis of living beings. It is a prevalent view that this gap can not be bridged by natural processes under existing conditions. On the face of things this view seems to be supported by the testimony of experience. This experience, however, when critically examined, is not altogether conclusive. Even if it could be shown beyond question that the chain of carbon compounds necessary to bind the inorganic to the organic never is built up under present conditions, there would still remain a legitimate ground of doubt in the possibility that this may be due to predaceous plants and animals, especially bacteria, which attack the carbon compounds at the first stages at which they become available for food and thus cut off the evolving series before it is complete. In this it is assumed that the formation of the more complex carbon compounds can come about only as the result of a long series of synthetic steps, and that at some of these stages, probably at many of them, the products would be suitable food for existing beings, especially for the almost omnivorous and ubiquitous bacteria. This prolonged evolution may thus be regarded as an extremely precarious process in the presence of predatory organisms; may indeed be regarded as practically prohibitive after the earth was once well planted with the rapacious varieties. This adverse contingency obtains quite irrespective of the theoretical possibility of such an evolution under favorable conditions, if left undisturbed.

A further element should not be overlooked. Before an organic series can be permanently assured, the power of self-propagation must be acquired. What may be the contingencies attending the addition of the self-propagating function to the acquisition of the requisite chemical constitution is at present quite beyond determination. There may be in this supplementary process, if indeed it be a supplementary process, as great a liability to predatory arrest, as in the chemical synthesis itself. Probably the safest answer which the extreme evolutionist can give to the suggestive question why wholly new orders of living beings have not appeared at frequent intervals in the geologic record, lies in an appeal to the rapaciousness and universality of the attack of organisms already present.

It is merely as a matter of precaution that these considerations are cited here. It does not seem to us safe to make the unqualified affirmation that present terrestrial conditions are wholly incompatible with the natural synthesis of a series of carbon compounds linking the inorganic to the organic if the whole predaceous kingdom were removed so as to leave the organizing agencies unlimited opportunities for interaction for an indefinite period. The purpose of this paper is not to meet a geologic necessity, but merely to consider those conditions in the early history of the globe which may be thought to have been specially favorable to organic synthesis, irrespective of the question whether the natural evolution of life was wholly dependent upon them or was merely facilitated by them. The paper is not the result of an inquiry into the problem of organic synthesis, as such, but is rather a preliminary statement of supposed geologic conditions intended to suggest inquiry in certain lines which do not seem to have been critically pursued. At the same time, the treatment may serve to connect with this chiefest of synthetic problems the postulates of the planetesimal hypothesis which have been little discussed in this regard.[1] Only a part of the agencies herein suggested as bearing on the synthetic process are however peculiar to this hypothesis. In some notable part they are assignable to any mode of origin which the earth may reasonably be supposed to have had.

The growth of the earth by the planetesimal method leaves a rather wide speculative range relative to the conditions which prevailed at the stage when life was introduced. At the same time, the hypothesis recognizes limitations which shut out certain conditions that have sometimes been thought to be important to the evolution of the higher carbon compounds, notably high atmospheric pressure. Under the older cosmogonies very high atmospheric pressures associated with very high temperatures were postulated. Under the planetesimal hypothesis, it is indeed possible and logical to assign to the atmosphere as great an extent and as high a pressure as the gravity of the earth can control; but the hypothesis, as we hold it, is built on the assumption that molecular activities limit the atmosphere, a principle which, if true, limits it under any hypothesis. If the doctrine of Stoney, modified to meet the new advances in physics, is sound, it can not, of course, be violated by any cosmogonic hypothesis without self-destruction. If this doctrine is true, and the earth-mass lacks power to control an

[1] Chamberlin and Salisbury's "Geology," Vol. II., 1906, pp. 111–116.

atmosphere radically greater than the present one, it is obvious that the notion of an atmospheric pressure appreciably greater than the present should not be entertained. It is because this doctrine of Stoney is believed to be fundamentally sound, subject to some qualifications, that the planetesimal hypothesis has developed its postulates in consonance with it and has not consciously entertained assumptions regarding sequential states that are at variance with it. If the doctrine of Stoney is sound, the gaseous and gaseo-meteoritic hypotheses have no advantage as to the pressures of the early atmospheres; on the contrary, the higher temperatures they assume imply greater molecular activity and hence greater molecular losses and less pressures than prevail around the present relatively cool earth. In this paper, therefore, no appeal will be made to *general* atmospheric pressures appreciably greater than the present; indeed, we shall try to be true to the assumption that the *general* atmospheric pressures in the formative stages of the earth were lower rather than higher than they are at present. What volume of atmosphere and what degree of atmospheric pressure may have been compatible with the gravitative power of the earth at such early stages as were first suitable for the evolution and preservation of organic compounds is not yet definitely postulated by the planetesimal hypothesis. It is merely assumed that a suitable atmosphere, hydrosphere, temperature and other conditions were found at some one of the progressive stages leading up to the present state and that there was a gradual transition from that stage to the existing state of things. So far as gravity alone is concerned, a sufficient atmosphere and hydrosphere might apparently be held when the earth had about one tenth its present mass, *i. e.*, about the present mass of Mars, which apparently holds an atmosphere and perhaps a hydrosphere.

If the earth were formed by a gathering of planetesimals into a nucleus which at an earlier stage was one of the nebulous knots of a spiral nebula, the value of the mass at the time it first became a solid body should have hung upon the ratio of the original knot to the scattered nebulous matter destined to be gathered into it, concerning which there is little to guide opinion. In this uncertainty, let it be assumed that at the stage when the growing earth was ready for the critical synthesis, its mass lay somewhere between one tenth and three fourths of the present mass, and that the mass of the early atmosphere held a proportionate ratio to the mass of the existing atmosphere. Let it also be assumed that at the time at which the hydrosphere began to gather about the globe, the earth's surface was formed of a heterogeneous, uneven, talus-like mantle, such as the infalling planetesimals would naturally produce, and that this constituted a deep porous zone. Until the hydrosphere was added there was a lack of efficient solutions and inwash to cement the fragmental material. The hydrosphere, in its first stages, must have occupied the lower part of this porous zone, and must have crept upwards as its volume increased. It should have appeared at the surface first in the bottoms of the deformation sags, the innumerable craters and the other depressions, and as it gradually extended itself, it must have linked more and more of the isolated water-bodies together. Throughout the earlier stages of growth, the prevailing aspect should have been that of innumerable small water-bodies scattered over the face of the land, rather than that of the great confluent ocean of to-day.

This then is the general physiographic setting which the planetesimal hypothesis, at least in one of its phases, presents for the initiation of the chemical synthesis to which is assigned the task of bridging the gap between the inorganic and the organic compounds.

So far as chemical reactions of the familiar inorganic class are concerned, such a stage of earth-growth must obviously have presented conditions favorable to unusual activity, since the contact surfaces between the atmosphere and the hydrosphere, between the hydrosphere and the rock surfaces, and between the atmosphere and the rock surfaces, were all relatively large and varied, while the temperatures produced by the radiation received from the nebulous sun and by the heat of impact of the planetesimal matter may be presumed to have given a varied range of thermal conditions. As a result, reactions of exceptional variety should have been developed. In view of the vast number of bodies of water and their varied contacts with all sorts of rocks, together with the possibilities thus presented for the isolation of special combinations in their early stages and the correlative possibilities of conjunctions and minglings of these in their subsequent stages, there may well have resulted numerous diverse chains of sequences.

At that stage the atmosphere should have held each of its present constituents but probably not in the same proportions as now. The elements of lower specific gravity should have been smaller in amount relatively than at present, while those of higher specific gravity should have been more abundant relatively, because the controlling power of the smaller earth limited the range of molecular retention. Relative to the lighter constituents, it need only be added that, instead of escaping completely from the control of the earth, as postulated in the earlier phases of the doctrine of Stoney, the lighter molecules should in the main have escaped merely into the supplementary orbital atmosphere, where they might have persisted for long periods during which they were always subject to being driven back to the earth by occasional encounters, so that, although these constituents may have been rare in the denser collisional atmosphere near the earth's surface, they were doubtless present in sufficient amounts to have participated in any appropriate chemical synthesis. It is to be added further in qualification of this that, with the exception of hydrogen, which might have been derived from its compounds, the lighter atmospheric constituents, such as helium and neon, are chemically inert and there is no specific reason for supposing that they entered into any stage of the organic synthesis. The heavier constituents of the early atmosphere would include the compound gases of carbon, nitrogen, sulphur and phosphorus.

During the critical stages of growth, the infalling of planetesimals is supposed to have continued to be active. The planetesimals are assumed to have contained carbon, sulphur, phosphorus and all other elements found in organic matter; and as they impinged more or less violently upon the surface formed of previous accessions of similar matter, there should have been generated various compounds of these elements. A portion of these compounds should have been gaseous or vaporous and should have been variously disseminated into the atmosphere, or else absorbed into the waters or into the porous earthy mantle. The volcanic action of the period should have contributed its characteristic constituents in similar variety of combination. It may therefore be assumed with plausibility that a larger percentage and a greater variety of volatile compounds of the critical class prevailed in the air, subject to absorption into the earth-mantle and the waters, during the stages of active terrestrial growth than at the present time, when terrestrial activities have more largely settled down into a state of less disturbed equilibrium. The same may doubtless be presumed of the unstable non-volatile compounds of the critical elements, but just here we are considering only the factor which worked through the atmosphere.

We have already denied ourselves any special appeal to *general* atmospheric pressure as an agency of the particular synthesis in question, but in doing this we have limited our abnegation to the sum total of pressure. It is still pertinent to inquire what may have been the effects of *partial* pressure. Starting with the familiar postulate that each constituent of a mixed gas acts in accordance with its own individual partial pressure, it appears that high partial pressures of the *critical* constituents should have been more effective in causing their entrance into combination than high general pressure without such high partial pressures. We have just seen that the chemical and physical conditions attending the stages of active earth-growth might well have given rise to large proportions of the critical compounds. By extending the argument it is not difficult to see that the actual amount of the carbon, sulphur, phosphorus and nitrogen gases might have been sufficiently greater than now to have promoted their union, for they all have high specific weights and could be held in relatively large proportions by the gravity of even a small earth. The gaseous compounds of nitrogen have a place in this class, though the free nitrogen was probably less abundant than now, but since free nitrogen is organically inert, it is negligible except as a source of its compounds.

If we turn to the non-volatile or slightly volatile compounds of the critical elements, we find, as already remarked, reason for thinking that there may have been more of the unstable compounds of this class than now, for secular progress would be in the direction of chemical stability. There are certain probable sources of unstable compounds of carbon, sulphur, phosphorus and nitrogen which call for special notice. Planetesimals are only one form of meteoroids and it is possible that the meteorites which reach the earth in appreciable masses may not often be true planetesimals of the class supposed to have formed the earth, but if the theory of common meteorites advanced by the senior author be the true one,[2] the compositions of the two classes are probably much alike, for according to this theory meteorites are supposed to be the fragments of small planetoidal bodies which have been disrupted by close approach to large bodies. These planetoidal bodies are supposed to have been too small to hold atmospheres and hydrospheres, and hence the planetesimals which formed them were never subjected to atmospheric and hydrospheric agencies, and hence they retained their planetesimal constitution with little modification.[3] This furnishes ground for assuming that the compounds found in meteorites were also present in the planetesimals. This presumption finds support in the nature of the case, for the gases shot forth from the sun to form the planetesimals probably were much dissociated by high temperature at the instant of emerg-

[2] *Astrophys. Jour.*, Vol. XIV., 1901, pp. 17–40; *Jour. Geol.*, Vol. IX., 1901, p. 369, and Chamberlin and Salisbury's "Geology," Vol. II., pp. 22–38.

[3] Dewar states that at a temperature of —130° C. liquid oxygen has no chemical action on hydrogen, potassium, sodium, phosphorus, etc. (*Proc. Roy. Inst.*, Vol. 11, 1884–6, p. 550), and this is perhaps an additional reason why planetesimals and meteorites enveloped in the low temperatures of space prevalent at considerable distances from the sun have been subjected to little oxidation.

ence and later combined in all available ways as they met appropriate elements at the various lower temperatures through which they passed in the course of their cooling.

Meteorites contain a very suggestive series of compounds of the essential elements, carbon, oxygen, nitrogen, hydrogen, sulphur and phosphorus. Among these compounds it is especially interesting to note that several are unstable under the usual conditions that prevail at the surface of the earth. Among these are the phosphide, schreibersite, the sulphides, troilite, daubréelite and oldhamite, the carbide, cohenite and the chloride, lawrencite. These unstable compounds are sometimes intergrown or otherwise closely associated with one another, so that the products of any reactions that may grow out of their instability are favorably located for reaction upon one another, and such reaction is liable to arise when the celestial equilibrium is disturbed by terrestrial conditions. There is also present a form of graphite which oxidizes more rapidly than terrestrial graphite. Such graphite, as well as amorphous carbon, is intergrown with the unstable sulphide, troilite, and the unstable phosphide, schreibersite. The readily oxidizable graphite sometimes contains within itself sulphur and hydrocarbons. Roscoe extracted from a meteorite a hydrocarbon which contained sulphur.[4] Clöez and Pisani found in the Orgueil meteorite matter of the organic type which had a composition closely similar to terrestrial humus, viz., C, 63.45; H, 5.98; O, 30.57.[5] Lawrence Smith also extracted hydrocarbons from meteorites, among which was a compound of carbon, hydrogen and sulphur having approximately the composition of $C_4H_6S_4$; also one which he formulated as $C_4H_6S_5$.[6] Ansdell and Dewar favor the view that the hydrocarbons had their origin in carbides, a view supported by the observed presence of carbide in meteorites.

> It may be assumed that the graphite resulted from the action of water, gases and other agents, on the carbides of the metals, and that during the chemical interactions which took place, a portion of the carbon became transformed into organic compounds.[7]

The hydrocarbons in meteorites embrace, according to Cohen, compounds of carbon and sulphur; of carbon, hydrogen and sulphur; and of carbon, hydrogen and oxygen, respectively. The hydrocarbons sometimes have a resinous or waxy aspect, and on decomposition may give an oil of bituminous or fatty odor. The compounds of carbon, hydrogen and oxygen afford extracts resembling peat, humus or lignite. All the alkalis, and all the earthy and metallic constituents which are essential to plant life are present in meteorites in variety and abundance. Besides the solid minerals, the gases carbon dioxide, carbon monoxide, methane, hydrogen, nitrogen and sulphuretted hydrogen are either present or are susceptible of development by moderate heat such as the infalls would inevitably produce.[8] It will be noted that these embrace the more common gases associated with ultimate organic reactions.

The chief point of interest here is not simply the presence, but the close intergrowth, of compounds of the organic elements in states of combination which, while stable in the cosmic regions surrounding the earth from which the planetesimal material was gathered, are pronouncedly

[4] *Proc. Phil. Soc. Mon.*, 1862.

[5] *Compt. rend.*, Vol. 59, 1864, pp. 37, 132.

[6] *Am. Jour. Sci.*, 1876, pp. 388–95, also 433–42. Many suggestive details.

[7] *Proc. Roy. Inst.*, Vol. XI., 1884–6, p. 549.

[8] For details see "The Gases in Rocks," R. T. Chamberlin, Carnegie publication No. 106, Washington, 1908.

unstable in the presence of the air and water, even at the ordinary temperatures at which organic synthesis takes place. On reaching the surface of the earth, these compounds would therefore have been no longer stable, but must have sought new relations. The transfer from the one state to the other may well have been accompanied by combinations not likely, or at least less likely, to arise under modern conditions of greater stability.

