NATURE

SATURDAY, NOVEMBER 15, 1924.

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Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON

The State and Productive Research.[1]

BY Order in Council of July 28, 1915, the Committee of the Privy Council for Scientific and Industrial Research was established "to direct, subject to such conditions as the Treasury may from time to time prescribe, the application of any sums of money provided by Parliament for the organisation and development of scientific and industrial research." The Order in Council further provided that there should be an Advisory Council to which should stand referred, for its report and recommendation, proposals—(1) for instituting specific researches; (2) for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; and (3) for the establishment and award of research studentships and fellowships.

On December 1, 1916, the work of the Committee of Council for Scientific and Industrial Research with that of its Advisory Council, hitherto under the ægis of the Board of Education, was assigned to a separate department—the Department of Scientific and Industrial Research—having its own estimates in charge of a minister responsible to Parliament. This was followed by the creation, under His Majesty's Sign Manual, of the Imperial Trust for the Encouragement of Scientific and Industrial Research, to hold funds, to enter into contracts and agreements, and to do other things in furtherance of the objects of the Committee of Council for Scientific and Industrial Research.

Parliament having voted the sum of one million sterling for the purposes of the Department, the fund was deposited with the Imperial Trust to be expended in accordance with the directions of the Committee of Council. On the recommendation of the Advisory Council, the Committee of Council decided that the money should be spent in the form of grants in aid of research in any industry undertaken by firms which might combine to conduct it on a co-operative basis. The means devised to this end was the establishment under the Companies Acts of Associations for Research limited by guarantee and trading without profit. The number of these industrial research associations in actual operation to-day is twenty-three, and there is one which has not yet commenced full operations.

The position of the Research Associations and their future in the industrial system of Great Britain are well worth separate consideration, but as the policy of establishing them at all has been challenged, even in quarters unquestionably anxious to promote the fullest use of scientific knowledge, it may be well to say a

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1923–24. (Cmd. 2223.) Pp. iv+139. (London: H.M. Stationery Office, 1924.) 3s. net.

word on the general question. That question is, granted that a million fund is for disposal to bring the results of scientific research to the continuous aid of industry, is the method of establishing research associations the best method, or at least as effective as any other method, of doing so? The Advisory Council, in its annual report for 1919–20, says:

"It may be said that a million spent upon research work done at the National Physical Laboratory and other research laboratories up and down the country would produce much greater scientific results of value to industry than the same sum spent in subventions to associations that have to buy their experience as well as their staff and equipment at a time when the country is short of both. It may be so. But it is only after the industries have done research for themselves that they can appreciate either its difficulty or its worth. They are trained to suspect that what can be got for nothing may have a corresponding value. Had the million been spent on research directed by the Government itself, its effect upon manufacturers would at the best have been destructive of their self-reliance and at the worst a free gift to their competitors in other lands."

To the writer these considerations seem sound and over-riding. The essential problem would not be solved by the mere increase, in quantity and quality, of the results of scientific research of value, direct and indirect, to industry. It was a part, and not the least part, of the problem to get science domiciled in the industries themselves; to bring about an interfusion, not only of the theoretical knowledge of the man of science and the practical knowledge of the manufacturer, but also of the corresponding personalities; and to make the manufacturers themselves (in greater or less degree, according to the character of the industry) working, and not sleeping, partners in scientific research. It is difficult to see what better means to these ends could have been adopted than the method of industrial research associations.

On one major point, however, there may well be doubt and criticism. The scheme was based on the expectation that at the end of the first five years the industries concerned would find themselves both willing and able