As already noted, a carbide of iron, nickel and cobalt is found in meteorites. The conditions attending the formation and infall of planetesimals encourage the belief that a wide range of carbides, and probably also of nitrides, may have existed among the accessions to the growing earth. But whether the amount of such material was large or small, it is clear that, as it was borne to the earth in the divided state of planetesimals, its measure of contact with the moisture of the surface was exceptionally large and hence the suggestive reactions which follow under these conditions should have been large in proportion to the amount of carbides and nitrides present. Even with cold water, the carbides of barium, strontium and calcium give rise to acetylene, while the carbides of aluminium and beryllium generate methane. Under the same conditions, uranium carbide gives rise to a gaseous mixture of methane, hydrogen and ethylene, and in addition to this generates considerable quantities of both liquid and solid hydrocarbons.[9] While nitrides are not known to furnish directly such a varied assortment of gases, they may readily give rise to ammonia gas under various conditions. Iron nitride, heated to 200° C. in the presence of hydrogen sulphide, yields iron sulphide, a sulphide of ammonium, and free hydrogen ($2Fe_2N + 6H_2S = 4FeS + 2NH_4HS + H_2$).[10]

It is impossible to follow the remoter reactions which might spring from these various first products of the carbides and nitrides by further interaction, but it is to be noted that all the new products, *if closely associated,* as the conditions of the case imply, were liable to meet one another while in the state of nascent activity, or in such stimulated activity as may attend previous activities, however this may be interpreted. Reaction might also have been aided by the catalytic relations into which these products came in their intimate association with the débris of the surface, with one another and with the new accessions added constantly to the earth's surface.

As already noted, the superficial portion of the growing earth is supposed to have been a loose, incoherent aggregate of highly fragmental planetesimal matter, and this was subject to weathering and various forms of comminution. The resulting porosity may have led to the condensation of much of the gaseous matter within its capillary and subcapillary pores, as soils are known to do at the present time. The graphite and amorphous carbon may have acted somewhat after the analogy of charcoal which is well known to absorb certain gases to a phenomenal extent. Various porous substances, including earths, possess this property of gas-condensation in appreciable degrees. Not a few metals also possess, irrespective of porosity, certain occlusive affinities or selective powers of absorption for certain gases, as palladium and platinum for hydrogen, etc. While the efficiency of charcoal is clearly due in large part to its extreme porosity, it is doubtless due in part also to the substance itself, for coal manifests a somewhat similar property. Fresh coal rapidly absorbs oxygen from the

[9] Moissan, *Proc. Roy. Soc.,* Vol. 60 (1897), pp. 156–60.

[10] Fowler, *Jour. Chem. Soc.,* Vol. 79, p. 297.

air, condensing it within the pores and crevices; but because of its activity in this condensed form, the oxygen soon unites with the substance of the coal and passes on to chemical union, making room for the absorption of more oxygen from the air.

Pursuing the phenomena of charcoal further by way of illustration, the well-known fact may be recalled that a layer of charcoal spread over decaying organic matter permits it to waste away gradually without giving off offensive odors, owing to the fact that the gases and the volatile products of the decomposition coming in contact with the charcoal are drawn into its pores and there oxidized by the condensed oxygen which the charcoal has absorbed from the air. Owing perhaps to a sort of catalytic action, the oxygen condensed in the pores of the charcoal becomes more active than the ordinary oxygen of the air. While charcoal furnishes the most declared case, soils and comminuted earth matter are known to possess similar properties in a notable degree.

In summation, we conclude that the porous mantle of the earth thus supplied by planetesimal infall with unstable carbides, nitrides, phosphides and sulphides undergoing transformation into more stable compounds, and generating during this process hydrocarbons, ammonia, hydrogen phosphide and hydrogen sulphide gases mingled with the ordinary gases carried by the planetesimals, furnished rather remarkable conditions for interactions and combinations, among which unusual syntheses would not be improbable.

If, with these special possibilities in mind, we turn to the question, what physiographic situation on the surface of the early earth presented the most favorable conditions for the organic synthesis, three general views offer themselves as alternatives, and under one of these there is a localization so specific as to have the force of a fourth view. The primitive organic synthesis may have taken place (1) in the ocean, (2) in some body of fresh water, or (3) on the land, or, more specifically, (4) in the soil. By soil in this connection is meant merely the earthy mantle of comminuted and weathered material; the absence of organic matter at the outset is of course assumed.

May we not take it for granted that the higher presumption will lie in favor of that localization which brings into closest interaction the requisite material in unstable states, attended by the maximum range of concentrations, condensations, catalytic, electrical, nascent and other favoring conditions?

If planetesimals carrying the essential constituents in unstable forms fell into large and deep bodies of water, the soluble and gaseous products of such reactions as followed would have been likely to be widely diffused and diluted, would have received little aid from the catalytic action of rock or earth material, would have been unassisted by soil porosity, and would have been but little favored by concentrations except such as involved an increase of density of all the constituents held in the water body whether favorable, hostile or indifferent in nature. Organic synthesis at present clearly involves a series of very special selections of material from among a miscellaneous association, the larger part of which is either neutrally obstructive or hostile. In the case of a completed organism, provided with the proper selective appliances, the requisite material may be gathered from such a dilute intermixture of the essential and non-essential materials as the water-bodies present, but until these selective appliances are provided, the water-bodies seem to us to be deficient in some of the most propitious conditions.

In the absence of such organic selective structures at the outset, it may be worth while to look for inorganic agencies that may perhaps have performed in a crude way the functions which the organic structures came later to perform in a much superior way. It is not clear that a selective concentrative agency can be found in the large water-bodies, independent of life, for their tendency is diffusive and equalizing rather than concentrative. Can it be found in the soil?

To form a definite picture of the conditions which may have been presented by certain soils, let a foreland lying between extensive uplands and a permanent water-body of appropriate salinity be chosen as a concrete example. In such a situation a constant water-level should have prevailed not only at moderate but at graded depths beneath the surface. The underground water should have received accessions percolating basinwards from the uplands bearing whatever soluble materials the uplands could furnish, while, on the other side, there should have been waters percolating landward from the water-body bearing such salinity as it possessed, while more or less spray from the water-body was scattered by landward winds over the surface and fed the soil from above. The measure of water-movement in the one direction or the other must obviously have depended on the balance between the precipitation and the evaporation on the adjacent land which varied with seasons and localities. The underground waters thus supplied by the slightly fluctuating water-table should have been carried up by the capillary passages of the soil to horizons of evaporation and concentration at or near the surface. The graded depth of soil above the water-table should have furnished unlimited adaptations to the porosity of the soil-mantle and to the meteorologic conditions of the seasons and the special situations.

The horizons of concentration by capillarity and by evaporation were affected by all degrees of insolation from direct sunlight, at the immediate surface, to all measures of shadowing below, furnished by the soil itself. The substances deposited within the soil and the substances leached from it, alike modified its porosity in their own special ways, and such deposits as were formed in the soils should have developed porosities of their own. Isolated cells and tubes may thus have been formed by travertine and similar deposits in the pores of the soil. As already implied, the capillary feeding from the water-table, when the balance set that way, and the partial evaporation of the solutions within the pores of the soil near or at the surface, must have produced concentrations of the non-volatile substances carried by the capillary waters into these upper horizons. Between these upper concentrated solutions and those below there should naturally have followed inter-diffusion and osmotic action, and thus there should have sprung up in the soil a circulation somewhat analogous to that of the plant; indeed, it may not be going too far to suggest that this circulation within the soil is more than a simple analogue of the systematic circulation which is definitely organized in the plant structure; it may possibly be its genetic forerunner. The larger cavities within the soil were inevitably connected by constricted passages which were liable to be partially or wholly filled with porous precipitates or with inorganic colloids, and these chains of pores might thus come to serve a circulatory function which was an actual precursor to that circulation from cell to cell through membranous walls which distinguishes compound plants. It is even more probable that the circulation within an earth-pore, partially isolated from adjacent earth-pores containing solutions of different density, might develop a circulation closely like that of unicellular plants. A constant evaporation at the surface might perpetuate the differences of density sufficiently to continue the circulation for the requisite period. So, on the other hand, if the ground waters were sufficiently saline, the periodic accession of fresh water at the surface might give, in reverse order, density-differences sufficient to perpetuate circulation.

Whether analogy may be pushed so far as this on substantial grounds or not, it is obvious that the soil presents a suggestive assemblage of conditions favorable to chemical synthesis, and that these deserve a critical attention which the limits of this paper forbid us to try to pursue into fuller detail. It is clear that under these conditions evaporation was permitted to develop the greatest variety of concentrative effects which can well be assigned to it, and that at least some facilities were offered for the perpetuation and modification of these concentrations when once established. It is obvious that in the soil there might have been any degree of exposure of the reacting substances to light within very small differences of depth, and that there was easy intercommunication and commingling of the different products of such photosynthesis by means of capillary circulation. It is obvious that in the soils there might have been found the full range of capillary dimensions from coarse tubes and pores down to the limits of sub-capillarity with the full gamut of condensation-effects assignable to these. The same may be said of all catalytic effects referable to the relations of the solids and solutions concentrated in the soils.

An important class of chemical reactions observed in the matured plant of to-day takes place within the organism without much obvious addition or loss of material, apparently an internal readjustment of matter under its own stimulus. This is familiarly seen in the maturing of seeds after they have been separated from all connection with the plant circulation, in which little external change beyond some possible loss of moisture is observable. In many cases, germination will not take place at once; a period of internal organization or ripening must intervene. This thus represents a last stage of preparation for self-propagation, or, in other words, the last stage of an advanced phase of organic synthesis. It may not accord with conventional usage to call this self-catalytic action, but in some way it seems to be due to stimulus which the partially organized materials exert on one another and by which they thereby push farther forward the synthetic process. The prevalence of this internal action in the last stage of the organic cycle suggests that analogous action may occur far back in the synthetic series, and that much of the more complex part of the cycle may perhaps be accomplished by such action, conditioned like it on the confinement of the partially organized material in a cell-like cavity where it was subject to accessions of the sustaining solutions and to concentrations by the removal of water and volatile matter. If this speculative conception be warranted at all, the quasi-cellular structure of the porous soil might not inappropriately be conceived as serving the function of a rude inorganic husk, or shell, abetting by confinement and protection the internal synthesis of its contents.

If we may appeal to still other agencies whose functions are as yet imperfectly understood, the electrolytic action of earth-currents may be worthy of mention. It is well known that saline waters are better conductors of electricity than fresh waters or dry earth, and hence it is probable that the restoration of electrical equilibrium on the earth's surface after it has suffered disturbance may be attended by electrical passages between the saline water-bodies and the land tracts. There are reasons for believing that electrical interchanges were more active in the growing stages of the earth than at the present time when the solar system may be presumed to have settled down into a condition nearer equilibrium. The planetesimal matter circulating about the planetary nucleus and the sun, and between them, probably served both to disturb the electrical status of these bodies and to afford a means of electrical communication between them and the planetesimals. Under electric laws, planetesimals charged with electricity and circulating at high velocities about the young planet should have had the effect of electrical currents, and should have generated magnetic fields about the magnetizable matter of the earth; and these magnetic fields, in turn, should have modified and perhaps controlled the paths of electrons and ions traversing these fields. It is beyond the scope of this paper to try to follow these into detail, and it may suffice to merely indicate that electrolytic action stimulated by electrical currents traversing the surface may fairly be presumed to have played a more active part during the nebular stages than they do to-day, whatever that part may be.

On similar grounds, it may be suggested that the agitations of radioactivity, and the states of ionization to which it gives rise, may have played a slightly more active part in the chemical processes of early times than they do to-day, whatever that may be, because of secular decay.

Some suggestions respecting the original localization of terrestrial life may be derived from a study of the localizations of to-day. The more primordial types of the vegetal life of the mid-ocean are limited in variety and in susceptibility to variation. In the judgment of some of our most trusted botanists, pelagic vegetal life does not present pronouncedly the qualities which imply germinal or evolutionary power. A similar statement may be made, with qualifications, relative to the life of the larger fresh-water bodies. In the shore tracts, indeed, there is greater variety of life and greater indication of germinal competency, but even here the forms which lie nearest the hypothetical primitive types do not give signs of conspicuous evolutional potency. On the other hand, the plant life of the land presents much greater variety of form and of organization, and greater signs of germinal virility.

If we may judge of the fitness of soils to serve as a nidus of organic genesis, by the life it fosters to-day, a favorable verdict seems warranted by the remarkable assemblage of low forms which make the soil their habitat and which manifest peculiar adaptations to their earthy conditions and to one another. There are not only a host of simple forms in which photosynthesis plays its usual part, but forms that flourish quite irrespective of sunlight; there are not only species that use carbon dioxide and require oxygen, but species that live quite without free oxygen, and even find it a hostile element; there are forms that oxidize sulphuretted hydrogen and use the energy thus derived for their activities, and there are forms that oxidize ferrous to ferric iron to like ends.[11] Some of the sulphur-bacteria seem to combine the generation of energy from sulphuretted hydrogen with the more common mode of oxidizing carbon compounds, thus uniting in a suggestive way independent chemical processes. There are also bacteria that oxidize free nitrogen into nitrites and others that promote the formation of nitrates. The rich

[11] Jost's "Plant Physiolcgy," Gibson's translation, 1907, pp. 220–31.

realm of soil life seems yet far from being exhausted by research either in respect to the range of forms or the scope of their chemical activities, but it is at least clear that the soil is the foster-ground of remarkable biochemical activities. Some large part of such activities is dependent on preexistent organic matter and is in no sense initial, but in a significant part of it, organic compounds do not seem to be prerequisite. This variety of action and these peculiarities of the life of the soil-mantle are at least suggestive of genetic conditions.

If we seek for such uncertain light as the geological record may throw upon the habitat of the first life, we are confronted by the fact that the record makes only a very distant approach to the real genesis of life. If we permit ourselves to reason from the nature of the Proterozoic formations, we find grounds for a belief in a very early mantling of the land surface with vegetation.[12] A study of the early habitat of some of the leading forms of life seems also to favor the land or the land-waters.[13] While these geological considerations have their obvious limitations and may seem to be too far removed from the specific question of organic synthesis to have much value, they may at least be permitted to serve as an offset to the prepossessions which seem heretofore to have obtained widely in favor of the origin of life in the ocean. They may also help to bring into equitable competition the view that primitive organic synthesis may have found its genetic conditions in some of the lowland soils on the borders of the permanent water-bodies.

[12] Chamberlin and Salisbury, "Geology," Vol. II., pp. 139, 199, 302.

[13] Chamberlin, "The Habitat of the Early Vertebrates," *Jour. Geol.*, Vol. VIII., 1900; Sardeson, "The Phylogenic State of the Cambrian Gasteropods," *Jour. Geol.*, Vol. XI., 1903; Chamberlin and Salisbury, "Geology," Vol. II., p. 480.

The original organic process was undoubtedly vegetative rather than animal in type, *i. e.*, the primitive organisms increased the sum total of organic matter and stored energy in it. The store of energy attained by any given plant consists (1) of that which it inherits with its spore, seed or germinal part and (2) of that which it adds thereto from terrestrial and cosmic sources of energy. If the plant feeds wholly on carbon dioxide, water, nitrates, sulphates, phosphates and similar *wholly oxidized* compounds, its sources of free energy are essentially limited to two classes: (1) radiant energy, derived chiefly from the sun and allied sources, and (2) chemical energy, derived from the oxidation of a portion of the germinal matter. The peculiar cooperation of these two sources of energy forms a distinctive combination. A part of the energy set free by germinal oxidation cooperates with the remainder and with solar energy to build up additional complex compounds. This new complex matter is built up from fully oxidized material by deoxidation combined with a synthetic process which gives it higher complexity. This process obviously requires additional energy. The synthetic function resides primarily in the germinal matter, for the formation of new compounds may proceed to certain lengths without sunlight; but the main source of the energy required for deoxidation resides in the sun. The germinal matter thus seems to have two phases of action: (1) simple oxidation, which gives free energy for its own activities, and (2) synthetic stimulus, by which complex carbon compounds are organized. This last takes place at the outset by the transformation of its own substance, but later, with the cooperation of sunlight, by the synthesis of simpler substances previously in a fully oxidized state.

Now, if any inorganic matter is to take

the place of this germinal matter in synthesis, it must apparently subserve this double function of suffering oxidation of a part to yield the energy required to organize its remaining part into other complex compounds. This peculiar double function seems to furnish a criterion which must probably be met, if we are to find in early terrestrial history any inorganic agency which may have subserved crudely the synthetic function which has since been developed so extraordinarily by self-perpetuating organic agencies. Are there any agencies among those previously under review which act in any such way, and which might be supposed, even by the license of hypothesis, to serve as a crude substitute or forerunner for the germinal matter?

Before trying to answer this crucial question, let another characteristic of organic matter as a source of energy be noted. The energy which can be derived from living matter by oxidation is distributed among many atoms, or, if it be interpreted as concentrated in certain of the atoms among the complex assembage, it is so diluted or distributed by the neutral atoms present that its effect is distributive. *The end secured by this is a slow—perhaps one may say a controlled—use of energy in oxidation distributed over a prolonged period.* The organism is indeed a thermal engine, but its temperature is phenomenally conservative, uniform and sustained, and its consumption of fuel in any unit of time is small. At the same time its constructive work, both of material and of energy, is so much more conspicuous than its consumptive work as to almost completely mask the latter. This distributive conservative action is perhaps the key to the successful absorption and utilization of the mild but pervasive energies of cosmic origin which furnish the increment of energy necessary to increase the sum total, notwithstanding the portion expended.

Now if we gather together the essentials of the energy processes previously cited as probably present in the primitive days of the earth, shall we find in them any analogues of this cooperative, controlled and constructive process?

Summarizing these essentials in terms of energy, it appears (1) that several of the elements that take part in organic activities were probably present at the outset in a free state and capable of yielding their maximum of energy by oxidation, such as graphite, amorphous carbon, and perhaps sulphur, together with the free gases, hydrogen, nitrogen and oxygen; (2) that there were probably present simple binary compounds such as the carbides and nitrides, which were capable of reacting with water and of setting energy free, and at the same time generating somewhat more complex compounds; (3) that there were hydrogen compounds susceptible of oxidation with liberation of energy, such as the hydrocarbons, ammonia, sulphuretted and phosphoretted hydrogen; (4) that there were partially oxidized compounds susceptible of further oxidation with a liberation of energy, such as the nitrites and ferrous salts; (5) that there were fully oxidized compounds, end products, such as carbon dioxide and water, from which, *by the expenditure of energy,* the carbohydrates might hypothetically be derived by deoxidation and combination; as well as such end products as nitric acid, nitrates, sulphates and phosphates from which, in combination with the preceding, proteids and the nitrogenous group generally might, hypothetically, be compounded; (6) that there were abundant supplies of potassium, calcium, magnesium and silicon in combination from which these elements could be derived by similar means; (7) that there was abundant diffuse energy in sunlight and other forms of solar radiance, and (8) there were pervasive free energies in states of ionization, in earth currents and in local electric potentials. In short, it appears that there was a group of oxidizable substances which might give up energy by combination, but not in indefinite amounts; that there was an ample supply of substances already oxidized to the full, but which could be partially deoxidized and combined hypothetically to give the complex organic compounds, but only at the expense of energy. A continuous source of pervasive, diffuse energy was afforded by sunlight and other forms of solar radiance, perhaps aided by molecular agitation through ionized states, diffuse electric earth-currents, and local electric potentials; and these sources were ample to meet the requirements of the case.

Recalling the combination of functions required, the most plausible suggestion is offered by the cooperation of the unstable carbides, nitrides, sulphides and phosphides with moisture, sunlight and allied agencies.

Somewhat after the analogy of germinal matter, certain metallic carbides react at ordinary terrestrial temperatures on the accession of water, freeing energy and raising the temperature, but retaining a portion of their power of oxidation and at the same time forming carbon compounds of slightly more complex nature. The phenomena of polymerization may intervene in some cases and favor complex compounds. Some of these compounds are unsaturated, and by additions and substitutions may lead on to other complexities.[14] If the reactions of these carbides took place in the presence of the associated unstable nitrides, sulphides, phosphides and chlorides, there is reason to believe that more complex results would follow, involving other organic elements. Experimental results do not greatly help on this point, because high temperatures, strong reagents and artificial conditions have usually been employed in forming the more complex compounds of the organic elements. Violent agencies and extreme conditions are excluded from organic action, and hence presumably from any antecedent action closely precedent to it. In the case in hand, combination could be abetted by evaporation, by porous condensation, by selective concentration, by catalytic action, by confinement in pores, cells and ducts, by capillary and osmotic action, by genial temperatures, by sunlight and by allied agencies. How far these could go in giving rise to the higher compounds of the organic type experimentation has not yet satisfactorily determined. The analogy of the carbide action does not go very far, but it is something that it takes even a short step in the direction so characteristic of organic synthesis.

While the foregoing combinations and activities seem to us suggestive of the most favorable primitive conditions, they obviously do not warrant anything approaching an affirmation that organic synthesis really took place in this way in the soil, or that it is the offspring of inorganic antecedents solely. It has been our endeavor to trace the early terrestrial conditions and activities into as close an analogy to those that dominate the organic kingdom as present imperfect data permit. The conservative considerations that make it unsafe to assign organic genesis to an early terrestrial age without reserve, simply because it is not now in evidence, find their complement in withholding opinion respecting the possibility of such genesis by any combination of inorganic influences whatsoever, until it shall be experimentally settled. The great problem

[14] Moissan, "The Electric Furnace," translation by Moulpied, pp. 244 and 256.

must lie open yet awhile at least, but every line of approach, however hypothetical, may well be pursued if controlled by due reservations.

As remarked at the outset, many of these considerations are applicable to states of the earth which might have arisen at an early day under any of the cosmogonic hypotheses. We have given precedence to one of these hypotheses partly because it seems to merit a fuller exposition in this particular than it has received, and partly because it seems to us to present a physiographic setting more favorable for synthesis than would probably have arisen under the alternative cosmogonic hypotheses.

T. C. Chamberlin,
R. T. Chamberlin
University of Chicago

UNIVERSITY REGISTRATION STATISTICS—I.

The registration returns for November 1, 1908, of twenty-five of the leading universities of the country will be found tabulater on page 912. One institution has been added to the list this year, namely, Western Reserve University. A special effort was again made this year to prevail upon the reporting officers to do away altogether with the first item of double registration, but without complete success, and it must, therefore, be borne in mind that an institution with a large double registration in the fall enrollment naturally makes a comparatively better showing in the schools in which this duplication occurs, than one where this item has been reduced to zero. Furthermore, some difference of opinion evidently still exists concerning the proper classification of students enrolled in extension courses, evening courses, etc., for entrance upon which standards of admission are, to all intents and purposes, nonexistent, and similarly there will be found in the summer session and even in regular faculties, for example, in music and agriculture, students who have not completed a high-school course. Then again, a few institutions demand a baccalaureate degree or its equivalent for admission to one or more of their professional schools, as Harvard does for law, medicine, theology and engineering, Johns Hopkins for medicine, and Columbia for law, whereas at certain other institutions admission to the professional schools rests practically on a high-school graduation basis. Another factor that must not be overlooked is the difference in the number of partial students in attendance on various institutions: Columbia and Chicago, for instance, are apt to have more than Princeton or Stanford, and this circumstance should not be lost sight of in preparing figures intended to show the proportion of officers to students. All of these points are mentioned in order to emphasize once more the fact that the figures herewith presented have, from the very nature of the case, little qualitative significance, inasmuch as such items as standards of admission and advancement, efficiency of instruction, equipment, and the like, are necessarily ignored in the comparison. The figures have in every instance been furnished by the proper reporting officer, who has, in a number of cases, added interesting information about the development of the institution involved during the year just past.

Comparing the figures for 1908 with those of the previous year, it will be seen that, in spite of the prevailing economic depression, only two institutions, Harvard and Stanford, show a slight loss in enrollment, whereas two years ago five suffered a decrease. Taking the total attendance into consideration, *i. e.*, including the summer session, the greatest gains in terms of student units have been made by Chicago, Columbia, Wisconsin, Indiana, Pennsylvania, Cornell, California and Minnesota, each one of these having gained over four hundred students; omitting the summer session attendance, the largest increases have been registered by Columbia, Minnesota, Cornell, Northwestern, Wisconsin, Pennsylvania and Ohio, in the order given, the growth in each case being one of more than three hundred students. Comparing this year's grand totals with those of 1902, we find that Harvard and Princeton are the only institutions that exhibit a loss in registration during the intervening period, but the higher education of this country would suffer no deterioration if more of our institutions would only copy Harvard's standards at the risk of quantitative losses in enrollment. The largest gains during this period have been made by Pennsylvania, New York University, Illinois, Michigan, Cornell, Columbia, Syracuse, Minnesota, Missouri, Ohio and Iowa, each of these universities showing an increase of over one thousand students, an increase in which the establishment of summer sessions plays no small rôle in several instances.

According to the figures for 1907, the twenty-four universities included in the table ranked as follows: Harvard, Columbia, Michigan, Chicago, Cornell, Minnesota, Illinois, Pennsylvania, New York University, Yale, Wisconsin, California, Syracuse, Nebraska, Northwestern, Ohio, Missouri, Iowa, Kansas, Indiana, Stanford, Princeton, Virginia, Johns Hopkins.

Faculties	California	Chicago	Columbia	Cornell	Harvard (incl. Radcliffe)	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	Nebraska	New York	Northwestern	Ohio State	Pennsylvania	Princeton	Stanford	Syracuse	Virginia	Western Reserve	Wisconsin	Yale§
College Arts, Men	526	749	645	873	2231	402	536	518	166	427	1027	557	478	289	298	480	335	352	641	434	1387	292	310	842	1273
College Arts, Women	879	685	467		394	442	405	520	......	515	653	909	432	523	167	495	323	20	......	496		......	269	788	......
Scientific Schools*	818	......	677	1727	109	1081	......	223	......	433	1352	684	677	630	232	......	925	815	582	388	390	98	......	894	967
Law	95	209	318	223	681	174	126	209	......	184	706	523	260	168	809	252	125	326	......	119	180	282	142	154	428
Medicine	36	148	306	207	319	502	260	302	355	79	445	244	55	110	408	524	......	563	......	......	152	89	98	30	142
Graduate Schools	324	408	737	246	460	233	40	126	177	48	160	97	137	94	255	......	71	339	91	95	45	31	15	216	391
Agriculture	137	......	......	394	......	443	......	......	......	......	......	1029	222	375	......	......	216	......	......	......	......	......	......	211	......
Architecture	†	......	131	130	†	182	......	......	......	......	†	......	......	......	......	......	†	168	......	......	60	......	......	......	......
Art	107	......	......	......	......	4	......	†	......	22	......	†	......	52	......	......	......	......	......	......	80	......	......	......	45
Commerce	183	......	......	......	56	136	......	†	......	......	†	......	......	......	875	213	......	463	......	......	......	......	......	†	......
Dentistry	56	......	......	......	66	105	......	163	......	......	192	192	......	......	......	247	......	383	......	......	......	......	63	......	......
Divinity	......	198	......	......	30	......	......	......	......	......	......	......	......	......	......	235	......	......	......	......	......	......	......	......	106
Forestry	†	......	......	......	†	......	......	†	......	......	†	†	......	36	......	......	35	......	......	......	......	......	......	......	70
Music	†	......	25	......	......	81	......	61	......	126	......	†	......	450	......	255	......	35	......	......	690	......	......	216	91
Pedagogy	†	183	950	......	......	......	......	†	......	......	†	31	315	262	469	......	30	†	......	......	102	......	......	†	......
Pharmacy	65	......	284	......	......	229	......	65	......	94	102	89	......	12	......	171	77	†	......	......	......	......	75	37	......
Veterinary	†	......	......	91	......	......	......	......	......	......	......	......	......	......	14	......	186	150	......	......	......	......	......	......	......
Other Courses	......	292	......	358	......	38	......	50	......	......	......	......	60	......	......	270	119	624	......	......	40	......	58	......	......
Deduct Double Registration	*27*	*209*	......	*3*	*10*	......	......	*115*	......	*62*	......	......	*416*	*80*	*70*	*150*	......	*15*	......	......	*42*	*35*	*14*	*151*	*65*
Total	3199	2663	4540	4246	4336	4052	1367	2122	698	1866	4637	4355	2220	2921	3457	2992	2442	4223	1314	1532	3084	757	1016	3237	3448
Summer Session, 1908	661	2991	1532	841	1349	656	1005	363	......	381	1086	332	508	348	626	257	503	472	......	60	189	......	......	1027	48
Deduct Double Registration	*109*	*540*	*397*	*387*	*343*	*308*	*259*	*129*	......	*161*	*535*	*80*	*170*	*115*	*182*	*136*	*245*	*140*	......	*51*	*69*	......	......	*388*	*80*
Grand Total, 1908	3751	5114	5675	4700	5342	4400	2113	2356	698	2086	5188	4607	2558	3154	3951	3113	2700	4555	1314	1541	3204	757	1016	3876	3466
" " 1907	3346	4594	5197	4293	5346	4172	1667	2188	651	1932	4953	4207	2274	2812	3648	2714	2344	4134	1311	1594	3162	757	914	3401	3435
" " 1906	3246	4731	4650	4075	5343	3810	1515	1950	618	1690	4674	3944	2071	2807	3283	2635	2180	3934	1352	1530	3004	745	905	3099	3477
" " 1905	3631	4557	4755	3871	5283	3635	1377	1700	688	1706	4521	3940	1887	2635	2912	2791	2057	3430	1361	1606	2776	696	856	3083	3477
" " 1904	3738	4035	4833	3833	5392	3369	1206	1460	740	1446	4000	3886	1704	2728	2380	2856	1758	3027	1385	1424	2452	691	808	3370	3008
" " 1903	3690	4146	4557	3438	6013	3239	1614	1260	694	1319	3926	3550	1540	2513	2177	2740	1710	2644	1434	1370	2207	638	765	3221	2990
" " 1902	3676	4296	4302	3281	5468	2819	1648	1320	669	1294	3764	3505	1408	2560	2201	2875	1603	2549	1345	1378	2020	586	......	2884	2804
Extension and Similar Courses	1150	2	2879	......	1132	......	......	......	......	......	......	......	......	......	......	......	6	......	......	......	......	......	80	1165	......
Officers	303	303	655	572	654	477	100	160	192	126	409	200	195	240	338	368	209	466	168	139	220	94	227	395	397

* Includes schools of mines, engineering, chemistry and related departments.

† Included elsewhere.

§ The attendance on the 188 courses given during the past year was 53,841.

Comparing this with the order for 1908, we observe that Columbia now heads the list, having changed places with Harvard, Pennsylvania has passed Illinois, Wisconsin and California have passed Yale, and Indiana has passed Kansas. Omitting the summer session enrollment, the order is, of course, somewhat different, namely, Michigan, Columbia, Minnesota, Harvard, Cornell, Pennsylvania, Illinois, New York University, Yale, Wisconsin, California, Syracuse, Northwestern, Nebraska, Chicago, Ohio, Missouri, Iowa, Kansas, Stanford, Indiana, Princeton, Western Reserve, Virginia, Johns Hopkins—Columbia and Minnesota having passed Harvard, Cornell having passed Pennsylvania, New York University having passed Yale, California having changed places with Syracuse, Northwestern with Nebraska, and Missouri with Iowa.

Considering in order the various faculties, we find first, that so far as the undergraduate academic department is concerned, there has been a general increase of men as well as of women, the actual and percentage gains being larger in the case of the male than in that of the female students. Chicago, Harvard, Princeton, Stanford, Virginia and Yale have experienced losses in the number of male academic students, while California, Michigan, Minnesota, Nebraska and Northwestern—all western institutions—have fewer academic women students than they had last year. At more than half of the western institutions there are more women than men in the academic department, the exceptions being Chicago, Indiana, Michigan, Missouri, Ohio, Western Reserve and Wisconsin. In all of the eastern institutions, on the other hand, with the possible exception of Cornell and Syracuse, who do not separate their academic registration into two divisions, the number of men is considerably in excess of that of women. In spite of a large growth this year in the number of men, Wisconsin still has fewer than it had in 1904, while the number of women is larger by 180. Comparing the total academic enrollment—men and women—for 1908 with that for 1902 in the case of those institutions which are included in the tables of both years, we find that there has been a loss in numbers at Chicago, Indiana, Nebraska, Pennsylvania and Princeton, while the largest gains in the academic division during the same period have been made by Syracuse, Wisconsin, Michigan, Missouri, Northwestern, Minnesota and Columbia. The scientific students were grouped with the academic students at California and Stanford in 1902, and consequently no comparisons can be made for these institutions. The largest number of male academic students is still found at Harvard, which is followed by Yale, Michigan, Wisconsin, Chicago, Columbia, Princeton, Minnesota, whereas if the women be included the order would be Harvard, Michigan, Wisconsin, Minnesota, Chicago, California, Syracuse, Yale, Columbia, Iowa—each of these enrolling over one thousand academic students.

The only institutions that have registered a decrease in the number of scientific students are Harvard, Kansas, Nebraska and Virginia, and of these the first mentioned is the only one that shows a loss as compared with 1902, of course owing to the fact that the baccalaureate degree is now required for admission to the Harvard engineering schools. The gain in this field since 1902 is in several instances quite remarkable, *e. g.*, from 597 to 1,352 at Michigan. The largest number of scientific students is still found at Cornell; Michigan and Illinois being the only others that attract over one thousand students to their scientific schools; these are followed by Yale, Ohio State, Wisconsin, California, Pennsylvania, Minnesota, Columbia, Missouri, Nebraska and Princeton, each of these universities having over five hundred students in attendance on their scientific schools.

The attendance on the schools of law connected with the universities under consideration shows, in general, a fair gain since last year, whereas in the case of the medical schools the gain is only slight; in fact, there are at present no less than approximately eight hundred fewer students of medicine in attendance on the institutions credited with medical schools in the tables of both 1908 and 1902, than there were in the latter year, while in the case of the law schools there has been a gain of about five hundred students during the same period. Minnesota, Yale, Columbia and Virginia exhibit the largest increase in law since last year, Indiana,[1] Minnesota and Illinois in medicine; Harvard, Illinois, Indiana,[1] Michigan, New York University and Ohio showing losses in law, and California, Cornell, Harvard, Kansas, Missouri, Nebraska, New York University, Northwestern, Pennsylvania and Virginia in medicine. New York University still possesses the highest law school enrollment, being followed by Michigan, Harvard, Minnesota, Yale, Pennsylvania, Columbia and Virginia. Of these the Harvard and Columbia schools are the only ones on a graduate basis. Pennsylvania continues to have the largest medical school, followed by Northwestern, Illinois, Michigan, New York University, Johns Hopkins, Harvard, Columbia and Iowa—Harvard and Johns Hopkins having the only graduate schools of medicine among those here mentioned.

The graduate schools show healthy gains all along the line, with the exception of Indiana, Syracuse, Princeton and Nebraska, the increase being especially noteworthy at Michigan, California and Illinois—all western institutions. Columbia, with an enrollment of 958 students (to the 737 in the table should be added 221 graduate students at Teachers College, who are omitted here for the sake of avoiding the item of double registration), has by far the largest graduate school, followed by Harvard, Chicago, Yale, Pennsylvania, California and New York University.

The agricultural schools show a most encouraging increase, practically without exception, Minnesota this year having an enrollment of over one thousand, being followed by Illinois and Cornell. The schools of architecture have likewise grown, the largest being those connected with Illinois, Pennsylvania, Columbia and Cornell. The largest schools of commerce are at New York University and Pennsylvania, and they exhibit a large increase over last year. The dental schools for the most part have suffered a loss, Pennsylvania still having by far the largest number of dental students, being followed by Northwestern. The latter, Chicago and Yale show a slight gain in the number of divinity students, whereas the enrollment at Harvard has remained stationary. Where the forestry students are listed separately, a small increase is apparent, whereas a number of institutions have registered losses in music, Syracuse, with 690 students, still heading the list in the latter department, followed by Nebraska and Northwestern. Syracuse is the only institution to report a decrease in the number of students of education, Teachers College of Columbia University, with 950 students, continuing to head the list, being followed by New York

[1] The large increase in the school of medicine is accounted for by the consolidation of all the medical schools in Indianapolis and their absorption by Indiana University, while the falling off in the school of law is due to the fact that all the duplicates have been eliminated this year, only actual candidates for the law degree being included.

University and Missouri. All of the schools of pharmacy, with the exception of that of Illinois, have experienced satisfactory gains in attendance, Columbia now having the largest enrollment, with Illinois second and Northwestern third. Ohio State and Pennsylvania report gains in veterinary medicine, these being the two largest schools.

Northwestern, Stanford and Syracuse are the only institutions that experienced a loss of students in the summer session of 1908, the Yale summer courses having been withdrawn this year. In some instances, the growth has been quite noteworthy, for example at Wisconsin, where no less than 1,027 students were enrolled, as against 651 in 1907, and at Indiana, which reported an increase from 721 to 1,005. In addition to Chicago, the following institutions attracted over one thousand students last summer, ranking numerically in the order given: Columbia, Harvard, Michigan, Wisconsin and Indiana. The students taking summer work in surveying, geodesy or mining are not included in the Columbia figures.

The eastern colleges for men and those for women included in the writer's geographical distribution statistics[2] all report gains in the fall registration over last year, with the single exception of Bryn Mawr. The Massachusetts Institute of Technology shows an increase from 1,415 to 1,462, Purdue one from 1,518 to 1,534. Similarly Bowdoin has grown from 394 to 419, the loss in medicine occasioned by an increase in standards being more than offset by gains in the collegiate department, Amherst from 513 to 525, Dartmouth from 1,219 to 1,233 (the academic department from 1,131 to 1,136), Brown from 924 to 995 (the academic department from 661 to 727), Wesleyan from 316 to 319, Lehigh from 655 to 664, Wellesley from 1,209 to 1,281, Smith from 1,482 to 1,561, Mt. Holyoke from 711 to 746, and Vassar from 996 to 1,014, while Bryn Mawr has registered a decrease from 407 to 395. Comparing the enrollment of these institutions with that for November 1, 1903, we note a slight loss in attendance at Wesleyan (3 per cent.), Massachusetts Institute of Technology (4 per cent.), and Bryn Mawr (7 per cent.), while gains have been made in the following order: Smith, 51 per cent.; Dartmouth, 42 per cent.; Wellesley, 31 per cent.; Purdue, 29 per cent.; Amherst, 28 per cent.; Bowdoin, 14 per cent.; Mt. Holyoke, 11 per cent.; Lehigh, 10 per cent.; Vassar, 9 per cent., and Brown, 6 per cent. In the case of the Massachusetts Institute of Technology, the relatively large registration in 1903 (1,528) was due to the unusually heavy enrollment in the class of 1906, which entered immediately before the increase in entrance requirements and in tuition fees became operative. During the past ten years the percentage of students entering the Massachusetts Institute of Technology from other colleges has grown from 6 to 13 per cent. At Bryn Mawr the decrease in numbers is accounted for by the facts that the fees for board were increased from $175 to $200 in 1907 and that the charge for tuition for undergraduate students was increased by $50 in 1903. It has been the policy of the board of directors to limit the attendance to the number which can be accommodated in the halls of residence, and for the last year or two the enrollment has been within forty of that number. The entering class at Dartmouth is smaller than it was last year, owing to the financial stringency of the past year. At Mount Holyoke the increase in registration is due to the larger number of rooms at the disposal of students, the number accepted each year being determined by the accommodations available on the campus and in the village. At

[2] Science, October 30, 1908.

present admission is being refused to several hundred applicants each year. At Vassar the total number of students is limited to about one thousand.

The following changes in the course of study and additions to the equipment have been reported: At Dartmouth a new dormitory, New Hampshire Hall, accommodating 107 students, has been erected, and the chapel has been enlarged, its capacity having been increased about half. Wesleyan has adopted a new course of study, which substitutes the "group and major" system for the semi-required system of previous years. English is the only subject required of all students, while candidates for the B.S. degree must take some mathematics and some modern languages. North College, the new dormitory to take the place of old North College, burned a few years ago, was opened last January and is now fully occupied. The most important change instituted at Lehigh this fall is the establishment of a conference department, which provides extra instruction in modern languages, mathematics, physics, and chemistry for freshmen and sophomores, the purpose being to furnish help at a very low rate to students of the first two years who experience difficulty in handling their work. Smith reports the erection of a new college library, which is to be ready for occupancy next September, and Mount Holyoke the addition of a music hall—containing a concert room, class rooms and practise rooms—and a library, which are to be completed before the close of the present academic year. The Sanders Laboratory of Chemistry, at Vassar, is to be completed before the second half-year. An additional instructor has been engaged for the German department, who gives her entire time to colloquial practise. A half-year of work in the history of philosophy is now prescribed as a prerequisite for the senior course in ethics, both of these courses being required at Vassar for the A.B. degree. At the Massachusetts Institute of Technology physical training has been prescribed for all first-year students.

Rudolf Tombo, Jr.
Columbia University

(To be concluded)

JAMES FLETCHER

Doctor James Fletcher, botanist and entomologist of the Experimental Farms System of Canada, died November 8 in Montreal. He had been suffering for some time with internal hemorrhage, and went to Montreal to consult a specialist. He remained there for a week under treatment, but in spite of expert medical assistance the illness terminated fatally. Doctor Fletcher was one of the most widely known and most universally loved entomologists in North America. He was also widely known among the botanists and other men of science. He had been connected with the American Association for the Advancement of Science since 1883, had attended most of the meetings, and had thus become known to very many.

He was born at Ashe, Kent, England, March 28, 1852. He was educated at Kings School, Rochester, England, and came to Canada in 1874, taking a position in the Bank of British North America. Later he became connected with the Library of Parliament at Ottawa, and in 1887 was made entomologist and botanist to the Dominion Experimental Farms, and entomologist to the Geological Survey. His acquaintance with Canadian naturalists was, of course, even wider and closer than with those of the United States. He organized the Ottawa Field Naturalists' Club and was president of it. He was one of the leading spirits in the Ontario Entomological Society, and for a long time had been a fellow of the Royal Society of Canada, at one time holding the office of honorary secretary and honorary treasurer of that important organization. He was the heart and soul of the Botanical Club of Canada. He was also a fellow of the Linnean Society of London, and had received the honorary degree of LL.D. from Queens University. He was also a member of the St. George's Society and of the Rideau Club of Ottawa. Doctor Fletcher threw his whole force into his scientific work. He was a practical man, and was constantly looking for the practical applications of both zoological and botanical science. At the same time he was a close observer and made innumerable observations of novelty and value. As a public speaker he was unexcelled, and the educational value of his addresses to farmers and others on timely and practical topics was very great. During the time of his occupancy of his official position he published a valuable series of annual reports which, in their bulk, constitute a compendium of the economic botany and entomology of Canada for the whole period. He published also many shorter articles in the scientific journals of both Canada and the United States.

Aside from the practical aspect of his work Fletcher was of the type of the old naturalists. He loved nature deeply. Asked a short time ago by a friend why he did not take a holiday and a rest from his incessant labor, he replied: "Why should I take a holiday? My whole life is a holiday because I love my work." Everything living interested Fletcher. To take an excursion with him was a delight. His quick eye saw everything. His philosophic mind sought at once for the why and wherefore. He had no patience with the careless and unobservant. In the course of a typically fascinating and eloquent lecture that he delivered years ago before the National Geographic Society in Washington, on the Canadian Northwest, he was describing the journey from Winnipeg westward on the Canadian Pacific railway. He had dilated upon the flower-massed prairies and the other natural beauties with his hearty enthusiasm and then, he said: "Suddenly the glorious mountains came in sight. I could not contain myself. I must share my delight with some one. I touched the man in the seat ahead on the shoulder. 'See, see the mountains'! I said. 'Ah! indeed'! said the man! And then," said Fletcher with a fine show of indignation, "he went back to his *trumpery* novel!"

Among his many enthusiasms possibly his interest in the biology of the diurnal Lepidoptera was the greatest, and he was the first to work out the life history of *Œneis macounii* and other rare forms. His relations with that master of American butterfly lore, Samuel H. Scudder, were of the most intimate personal kind, and his death will be a sad blow to that other beautiful and strong character whose life is now fading away in Cambridge.

Probably no other Canadian naturalist was so well known and so well loved by his colleagues in the states as was Doctor Fletcher. Surely he will be as deeply mourned here as in his own country.

L. O. Howard

THE SMITHSONIAN INSTITUTION

The annual meeting of the board of regents of the Smithsonian Institution was held at 10 o'clock on the morning of December 15 at the institution. The chancellor, Chief Justice Melville W. Fuller, presided, and the following regents were present: Vice-President Charles W. Fairbanks, Senator Shelby M. Cullom, Senator Henry Cabot Lodge, Senator Augustus O. Bacon, Representative James R. Mann, Representative William M. Howard, Dr. James B. Angell, Dr. Andrew D. White, the Honorable John B. Henderson, Dr. Alexander Graham Bell, the Honorable Charles F. Choate, Jr., and the secretary, Mr. Charles D. Walcott.

The appointment of the Honorable Charles F. Choate, Jr., of Massachusetts, as a citizen regent in place of the Honorable Richard Olney, resigned, was announced.

The secretary presented his report for the fiscal year ending June 30, 1908, which was accepted. Statements were received from the permanent and executive committees. The resignation of Dr. Cyrus Adler, assistant secretary of the institution, in charge of library and exchanges, was announced, and also the death of Professor Otis T. Mason, head curator of the department of anthropology of the National Museum.

A statement was presented of the affairs of the institution since the close of the fiscal year. Referring to the institution's part in the International Congress on Tuberculosis, held in the new National Museum building, September and October last, it was stated that the institution, in conjunction with the Indian bureau, exhibited the results of an expedition by Dr. Ales Hrdlicka, of the U. S. National Museum, among the Menominee, Sioux, Quinault, Mohave and Hopa Indian tribes, for the purpose of showing the extent of tuberculosis among the Indians. The congress awarded the institution a gold medal for this exhibit. Of the appropriation of $40,000 made for the purpose, $25,000 was used and $15,000 went back to the U. S. Treasury.

The board was informed of the removal of the Greenough statue of Washington from its long-accustomed position east of the capitol to the Smithsonian Institution. The statue is now on the lawn south of the west wing of the building, whence it will be removed into the building as soon as the necessary foundation can be provided.

There was submitted a brief statement of the art objects in the collection of Mr. Charles L. Freer, of Detroit, the title to which has already passed to the institution. These comprise 2,873 objects in all branches of art. A number of valuable recent additions have been made which with the original donation represent a cost to the donor of nearly a million dollars.

The secretary read a letter from President Roosevelt, dated June 20, 1908, stating his intention of visiting Africa after the expiration of his term, and offering to give to the Smithsonian Institution for the National Museum the results of his expedition, provided the Smithsonian should send the necessary naturalists to prepare and ship the materials. The offer was accepted by the secretary, and arrangements were at once made by the secretary to provide funds for the expenses of the Smithsonian representatives, without using the Smithson fund or money derived from any government appropriation. Upon motion of the Vice-President, a resolution was adopted conveying the thanks of the board to the President for his very generous offer, and the acceptance of the offer. A further resolution was adopted thanking the donors of the funds for the expedition.

Progress on the new building for the National Museum was reported and it was thought that the building would be occupied in the summer of 1909. In keeping with the improvements projected for this locality, the board adopted a resolution expressing its sense that the further use of B Street, Northwest, just north of the new building between 9th and 12th Streets, for market purposes, be prohibited.

It was reported that Mr. C. G. Abbot, director of the Smithsonian Astrophysical Observatory, had established a station on Mt. Wilson, California, through courtesies extended by the Carnegie Institution of Washington, where measurements of the sun's radiation may be conducted as free as possible from earth tremors and cloud interference. A shelter will also be erected by the institution on Mt. Whitney, California, at an elevation of over 15,000 feet above sea level for the study of the atmosphere under the peculiarly favorable conditions there prevailing.

A resolution was adopted establishing a medal to be known as the Langley medal, as a tribute to the late Samuel Pierpont Langley, third secretary of the Smithsonian Institution, to be awarded for specially meritorious investigations in connection with the science of aerodromics and its application to aviation.

THE BALTIMORE MEETING

A preliminary announcement of the arrangements for the convocation week meeting of the American Association for the Advancement of Science and the affiliated societies, which begins at the Johns Hopkins University, Baltimore, on Monday, December 28, will be found in the issue of Science for November 27. In the present issue of Science will be found a list of the sections of the association and of some twenty-five national scientific societies which meet in affiliation with it. These and other issues of Science contain various notes concerning features of interest to men of science, which will form part of the programs of the association and of the national societies. The meeting promises to be of unusual interest; there is reason to believe that the attendance and the value of the scientific programs will not be exceeded by any of the preceding convocation week meetings.

For the convenience of members of the special societies, it may be noted here that the American Association for the Advancement of Science expects to meet next year at Boston. There will be no summer meeting, but the British Association for the Advancement of Science has invited members of the American Association to take part in the meeting to be held in Winnipeg at the end of August. Plans have been proposed for a summer meeting in the Hawaiian Islands in the summer of 1911, with a possible meeting on the Pacific Coast, and it would be advisable for any societies or individuals who might like to take part in such a meeting to communicate with the permanent secretary of the American Association. After two meetings on the Atlantic seaboard, the association and the affiliated societies would expect to meet in the central states in convocation week of 1910–11. At the Chicago meeting a cordial invitation was presented to meet in Minneapolis on the earliest available occasion. The place of meeting will be recommended by the nominating committee at Baltimore, and invitations and suggestions should be communicated to the permanent secretary of the American Association or to the secretaries of the affiliated societies.

At a meeting of plant pathologists held at Washington, D. C., December 15, 1908, and after consultation with several experiment station pathologists, it was unanimously decided that an effort should be made to organize an American pathological society. A committee consisting of the following members, C. L. Shear, Donald Reddick and W. A. Orton, was appointed to arrange for a preliminary meeting in connection with the American Association for the Advancement of Science at Baltimore. Invitations have been issued to plant pathologists to meet December 30, 1908, at an hour and place to be announced later and take part in the organization of the proposed society which, it is believed, can exercise great influence in advancing the study of phytopathology in America.

The tenth annual meeting of the Society of American Bacteriologists will be held in the rooms of the pathological laboratory of the Johns Hopkins Medical School, Baltimore, on December 29, 30 and 31, in affiliation with the American Association for the Advancement of Science. The program will be arranged to permit of joint meetings with Sections K and I of the association and the American Health League on the above dates, where subjects of interest to the members of the society will be under discussion.

The Botanical Society of America will hold its fifteenth annual meeting, in conjunction with the American Association, at Baltimore, on December 28, 29 and 30, under the presidency of William F. Ganong. The scientific sessions will be held at the Eastern High School in alternation with those of Section G of the association. The address of the past-president, Professor G. F. Atkinson, will be given on Tuesday, December 28, at eight P.M., in McCoy Hall. After the address members and visiting botanists will be invited to remain to meet Professor Atkinson and the officers of the society. On Wednesday evening there will be a dinner for botanists at Hotel Caswell. The special features of the scientific program for the Baltimore meeting will be addresses by Professor Roland Thaxter and Professor J. C. Bose; symposia on "Progress in the Study of Vascular Anatomy of Higher Plants," on Tuesday morning, and on "Present Problems in Plant Ecology" on Wednesday afternoon; a Darwin memorial session on Thursday afternoon. The symposia are arranged in accordance with the desire generally expressed at the Chicago meeting, that more time be given in the programs of the Botanical Society of America to synthetic papers given by leading workers, upon invitation by the council. The Darwin memorial session will be devoted to a series of addresses giving estimates of Darwin's service to botany in the several fields in which he worked. It is intended to supplement and not to encroach upon the Darwin memorial session of the American Association.

Section K—Physiology and Experimental Medicine—of the American Association will hold two sessions at Baltimore. At the first, on Tuesday afternoon, Dr. Ludwig Hektoen, of the University of Chicago, will give the vice-presidential address on "Opsonins and Other Anti-bodies." This will be followed by a symposium on the "Regulation of Physical Instruction in Schools and Colleges, from the Standpoint of Hygiene." Those who will take part are Dr. William H. Howell, Dr. R. Tait-Mackenzie, Dr. Thomas A. Storey, Dr. Frederic S. Lee and Dr. Theodore Hough. At the second session, which will be held on Wednesday afternoon, and is a joint meeting with the American Physiological Society, the Society of American Bacteriologists and the American Society of Biological Chemists, general papers will be presented by Dr. M. J. Rosenau, Dr. Lafayette B. Mendel and Dr. Albion W. Hewlitt.

Dues of Members of the American Association for the Advancement of Science.—The permanent secretary of the American Association for the Advancement of Science urges all members of the association to make an especial effort to pay their dues for the year 1909 before the first of January, and as far in advance of that date as is now possible. He calls the attention of members to the notice in Science, No. 728, December 11, 1908, page 834, to the effect that the publishers of Science will require members to pay the postage on back numbers at the rate of one cent per number provided they pay their dues after the beginning of the year. It is most important for the proper conduct of the business of the association that dues should be paid promptly.

SCIENTIFIC NOTES AND NEWS

The Vienna Academy of Sciences has elected M. Henri Poincaré, the eminent mathematician, to honorary membership. Among the corresponding members elected is Dr. G. H. Darwin, Plumian professor of astronomy at Cambridge.

Dr. Sergius Nawaschin, director of the Botanical Garden at Kiev, has been elected a corresponding member of the Munich Academy of Sciences.

M. Henneguy has been elected a member of the Paris Academy of Sciences in the Section of Anatomy and Zoology in the room of the late M. Giard.

The gold medal awarded under the Shaw Trust for Industrial Hygiene has been presented to Professor Galloway by the Royal Society of Arts, "In recognition of his valuable researches into the action of coal dust in colliery explosions, the outcome of which researches has been the provision of means by which the risk of such accident is materially diminished, and a consequent great saving of human life effected."

Students of the senior class of the Medical Department of the University of Buffalo, have presented Dr. Roswell Park with a silver service in honor of his completion of a quarter of a century as professor of surgery in the institution.

Professor William Kent, until recently dean and professor of mechanical engineering in the L. C. Smith College of Applied Sciences of Syracuse University, has accepted the position of general manager of the Sandusky Foundry and Machine Company, Sandusky, Ohio.

Dr. H. Morize has been appointed director of the Rio de Janeiro Observatory in the room of the late Professor L. Cruls.

Mr. Wilbur Wright, on December 18, again broke, at Le Mans, the aeroplane records for both duration and height of flight. In the morning he remained in the air one hour, fifty-three minutes and fifty-nine seconds, and in the afternoon attained an altitude of 360 feet.

The expedition to the Bismarck archipelago, which was organized a year ago by the Prussian ministry of education, has been unfortunate in losing its leader, Dr. Emil Stephan, who died in New Mecklenburg on May 25. The leadership of the expedition has been taken over by Dr. Krämer, whose former work in the western Pacific is well known.

It is stated in *The Condor* that Mr. Austin Paul Smith has returned from Mexico and is now working with the birds on the United States side of the lower Rio Grande in the vicinity of Brownsville, Texas.

Dr. Vernon L. Kellogg, professor of entomology at Stanford University, is spending the present year abroad. He will be in Paris until May, and may be addressed care of the American Express Company, 11 rue Scribe, Paris.

Professor C. V. Tower, of the University of Vermont, has gone abroad for graduate study and travel.

Professor Edward B. Titchener, of Cornell University, will give at the University of Illinois, a series of lectures in psychology, probably during the latter part of March.

Dr. Albrecht Penck, professor of geography in the University of Berlin, and Kaiser Wilhelm professor in Columbia University for 1909, has lectured before the Geographical Society of Philadelphia, on "The Origin of the Alps."

It is planned to collect $7,500 with which to purchase the valuable chemical library of the late Professor W. O. Atwater, and present it to Wesleyan University. The library contains more than 5,000 volumes, including about 2,500 volumes of periodicals.

Mr. Joseph H. Painter, assistant in the division of botany, National Museum, Washington, D. C., was drowned in the rapids of the Potomac on December 6, 1908, near the headquarters of the Washington Biologists' Field Club, of which he was a member. The evidence tends to show that he was overturned in a canoe with a boy companion, Robert S. Wallis, and lost his life in the vain endeavor to rescue his friend, who was unable to swim. The Field Club has added to the efforts and incentives to recover the bodies and has adopted the following memorial: "*Resolved*, That the Washington Biologists' Field Club has suffered a profound loss in the death of Mr. Joseph H. Painter. That the club has the highest admiration and respect for the noble character and heroic sacrifice for a younger companion, which appears to have led to Mr. Painter's untimely end. That the club extends its sincerest sympathy to the bereaved relatives."

M. Charles E. Stuivaert, associate astronomer in the Royal Observatory of Belgium, died on November 18, at the age of fifty-seven years.

The deaths are also announced of Dr. Hugo Hertzer, formerly professor of mathematics in the Berlin Institute of Technology, and of M. Charles Ballet, the French horticulturist.

The fifth and sixth stories of the building in Washington in which the Geological Survey is housed were swept by fire on December 16, and serious loss by fire and water was suffered by collections, books, maps and field notes. This building is rented by the government; the need of a fireproof building for the Geological Survey has each year been pointed out by the director.

Mr. J. C. Campbell, president of the National Bank of Commerce, Columbus, Ohio, has provided a fund for lectures on scientific subjects to be delivered under the auspices of the Omega Chapter of the Society of Sigma Xi in Ohio State University.

The Naples Table Association for promoting laboratory research by women announces that applications for the table at the Naples Zoological Station should be made by March 1, 1909. A prize of $1,000 for the best thesis written by a woman, on a scientific subject, embodying new observations and new conclusions based on an independent laboratory research in biological, chemical or physical science will be awarded for the third time in April, 1909. Further information may be obtained from the secretary, Mrs. A. D. Mead, 283 Wayland Avenue, Providence, R. I.

THE RESIGNATION OF PRESIDENT ELIOT

In accepting with reluctance and keen regret the resignation of President Charles W. Eliot, of Harvard University, the overseers of Harvard College make this record of admiration and esteem:

Called to the presidency in early manhood, he has administered the affairs of this university for forty years with eminent skill and fidelity. Its vast development during his term of service has been mainly due to his rare wisdom, his strong convictions, his enterprise and his zeal. Prompt to initiate reforms and fearless yet prudent in pressing them, he has by his constructive energy transformed Harvard College into a great university, and at the same time has exerted an influence on the educational forces of the nation which has largely shaped their policy, so that he stands to-day the leader in his age and generation.

Nor does Harvard alone attest his greatness. His mental precision and unusual capacity for lucid and apt discrimination have enabled him to treat public questions with singular authority and with an unerring instinct for the aspirations and needs of society. He has touched no subject without illuminating it; he has stood firmly for collegiate and civic righteousness; and so sane have been his counsels, so masterly his power of statement, that he not only commands to-day the attention of America, but he is honored by scholars and thinkers throughout the world. He has set an example to all by the simplicity of his life and by his absolute devotion to duty and the public interest. He lays down the cares of office voluntarily at the ripe age of seventy-five while "his eye is not dimmed nor his natural force abated." Indeed his temperament has mellowed with time, and he has grown young with the passing years.

This board, to every member of which association with him has been a privilege, congratulates him warmly on his long and distinguished service, and expresses the sincere hope that blessed with health he may enjoy for years to come the rest which he has richly earned and the honor freely accorded to him by a grateful community.

UNIVERSITY AND EDUCATIONAL NEWS

In a special report to President Schurman, Director V. A. Moore, of the New York State Veterinary College, asks the board of trustees of Cornell University to petition the New York State Legislature for appropriations amounting to $375,000 for improvements and additions to the Veterinary College. The following are the appropriations asked for in detail: (1) For maintenance for the college year 1909–10, $40,000, an increase of $10,000 over the present appropriation. The maintenance of this college as a teaching institution will soon require at least $50,000 per annum. (2) For research, experimental work and extension work, $10,000. This should be raised, as the work becomes organized, to $25,000. (3) For clinical buildings and equipment, $125,000. (4) For farriery, horseshoeing laboratory, stable for team and wagons, and fence, $50,000. (5) For the completion of the wing at the north end and the erection of the one at the south end of the main building, as originally planned, $150,000.

There are this year 403 students in the Graduate School of Arts and Sciences of Harvard University, distributed according to the divisions and departments under which their studies chiefly lie, as follows: Semitic, none; ancient languages, 26 (indic philology, none; classics, 26); modern languages, 121 (English, 80; German, 10; romance, 17; comparative, literature, 6; Scandinavian, 1; mixed, 7); history and political science, 75 (history and government, 46; political economy, 27; evenly divided, 2); philosophy, 48 (social ethics, 2); education, 10; fine arts, 6 (history and principles of the fine arts, 3; architecture, 3); music, 3; mathematics, 23; physics, 18; chemistry, 34; engineering, 1; biology, 18 (botany, 7; zoology, 11); geology, 6 (geology and geography, 4; mineralogy and petrography, 2); mining and metallurgy, 1; anthropology, 3. There are three students of the medical·sciences and one of comparative philology, and four whose studies are miscellaneous.

Dr. C. A. Waldo, professor in Purdue University, has accepted the chair of mathematics at Washington University, St. Louis.

At Hobart College on the William Smith foundation, Mr. E. H. Eaton has been appointed professor of biology and Mr. F. P. Boswell assistant professor of psychology and mathematics. Mr. Ernest W. Dean has been appointed professor in chemistry.

The Medico-Chirurgical College of Philadelphia has established a department of pharmaceutic chemistry, of which Dr. George H. Meeker is the dean. Besides the professors and instructors drawn from the other faculties of the college, there have been added to the teaching force Professor F. A. Genth, as professor of mineralogy and assaying, and Professor Charles E. Vanderkleed, as professor of pharmaceutic chemistry.

DISCUSSION AND CORRESPONDENCE

AFTONIAN SANDS AND GRAVEL IN WESTERN IOWA

To the Editor of Science: During the past summer investigations made by the writer for the Iowa Geological Survey revealed widespread deposits of Aftonian sands and gravels in the western part of Iowa.

The beds, where undisturbed, in some cases reach a thickness of 35 feet, and furnish fine examples of cross-bedding and interbedding of sands and gravels. They lie unconformably between the Pre-Kansan and Kansan drifts, and were evidently deposited in flooded streams during an interglacial period.

That the climate of this period was comparatively mild is shown by the presence of fossil shells of species of mollusks still living in Iowa, belonging to the genera *Unio, Sphærium, Pisidium, Valvata, Planorbis, Ancylus*, etc., and of numerous bones and teeth of extinct herbivorous mammals belonging to the genera *Elephas, Mamut, Equus*, etc. The latter were found exclusively in the coarse gravels, while the former occurred chiefly in the finer sands.

At a number of points these sands and gravels were plowed and folded, and heaped up to a height of more than 100 feet above the Missouri Valley by the mass of Kansan ice which passed over them and in some cases even displaced the underlying Pre-Kansan.

The discovery is of special interest because these western gravels may now be definitely referred to the Aftonian, and because the fossils present a fauna practically new to that horizon, and throw light upon the climatic conditions which existed during the period of deposition. B. Shimek

State University of Iowa,
December 14, 1908

SCIENTIFIC BOOKS

National Antarctic Expedition. Vol. IV., Zoology. London, British Museum, 1908. 4°, pp. 6, 279, and 65 plates. (Containing) *Solenogastres,* by H. F. Nierstrasz; *Aptera,* by G. H. Carpenter; *Schizopoda,* by W. M. Tattersall; *Copepoda,* by R. Norris Wolfenden; *Echinoderma,* by F. Jeffrey Bell; Echinoderm larvæ, by E. W. MacBride and J. C. Simpson; *Myzostomidæ,* by R. Ritter von Stummer-Frauenfels; *Sipunculidæ,* by W. F. Lanchester; *Actiniæ,* by J. A. Clubb; *Tetraxonida,* by R. Kirkpatrick; and *Calcarea,* by C. F. Jenkin.

Under the supervision of Mr. F. Jeffrey Bell, of the British Museum, another fine volume has been added to the series describing the scientific results of the expedition to the Antarctic under Captain Scott, R.N., and his companions. A brief reference to the subject-matter of the various memoirs is all that our space permits.

A single species of *Proneomenia* was obtained in about latitude of 78° S. This is described by Nierstrasz in great detail, followed by a proposed division of the family Proneomeniidæ into a large number of groups, based on the structure of the glands and radula. It may be heterogeneous, and the forms of which it is composed may be related to different members of the Proneomeniidæ.

Carpenter reports the presence of a wingless insect belonging to the Collembola in moss from Granite Harbor in 77° S. latitude, though the specimens were in rather imperfect condition. Enough was made out to allow placing it in a new genus, *Gomphiocephalus,* of the Poduridæ.

The Schizopod crustacea collected embraced considerably over ten thousand specimens, but of these the vast majority belong to a single species and the total number of species collected is only thirteen. The abundant material of the *Discovery* party enables Mr. Tattersall to combine under Dana's original name four subsequently described species taken from mutations due to age, or variability. Two species are cited as "bipolar" but further investigations of the deep sea may reveal them as cosmopolitan.

Of the Copepods seven proved new, and one new genus, *Paralabidocera,* is proposed by Wolfenden. Of the twenty-eight Antarctic species recognized, two are regarded as "bipolar," though many have Arctic analogues. Twenty-five species were collected by the *Discovery*.

Among the small collection of echinoderms was the *Promachocrinus* first obtained by the *Challenger*, six Holothurians, two species of *Antedon*, three Echini, eight Starfishes, and ten or eleven Ophiurans. The collection of larvæ yielded the discovery of two pelagic forms and of the brood-pouch in *Cucumaria crocea*. A well-marked axial sinus and pore-canal in the *Cucumaria* embryo is of importance as definite evidence of a structure about which doubt had previously existed.

Two species of Myzostomidæ are treated in great detail. The sipunculoids comprise about thirty specimens which were all small and are considered as belonging to a single species of *Phascolosoma*.

The Actinians comprised six genera and eight species, of which six are Antarctic, two having been obtained at the Auckland and Falkland Islands.

The Tetraxonid sponges are exquisitely illustrated with colored plates of the finest quality.

There are six forms of Tetractonellidæ described, of which two are new varieties. The species are equally divided between the genera *Craniella* Schmidt, and *Cinachyra*. Of Monaxonellida there are forty-three species, with four new genera. Of the species, when obtained, twenty-two were new to science, besides seven new varieties.

The calcareous sponges collected comprise eighteen species and one variety, out of which six new genera and two new family groups have been constituted. All but five belong to the Heterocœla. In the discussion Jenkin proposes a new arrangement, founded in the main upon the classifications of Polejaeff and Dendy. The most interesting features of the collection are the large number of species containing chiactine spicules; five new species with "linked" flagellated chambers; a sponge, *Megapogon villosus*, with larger spicules than any hitherto recorded for a calcareous species; the unusual development of the gelatinous mesoderm in *Leucandra gelatinosa;* and the duplicate ovum, apparently a new form of egg cell in *Megapogon raripilus*, and *Achramorpha nivalis*. In the latter case the ovum appears to be made up of two unequal parts. The larger part is very similar to the ordinary large ovum cell and contains a large transparent nucleus and a small, strongly staining, nucleolus. The smaller part appears to be a multicellular structure, consisting of a large inner cell surrounded by a sheath of small cells, but it is possible it may be a single cell, the large portion being the nucleus. The inner cell contains two structures; one strongly staining like the nucleolus of the larger part, the other a hyaline sphere packed with about a dozen grains of one color, and an odd one which stains a different shade. The cells forming the outer layer have each a nucleus and a nucleolus. This layer, or sheath, in some cases surrounds the inner sphere completely, in others only surrounds the outer part, not existing between the inner spherical cell and the twin half of the ovum. It is possible that the smaller twin may be a feeding cell for the nourishment of the larger twin.

All the species of calcareous sponges were obtained at the winter quarters and in comparatively shallow water.

W. H. Dall

Hygiene and Public Health. By Louis C. Parkes, M.D., D.P.H., University of London, and Henry R. Kenwood, M.B. Edin., D.P.H., London. Third Edition with Illustrations. 8vo, pp. 620 with 96 illustrations. Philadelphia, P. Blakiston's Son & Co. 1907.

The third edition of this valuable work under the conjoint authorship has been carefully revised and brought up to date. The book is divided into thirteen chapters and deals in a very comprehensive way with Water; The Collection, Removal and Disposal of Excretal and Other Refuse; Air and Ventilation, Warming and Lighting; School Hygiene; Soils and Building Sites; Climate and Meteorology; Exercise and Clothing; Food, Beverages and Condiments; The Contagia; Communicable Diseases and Their Prevention; Hospitals—Disinfection; Statistics; Sanitary Laws and Administration.

In the chapter on water, it is noteworthy that some of the large cities in Great Britain are rapidly following the example of ancient Rome to bring pure water from quite a distance. So, for example, Glasgow is supplied with water from Loch Katrine, thirty-four miles north of the city. Manchester has recently obtained a new source of supply from Thirlmere, ninety miles from the city, and by the construction of a dam the level of the lake has been raised and its storage capacity increased. Liverpool by immense engineering works has impounded the waters of the Vyrnwy in Wales. The work involved the construction of a massive masonry wall across a narrow part of the valley, creating an artificial reservoir four and three fourths miles in length and conveying the water a distance of sixty-eight miles.

Birmingham is likewise engaged in the task of bringing water from the upper sources of the Wye. There can be no question as to the sanitary and economic effects of these changes. It is well known that the greatest reduction in typhoid-fever rates has everywhere been accomplished when a pure water supply has been substituted for a previously contaminated one.

The vital statistics of our own country as analyzed by the present writer in his address on the "Conservation of Life and Health by Improved Water Supply, White House, 1908," show that the combined average death rate from typhoid fever in cities with a contaminated water supply was 69.4 and after the substitution of a pure supply it fell to 19.8 per 100,000, a reduction of 70.5 per cent. The reduction in ten cities in the state of New York, according to a paper published in the Bulletin of the New York State Department of Health, April, 1908, amounted to 53.4 per cent. One of the tables based upon data obtained from Dr. Wilbur, of the Division of Vital Statistics, U. S. Census Bureau, shows that during the last twenty-five years the death rate from typhoid fever has fallen in fourteen countries and large cities from an average of 42.3 to 18.1 per 100,000, a reduction of 54.3 per cent. It may be urged that improved methods of medical treatment are responsible for a considerable reduction in the death rates, but when we see such a striking change immediately after the installation of filtration plants as in the case of Albany, Watertown, Lawrence and Cincinnati, we are forced to the conclusion that water purification plays the most important rôle. We note that the authors still quote 27.08 gallons of water as a fair daily average per capita consumption. In most of our American cities the per capita consumption for household, trade and manufacturing and municipal purposes is three to four times greater.

The chapter on the collection, removal and disposal of excretal and other refuse is very complete, as are most of the English textbooks on the subject. Attention is directed in the comparison of methods on page 81 to the fact that in Nottingham, where middens, pails and water closets are in use in different parts of the town Dr. Boobbyer has shown that the greatest prevalence of enteric or typhoid fever is to be found in the houses with middens and the least in the water closeted houses, those with pails occupying an intermediate position. In 1902 there were thrice as many cases of enteric fever proportionately in "pail" houses as in "w. c." houses, and fourteen times as many in "midden" houses as in "w. c." houses.

The writer in 1895 in his typhoid fever investigation in Washington observed similar facts and offered as an explanation that the sewers carry away the filth which otherwise would be a source of danger chiefly through the agency of flies, who may carry the germs on their feet and infect the food supply of neighboring houses.

The value of pure air and outdoor life is pointed out on page 169, by referring to Dr. Ogle's researches which have shown "that of all the industrial classes, those which are the healthiest and have the lowest death rates are the gardeners, farmers, agricultural laborers and fishermen—those namely, whose occupations are carried on in the open air. The death rate from phthisis in these cases is only half that of the male community generally, and they enjoy about the same amount of freedom from diseases of the respiratory organs. Differences in food or housing accommoderations can not account for the comparative freedom of these classes from pulmonary disease."

The causal relation of foul air to tuberculosis is shown by the fact that since the British government has payed attention to air space and ventilation the death rate from consumption among the soldiers, sailors and prisoners which was formerly excessive is now considerably less than among the civil population.

The dangers of sewer air are being revived again by recent experiments of Horrock's at Gibraltar, which gave results at variance with those obtained by Laws and Andrews. He found that specific bacteria present in sewage may be recovered from the air of drains and sewers, even when the sewage is flowing smoothly and without splashing. He believes that they may be ejected into the air by: (*a*) the bursting of bubbles at the surface of the sewer, (*b*) the separation of dried particles from the walls of the sewers and pipes, and probably (*c*) by the ejection of minute droplets from flowing sewage.

A similar explanation was offered by Uffelmann over twenty years ago and Horrock's experimental data, which also showed that the disconnecting trap on a house drain prevents the passage of bacteria present in sewer air into the house drains, will naturally tend to revive the opinion, formerly held, that sewer and drain air may be the means of spreading infectious diseases unless the house drain and fixtures are properly trapped.

The section on vitiation of air in industrial occupations is very complete and the table on page 182, giving the comparative mortality figures for males engaged in different dust-inhaling occupations shows conclusively that the hard, sharp and angular fragments of mineral and metallic dust are especially calculated to cause irritation and abrasions of the respiratory passages and thus favor the invasion of the tubercle bacillus and also the production of other diseases of the respiratory organs in general.

The book is accurate and up to date in every respect and can be confidently recommended to all interested in hygiene and public health.

George M. Kober

Georgetown University

Soils and Fertilizers. By Harry Snyder, Professor of Agricultural Chemistry and Soils, University of Minnesota. Third edition. 8vo, 350 pp. New York, The Macmillan Company. 1908.

The first edition of Snyder's book, then entitled "Chemistry of Soils and Fertilizers," was at the time of its publication in 1899 a most welcome addition to the libraries of teachers of agriculture. It gave in logical and systematic form a brief course in agricultural physics and chemistry, and in the practise deducible therefrom, and was widely used in our agricultural colleges by both students and teachers. But the rapid advance of agricultural science made it advisable to publish a revised second edition in 1905, without, however, materially increasing the length of the text. In the new, third edition we have instead of the 287 pages of the previous editions, 344 pages, slightly smaller than before.

The increase is partly due to the addition of illustrations, as in the excellent chapter on laboratory practise, which has been enlarged from 13 to 19 pages, and forms one of the most useful features of the book for the guidance of teachers, who often fail to illustrate the facts and principles of their course in a manner both attractive and profitable to their students. Many of these experiments and apparatuses are original with Snyder, and very cogent. The twelve pages of review questions, also, are very well calculated to impress upon the student the practical applications of what is brought before him during his course, and to induce attention in advance of the final examination, in place of the "cram" so commonly indulged in at the end of the session.

The body of the text itself has been thoroughly revised so as to include the results of the latest researches in the agricultural field, and one recognizes plainly the ring of the diction of one who knows whereof he speaks from personal investigation. This influence, difficult to define exactly, is nevertheless most potent in securing the interest and attention of students, who instinctively recognize the difference between the teacher who merely transmits what others have said and done, and the one who as an active investigator has increased the store of knowledge.

Snyder's important researches on humus and the nitrogen of soils are well summarized and render this portion of the book especially valuable and complete, in showing quantitatively the increase and decrease of nitrogen under different methods of culture, largely on the basis of investigations made by the author himself. The entire subject of soil fertility and fertilization is so comprehensively yet briefly treated, that while nothing really essential is omitted, one is forcibly struck with the immensity of the field, and the total inadequacy of the time and preparation usually bestowed upon it even by those who are attempting to prepare themselves to be active workers in experiment stations. The one-sidedness and narrowness of the ordinary course of preparation for such activity is strongly emphasized by what, for brevity's sake, Snyder has to leave unsaid in this excellent book. But the practical applications of the facts and principles given are so well interwoven with the latter that "a peg is struck" in connection with each, in the mind of the reader or student, and will strike the practical farmer as well. To both classes of readers, and more especially to teachers of agriculture, this volume will be most welcome and useful.

Intended as the book is mostly for the temperate humid region, its omissions as concerns the arid region and the tropics are perhaps not a fair subject for criticism. The index is somewhat scantier than it should be for convenience of reference, when such subjects as alluvium, subsoil, leaching of soils, root penetration and others of similar importance, can not be conveniently located by its aid.

E. W. Hilgard

The New Physics and Its Evolution. By Lucien Poincaré. Authorized translation. Pp. 344. New York, D. Appleton & Co. 1908.

Professor Poincaré says in his preface:

It has occurred to me that it might be useful to write a book which, while avoiding too great insistence on purely technical details, should try to make known the general results at which physicists have lately arrived, and to indicate the significance of the recent speculations on the constitution of matter and of the recent discussion of first principles.

One of the most interesting things to the physicist in this book is the author's insistence on the atomic theory as a fundamental principle which he would place on a par with the principle of the conservation of energy and the principle of Carnot and Clausius (the second law of thermodynamics). Indeed, it may be said, using the author's words, that the atomistic synthesis, but yesterday so decried, is to-day triumphant.

Professor Poincaré is one of the leading exponents of the view, which has always been held by the experimentalist, that the truth of a theory is solely its availability for use, and the value of Professor Poincaré's recent books lies to a great extent in the manner in which he sets this view before that great body of insistent and shameless theorists, the general public.

The scope of Professor Poincaré's book is sufficiently indicated by the above extract from his preface, and its quality is sufficiently indicated by the statement that it has an interest to the physicist and a value to the general reader. Let us, therefore, return to the paradoxical statement concerning the general public, our persistent and contented theorists, and let us illustrate by taking an example which every one should be able to appreciate. It is very well for a sailor, perceiving that the wind blows, to set his sails accordingly; and he usually knows well how to do it. But a sailor's grandson who sets himself to studying the wind, let him be careful how he uses the idea which pervades this simple perception.

Even the apparently steady flow of a great river is an endlessly intricate combination of boiling and whirling motion; and the jet of spray from a hydrant, or burst of steam from the safety valve of a locomotive, what is to be said of such things as these? Or let one consider the fitful motion of the wind as indicated by the swaying of trees or as actually visible in driven clouds of dust and smoke; or the sweep of the flames of a conflagration! Let one think of these things and consider whether it is not necessary to bring the mind to some narrow view before any clear line of argument can be pursued relative thereto.

Yes, it is necessary, and the simple idea of flowing, or, to put it in the usual way, the *idea of simple flow*, when properly and precisely defined[1] constitutes the basis of the science of hydraulics; but the general public is so content with ideas (theories) that they project them unreservedly into objectivity and that ends the matter in their minds. The wind blows and water flows, they say, and if one objects they claim that by blowing they mean *what the wind actually does*, although they admit they do not *know* it all. Maybe that is what they do mean, but such symbolism is worse than useless in science. A physical theory, or let us say rather, for the sake of intelligibility, a physical idea has in every case a *structural* content which represents more or less completely a condition or thing and you *do* know it all. A physical theory is, in fact, a working model in one's head such as the kinetic theory of gases, or the wave theory of light.

The general public indeed are not only content with simple practical ideas such as the idea that the wind blows, but they are theorists also in a weak and contemptible sense, so many of them learn elaborate theories which they never use—and think themselves fine. It is a good thing, this recent talk about truth's being availability for use, and many intelligent people would be surprised indeed if they could understand to what extent this axiom has been driven into scientific men.

But let us go back to the man who says that the wind blows and who thinks he has in mind what the wind actually does, and let us consider whether this man's interest is in the kinematics of the atmosphere or in the deeply laid plans of men which the wind *undoes* in havoc and disaster. Can there be any doubt as to what his interests really are, and as to what he really has in mind? It is little indeed that most men know of that remarkable quality of science, the quality of detachment. Science leaves human values mostly to art and to the arts, and the symbolism of the artist and of the business man is very different from the symbolism of science. It would seem, indeed, that art and business procedure can project themselves unreservedly into objectivity and stand unabashed; but with science it is not so. The ideas of flowing and blowing are true because the sailor and the lock-tender use them and they work; but the subtlety of nature is far beyond that of sense or of the understanding, and to project such simple ideas unreservedly into objectivity is to make an end to science.

There is at the present time a general awakening in philosophy and many scientific men seem to think that the world-wide talk on pragmatism is simply the first, long-delayed response of the great mass of men to the compelling philosophy of the experimental sciences, but it seems to the writer that this is by no means a complete diagnosis of the situation because some of the most striking features of the present philosophical movement are to be found in the transformation or reversion which the philosophy of the exact sciences is now undergoing. A period of remarkable activity in the physical sciences has been followed by a revolution in the conduct of business and industry, impressing the methods of the physical sciences upon great numbers of men, and the reciprocal effect is a growing domination of the exact sciences by a spirit of humanism, as pragmatism has been called in England. Indeed, the changes which human interests as a whole are creating in the philosophy of the exact sciences

[1] See pages 219–221 of Franklin and MacNutt's "Elements of Mechanics," The Macmillan Company, 1907. This book is unique as an attempt to supplement precision of ideas and definitions (with due deference to the reviewer in *Nature*, who says the book is very inaccurate and has no reason to be) with suggestive allusions to the subtleties of nature in order to fortify the student against the confusion of boundaries between our logical structures and the objective realms of reality, a confusion which, to use Münsterberg's phrase, is "the gravest danger of our time."

are no less profound and significant than the changes which the physical sciences have brought about in the conditions of human life.

The change which is taking place in the philosophy of the exact sciences is many sided, but a prominent feature of it is the passing away of an old point of view, namely, that nature is exact and unvarying, that the so-called laws of the physical sciences are ultimate realities, and that great simple facts of the physical universe are revealed in their perfection, one after another, to the divining spirit of mankind. It is not easy, however, to characterize the point of view which is now becoming dominant. In one way it may be described as a reenthronement of sense, and it may be exemplified by contrasting what is said above with the point of view of the author of one of our best modern engineering treatises on hydraulics as indicated by the following extract: "Galileo said in 1630 that the laws *controlling* the motion of the planets in their celestial orbits were better understood than those *governing* the motion of water on the surface of the earth. This is true to-day, for *the theory of the flow of water in pipes and channels has not yet been perfected.*" [Italics ours.] No! and it never will be Perfected! It would take too long to explain here just what is meant by this declaration, for, indeed, it has nothing to do with the fool idea, if, indeed, it can be called an idea, that "the finite can not comprehend the infinite" so that "we may not presume to point out all the ways in which a God of unbounded resources might govern the universe." From such inanity may the great God of little things deliver us!

Every student should realize two things in connection with his study of the physical sciences. The first is that the study of the physical sciences is exacting beyond all compromise, and the second is that the completest science stands abashed before the infinitely complicated array of phenomena of the material world except only in the assurance which its method gives.[2]

The new physics! Let no one imagine that what he calls results (which are in nearly every case, and especially in the popular mind, a more or less shameless projection of ideas into objectivity) constitute the new physics. The readiness with which the physicist can nowadays meet a new group of observable effects with adequate instrumental and theoretical tools is strikingly exemplified by the recent work in radioactivity. This facility of the modern scientific method in the realm of the physical sciences *is* the new physics, it is a realization of what Bacon long ago listed as one of the deficiencies of knowledge, namely, the Art of Inventing Arts, and the very essence of it is an increased realization of the fact that ideas are not things. Boundaries are no longer confused.

W. S. FRANKLIN

November 22, 1908

[2] Taken from a paper on "The Study of Science by Young People," *New York State Education Department Bulletin*, No. 431, pp. 65–94, September, 1908.

SCIENTIFIC JOURNALS AND ARTICLES

IN *The American Naturalist* for November Thos. H. Montgomery gives the results of "Further Studies on the Activities of Araneads," dealing with questions of the snares, senses of touch and sight, and the average duration of life. To some it will seem a pity that the term Arane*ids* was not used, since this termination has been much used by zoologists. Floyd E. Chidester has "Notes on the Daily Life and Food of *Cambarus bartonius bartoni*," and Austin H. Clark describes "Some Points in the Ecology of Recent Crinoids," noting some of the factors that influence their size and distribution. Shorter articles are "Evolution Without Isolation" and "A Note on the [Spawning] of the Silverside." The book reviews are unusually full and important, especially those on "The Origin of a Land Flora" and "The Animal Mind."

The American Museum Journal for December contains an illustrated article on the "Exhibit Illustrating the Evolution of the Horse" in which it is noted that the American Museum collections of fossil horses are larger than those of all other museums put together. The "Department of Mineralogy" records the reception of what is probably the largest mass of polybasite ever taken from a mine. It is announced that the "Tuberculosis Exhibit" installed in the new wing on Columbus Avenue, will remain open for several weeks.

The Museum News of the Brooklyn Institute notices the installation of an exhibit illustrating Mr. Abbott H. Thayer's principles of obliterative shading, of a group of timber wolves and of a large painting showing the appearance of a coral reef. The main article in the Children's Museum section describes coffee culture in Guatemala.

SPECIAL ARTICLES

THE DETERMINATION OF THE CLAY CONTENT OF SOILS[1]

In the method of mechanical analysis of soils originally devised and used in the Bureau of Soils of the United States Department of Agriculture,[2] the amount of clay was determined—after the coarser particles had been separated by centrifuging—by evaporating the clay-water to small bulk in enameled-ware sauce pans, transferring it to platinum, carrying completely to dryness, and weighing the residue. This method was found undesirable on account of the excessive time required for the evaporation, because many dust particles and fragments cracked from the lining of the sauce pans got into the clay and were weighed with it, and because the transfer from sauce pans to platinum required much time and trouble and offered possibilities of loss. To avoid these difficulties, and especially to increase the rapidity of the work, it was therefore decided to abandon the final transfer to platinum, and to complete the evaporation in the enameled-ware dishes and weigh the clay in them without transfer. For convenience in weighing and to decrease the likelihood of entry of dust, the enameled-ware sauce pans were discarded and there were adopted instead much smaller enameled-ware cups, having a capacity of about 300 c.c. and weighing about 180 grams. This method has the disadvantage of requiring a much heavier balance, but the determinations seem none the less accurate, and a great saving of time has been effected.

It is now thought that the method may be still further shortened in the case of routine analyses by abandoning altogether the direct determination of clay and obtaining its percentage by difference. The error thus introduced will probably be far less than that involved in the centrifugal (or other) separation of the clay from the silt, and both errors are almost certainly within the limits of variation which may be expected between different samples of the same soil. In one hundred consecutive analyses taken at random from the recent files of the Bureau of Soils the variations between the percentage of clay as directly determined and that found by difference ranged between 0 and 2.28 per cent. In two cases the variation was over 2.00 per cent.; in three cases, between 2.00 per cent. and 1.50 per cent.; and in six cases between 1.50 per cent. and 1.00 per cent. In all other cases the variations were 1.00 per cent. or less.

It is indeed not improbable that in many cases the determination by difference is the more accurate, as all errors due to access of dust or to loss of clay water are thus avoided. Errors due to a not impossible change in the state of hydration of the clay are also eliminated. It is believed that in the vast majority of cases the difference method in clay determination will be accurate within 1.00 per cent., and no greater accuracy is necessary or even desirable for purposes of soil classification. The saving in time is at least 30 per cent., and is believed to be well worth while in routine laboratories making a large number of analyses. The direct determination must, of course, be retained for cases of especial importance, or where a check is necessary and is probably also advisable for students' use, and for use in small laboratories.

C. C. Fletcher

Bureau of Soils,
U. S. Department of Agriculture

[1] Published by permission of the Secretary of Agriculture.

[2] See Bulletin No. 24, Bureau of Soils, U. S. Department of Agriculture (1904).

NOTES ON THE ATROPHY OF THE EYE OF RAJA ERINACEA

In the skate, *Raja erinacea,* a clearly defined case of complete atrophy of the left eyeball was observed in our course this fall.

The brownish integument continued without any marked change over the region of the eye, the only indication of the place where the eye should be being a slight absence of pigment and a more delicate texture. When the dorsal integument was removed, no evidence of an eyeball was to be noted. The optic pedicel was present and in a normal condition as to both size and position. The several recti muscles were recognized with difficulty. Their origin was as in the right eye, but they were inserted into loose connective tissue surrounding the optic pedicel with their fibers from 2 to 5 mm. long. The fibers in the recti muscles of the right eye were 10–15 mm. long, which indicates something of the amount of degeneration of the recti muscles in the atrophied eye.

The trochlear, oculo-motor and abducens nerves were each found piercing the cranial capsule and passing to the short and mostly fused recti muscles. So far as one could determine by a gross examination, these nerves were the same as those passing to the fully developed eye, except much shorter. The optic nerve was surrounded by a greater amount of connective tissue than in the normal eye and terminated distally and abruptly at the end of the optic pedicel, with which it was closely united.

Two explanations are suggested for the disappearance of this eye. First, the loss of the eyeball was due to some injury. If such were the cause, then one would expect to find some evidence in the form of a scar, etc., but nothing was seen which pointed conclusively to any previous injury. Secondly, for some reason of which we have no knowledge, the embryonic eyeball tissues were arrested in their development. This seems the more probable as the integument over the eye was so much like the rest of the skin. The material was not fixed satisfactorily for a histological study.

W. M. Smallwood

Zoological Laboratory,
Syracuse University

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at the Johns Hopkins University, at Baltimore, during convocation week, beginning on December 28, 1908:

American Association for the Advancement of Science.—Retiring president, Professor E. L. Nichols, Cornell University; president-elect, Professor T. C. Chamberlin, University of Chicago; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. J. Paul Goode, University of Chicago.

Local Executive Committee.—William H. Welch, M.D., chairman local committee; Henry Barton Jacobs, M.D., chairman executive committee; William J. A. Bliss, secretary, Joseph S. Ames, William B. Clark, R. Brent Keyser, Eugene A. Noble, Ira Remsen, John E. Semmes, Francis A. Soper, Hugh H. Young.

Section A, Mathematics and Astronomy.—Vice-president, C. J. Keyser, Columbia University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Professor Carl E. Guthe, State University of Iowa; secretary, Professor A. D. Cole, Ohio State University, Columbus, O.

Section C, Chemistry.—Vice-president, Professor Louis Kahlenberg, University of Wisconsin; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor Geo. F. Swain, Massachusetts Institute of Technology; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Bailey Willis, U. S. Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor C. Judson Herrick, University of Chicago; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor H. M. Richards, Columbia University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Professor R. S. Woodworth, Columbia University; secretary, George H. Pepper, American Museum of Natural History, New York City.

Section I, Social and Economic Science.—Vice-president, Professor W. G. Sumner, Yale University; secretary, Professor J. P. Norton, Yale University, New Haven, Conn.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. H. Howell, Johns Hopkins University; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Professor John Dewey, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 31. President, Professor D. P. Penhallow, McGill University; secretary, Dr. H. McE. Knower, The Johns Hopkins Medical School, Baltimore, Md. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 30, 31. President, Professor H. S. White, Vassar College; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28, 29. President, H. W. Tyler, Boston, Mass.; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor E. L. Nichols, Cornell University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 29–January 1. President, Professor Marston T. Bogert, Columbia University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Professor Samuel Calvin, University of Iowa; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—January 1, 2. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor Richard Swan Lull, Yale University; secretary, Dr. W. D. Matthew, American Museum of Natural History, New York City.

The American Society of Biological Chemists.—December 28–30. President, Professor John J. Abel, The Johns Hopkins University; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 29–31. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 29–31. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–January 2. Vice-president, Professor H. L. Russell, University of Wisconsin; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 29–31. President, Professor William Morton Wheeler, Harvard University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn. *Central Branch,* December 28–30. President, Professor E. A. Birge, University of Wisconsin; acting secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The Entomological Society of America.—December 29, 30. President, Professor W. M. Wheeler, Harvard University; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor S. A. Forbes, University of Illinois; secretary, A. F. Burgess, Washington, D. C.

The Botanical Society of America.—December 29–31. President, Professor W. F. Ganong, Smith College, Northampton, Mass.; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—December 30, 31. President, Professor L. H. Bailey, Cornell University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Chapter.—President, Dr. T. C. Frye, Seattle, Wash.; secretary, Mr. N. L. T. Nelson, St. Louis, Mo. Address: Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Anthropological Association.—December 28–January 2. President, Professor Franz Boas, Columbia University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 28. President, Professor Roland B. Dixon, Harvard University; secretary, Dr. Alfred M. Tozzer, Harvard University, Cambridge, Mass.

The American Psychological Association.—December 29–31. President, Professor G. M. Stratton, University of California; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Philosophical Association.—December 29–31. President, Professor Hugo Münsterberg, Harvard University; secretary, Professor Frank Thilly, Cornell University, Ithaca, N. Y.

Southern Society for Philosophy and Psychology.—Convocation week. President, Professor J. MacBride Sterrett, The George Washington University; secretary, Professor Edward Franklin Buchner, The Johns Hopkins University, Baltimore, Md.

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 208th meeting of the society, held at the Cosmos Club, on Wednesday evening, October 28, 1908, under informal communications, Mr. J. S. Diller discussed briefly wind-blown grains of quartz in limestone.

Regular Program

Geologic Studies in Southwestern Alaska: Mr. WALLACE W. ATWOOD.

The island of Unga, a portion of the Alaskan Peninsula north of Unga in the vicinity of Balboa and Herendeen bays and a district in the vicinity of Chignik Bay were visited during the past summer with a view to determining the stratigraphy of the coal-bearing horizon. The island of Unga was found to consist chiefly of igneous rocks. On the north end of the island there are some lignite-bearing beds that immediately underlie Miocene sediments. The lignite-bearing beds have been determined on the basis of plant remains to belong to the Kenai horizon. Small patches of Miocene were found at various localities on Unga, Popof and the mainland.

In the Balboa-Herendeen Bay district a thickness of over 5,000 feet of sediments was found from which Eocene shells and Kenai plants were secured. The beds which yielded the marine shells were interstratified with the leaf-bearing beds in a conformable series. This great series of Eocene beds was traced eastward through the central portion of the peninsula to Chichagof Cove, where Dr. Palache secured marine Eocene shells. The age of the Kenai leaves has been a confusing problem in Alaska and the association of these leaves with marine shells is very gratifying. The Eocene belt has been folded and faulted and large masses of granitic rock have been intruded into it. These intrusions are in the forms of dikes, sills and laccoliths. North of the Eocene belt formations of Upper Jurassic, Lower and Upper Cretaceous were found. The Herendeen Bay coal field is located in the Cretaceous area and the coal is of Upper Cretaceous age. The structural relationship between the Upper Jurassic and Lower Cretaceous is that of conformity. Between the Lower Cretaceous and the Upper Cretaceous there is a faunal break, but no structural break was found at that horizon. Between the Upper Cretaceous and Eocene beds there does not appear to be any structural break but the faunal material received is not complete. Near the close of the Eocene times there were igneous intrusions, volcanic outbreaks and deformation. Miocene beds rest, at most places, unconformably upon underlying formations, although on the north end of Unga Island sedimentation was continuous from the Eocene on into the Miocene times.

Since the Miocene beds were deposited there has been further deformation and vulcanism in the region and volcanic activity has continued up to the present time.

The work in the Chignik district consisted chiefly in an examination of the coal field. The faunal material from that area has not yet been examined, but it is expected that the same horizons that were found in the Herendeen Bay district are represented in the Chignik area. Fossil shells and plants are there closely associated and it is expected that further light on the Kenai problem will be afforded by the collections secured from that place.

New Occurrence of Willemite and Anhydrite: Mr. W. LINDGREN.

Anhydrite occurs in the Cactus mine at Newhouse, southern Utah. The mineral accompanies the chalcopyrite of that copper mine as a primary gangue mineral and is associated with tourmaline and a small amount of calcite and siderite. The hydration of the anhydrite results, of course, in the formation of gypsum, which mineral is abundantly found throughout the mine.

Willemite as a commercially important mineral of zinc ores is mined at Tres Hermanas in southern New Mexico. The mineral forms dense masses consisting of slender hexagonal prisms, and is associated with calcite, a little smithsonite, and calamine, as well as hydro-zincite. The occurrence is in the oxidized portion of a contact metamorphic deposit in limestone at the contact with quartz-porphyry. A number of carloads of this mineral were shipped in 1905. The mineral was identified by analysis.

Lines of Inference in Paleogeographic Studies: Mr. Bailey Willis.

The primary difficulty in attempting to draw a map of North America, for example, to represent the continent as it was during a given period, is to select facts which may be assumed to have had approximate synchronism. The New York Trenton, for instance, can not be narrowly correlated with an equivalent in the Mississippi Valley region or in the Nevada basin, even where the sequence of Ordovician strata is unbroken and the Trenton interval is represented by some part of the sediments. Hence, in treating a large area, it becomes necessary to accept approximate correlations and to present a sequence of geographic changes or a tendency toward a certain geographic state, rather than a definite state which may have been attained at a definite time. The data of paleogeography are: (1) the criteria of overlap and shore sediments to determine coasts; (2) the distribution of marine sediments to determine known seas; (3) the arrangement of oceanic depths, negative continental elements and positive continental elements, to determine possible extensions of the more or less probable lands and seas.

From this consideration of stratigraphic data there results in any case a certain possible distribution of lands and seas which may be tested in the following manner. Under the supposed conditions and under general laws of atmospheric and oceanic circulation, ocean currents presumably took certain courses. If the lithologic and faunal facies of marine deposits (local modifying influences apart) are determined primarily by oceanic currents and distributed accordingly, then the courses of the currents deduced from the supposed arrangement of lands and seas should lead to a distribution of facies corresponding broadly with the observed deployment of facies over the continent.

Applying these criteria to a definite problem, it is suggested that the marine circulation during Trentonian time developed into a central epicontinental current, which flowed northward from the Gulf of Mexico; bathed the shores of Colorado on the west and Appalachia on the east; spread around the Ozark and Wisconsin islands, and penetrated across the Laurentian region to the Arctic. Return currents flowed southward along the St. Lawrence and Champlain trough and continued along the shore of Appalachia between the northward-flowing current and the land and their effect extended to Alabama and Arkansas. A similar current flowed south along the trough of the Rocky Mountains in British Columbia at least as far as the forty-ninth parallel. The distribution of two very distinct Ordovician facies, the Galena-Trenton and the Normanskill facies, appears to correspond with the deductions regarding currents.

Philip S. Smith,
Secretary

THE TORREY BOTANICAL CLUB

The first meeting of the season, held at the Museum of Natural History, on October 13, 1908, was called to order at 8:20 P.M. by Dr. Howe in the absence of other officers. Mr. George V. Nash was elected chairman. There were fourteen persons present. The resignation of Dr. C. Stuart Gager as secretary of the club, occasioned by his removal to the University of Missouri, was read, and accepted with regret, after an expression of the value of his services to the club.

The scientific program consisted of informal reports on field observations by members. Professor F. E. Lloyd was called upon first and spoke of his recent experiences in Mexico. He exhibited field notes and photographs of cacti collected largely in northern Zacatecas, Mexico; in a restricted region, about sixty species are found. Four species of *Opuntia* are reported to be new: there were no species of *Echinocereus*. Owing to the fact that cacti in conservatories often exhibit very different behavior from that in their natural habitat, the importance of such field study of the group is to be emphasized.

Professor Lloyd then spoke on the bionomics of *Parthenium argentatum*, known in Mexico as guayule. From this plant a large amount of commercial rubber is obtained; the rubber occurs in masses in cells of the pith, medullary rays and cortex, and is extracted by mechanical means. In addition to reproducing freely by seed, there is an interesting method of vegetative reproduction. The plant has, besides a tap-root system, long and slender horizontal roots near the surface, from which new shoots arise and produce new plants at a distance of a meter or more from the main plant. There may be from two to six of these shoots arising from one point, producing such a different habit that such plants may be easily distinguished from the seedlings with their single trunk. A piece of the stem of *Landolphia*, a tropical liana, was exhibited. In this case the latex coagulates in the canals and the rubber is extracted by mechanical means.

Mr. R. S. Williams spoke briefly of his five months' experience in Panama, particularly on the climatic and soil conditions as affecting vegetation.

Dr. E. B. Southwick exhibited a peculiar monstrosity of *Zea Mays*. Mr. Nash reported the discovery of the rare orchid, *Epipactis viridiflora*, at Letchworth Park.

TRACY E. HAZEN,
Secretary pro tem.

THE meeting of October 29, 1908, was called to order at the New York Botanical Garden at 3:30 P.M., Dr. M. A. Howe being asked to take the chair. Mr. Percy Wilson was elected secretary.

A microscopic preparation of the red snow plant, *Sphærella nivalis*, collected this autumn on Cape York, Greenland, was exhibited by Dr. N. L. Britton, who received it from the secretary of the Peary Arctic Club. Dr. Tracy Hazen gave a brief description of this interesting plant and raised certain questions still unsolved concerning it.

The first subject on the published program was "A Recent Collection of Mosses from Panama," by Mr. R. S. Williams. The following synopsis of this paper was written for the secretary by Mr. Williams:

"For the time spent in the field this was much the smallest collection of mosses ever made by the speaker. It may be accounted for partly by the fact that most of the work was done in the latter part of the dry season, namely, during the last week of February, through March and about three weeks of April, and partly because of the low level, mostly under 300 feet elevation, at which much of the collecting was done.

"In the city of Panama are a number of fine old ruins more or less overgrown with shrubs and smaller plants, but not a single species of moss was observed. On going to Penonome, some hundred miles west of the Canal Zone on the Pacific coast the conditions were found to be much the same. One species of moss, however, was found abundantly fruiting in a cultivated field of cassava. This was *Bryum coronatum* Schwaegr., a world-wide species of the tropics and occurring as far north as Florida. On going a few miles back of the town among the foothills and low mountains, various mosses become not uncommon, growing chiefly on trees, but even here very few species were obtained in anything like good fruiting condition. On leaving Penonome a trip was made southeast of the canal along the Pacific coast about 100 miles to the Gulf of San Miguel and up the Tuira River about 70 miles into the interior to the mining camp of Cana. Here much more favorable conditions were found, Cana being situated at an altitude of 2,000 feet above the sea with the Espirito Santo Mountains just back of the town rising 5,000 feet higher. Mosses and liverworts were fairly abundant and at a more favorable season doubtless a large collection might be made.

"Of the thirty species brought back from both sides of the Canal Zone, five sixths are known to be South American. Two of these, *Pilotrichum amazonum* Mitt., collected originally by Spruce on the Amazon, and *Lepidopilum brevipes* Mitt., found by Spruce in the Andes at 3,000 feet, had not been since reported by any other collector. The five remaining species appear to be unknown outside of Central America. They are *Syrrhopodon Bernoullii* C.M.; a species belonging to the very large genus *Macromitrium*, apparently undescribed; a species of *Cryphæa*, also undescribed, and bearing numerous propagula on the stems; *Porotrichum cobanense* C.M. and *Cyclodictyon Liebmanni* Schimp., these last two being previously known only from the type localities."

The second announced paper, "The Morphology of *Tænioma*," by Miss Elizabeth I. Thompson, was not read, Miss Thompson being absent.

Dr. N. L. Britton gave a brief account of *Rhipsalis*, a genus of the Cactaceæ whose members are pendulous from tree trunks or rocks. Most of these plants occur in tropical America, but a few species, strange to say, are found in tropical east Africa. Of the fifty-three species that have been recognized, the speaker discussed chiefly those of Mexico, Central America and the West Indies, illustrating his remarks with herbarium specimens.

Dr. Tracy Hazen described in detail an interesting phase in the development of a species of *Chætophora* found in the brook flowing through the herbaceous valley of the New York Botanical Garden. This investigation is, however, not yet complete. Dr. Hazen stated incidentally that the algal flora of this brook appeared to be considerably richer now than it was a few years ago, and a discussion followed as to the presence of additional forms, some attributing it to insects, frogs and other minor aquatic animals, and others to the wild ducks that frequent this brook through the summer season.

W. A. Murrill,
Secretary pro tem.

The club met at the American Museum of Natural History on November 10, 1908, and was called to order by Vice-president Burgess at 8:15 P.M. About 95 persons were present.

After the reading of the minutes of the meeting of October 29, Dr. N. L. Britton delivered the lecture of the evening on "Trees of the Vicinity of New York." The lecture was illustrated by lantern slides from the Van Brunt collection and was of a popular nature. The trees were taken up in a biological order, beginning with the gymnosperms, and the photographs exhibited illustrated both the general habit of the trees discussed and the details of their flowers and fruit.

Marshall A. Howe,
Secretary pro tem.

SECTION OF GEOLOGY AND MINERALOGY OF THE NEW YORK ACADEMY OF SCIENCES

A regular monthly meeting of the section was held October 5 in the academy rooms at the American Museum of Natural History. Four papers were presented, as follows:

Outline of the Geology of Long Island, N. Y.: Professor W. O. Crosby.

Professor Crosby is of the opinion that the Pleistocene history of Long Island is relatively simple, and the known facts are accounted for by a single ice-invasion. The recent reference of the underlying lignitic and pyritic Chesapeake (Miocene) clays and the Lafayette (Pliocene) yellow gravel to the Pleistocene glacial series is believed to be a mistake. From the early Pleistocene uplift dates the cuesta of Long Island, to which Long Island Sound holds the relation of an inner lowland. This lowland is still floored by Cretaceous clays and sands. The transverse valleys and deep bays of the north shore of Long Island are essentially preglacial, though greatly modified by glacial erosion and deposition.

The Production of Low-grade Copper Ore in the West: Professor James F. Kemp.

The speaker presented a brief description of the recent development of the so-called "low-grade" copper mines in Bingham Cañon, Utah, and at Ely, Nev. By means of maps the geographical situation was made clear and the geological relations were outlined. The ores consist of bodies of silicified and brecciated porphyry, impregnated with chalcocite. They are mined by means of steam shovels, in huge open cuts. They range in copper from less than two to two and a half per cent. The operation and processes of the mills and smelters were briefly outlined. The paper was based upon visits made the past summer.

Limestones Interbedded with the Fordham Gneiss in New York City: Dr. Charles P. Berkey.

The discovery of beds of limestone at three points in such relation as to indicate interbedding with the banded gneisses was announced. This is an additional feature of similarity between the gneisses of the Highlands and the Fordham at its type locality. The largest bed is about 27 feet thick and is exposed in the east wall of the new Jerome Park Reservoir at 205th Street. In all cases these limestones are very impure and coarsely crystalline, carrying many unusual minerals arising chiefly from recrystallization. Chondrodite and actinolite are abundant. Sphalerite and galenite are also found.

Continental Formations of the North American Paleozoic: Professor A. W. Grabau.

The change of opinion in regard to conditions under which many of the well-known sedimentary formations are originally deposited was outlined. A tabulated list of those formations of the Appalachian region whose characters seem to indicate continental origin was exhibited and the evidence was briefly discussed. This article is to be published in full in Science.

Charles P. Berkey,
Secretary of Section

WASHINGTON SECTION OF THE AMERICAN CHEMICAL SOCIETY

The 185th meeting was called to order by President Walker on Thursday evening, November 12. The attendance was 90, this large number being due to the fact that many visiting members of the A. O. A. C. were present. The following papers were read:

"Color of Lead Chromate," E. E. Free.

"Absorption of CO_2 by Moist Oxide," W. O. Robinson.

"Solubility of Gold in Salt Solutions," W. J. McCaughey.

"The Distribution of $NaNO_3$ in the United States," C. E. Munroe.

Three members of the society were elected as councilors to the American Chemical Society, viz., L. M. Tolman, E. T. Allen and E. M. Chace.

J. A. LeClerc,
Secretary

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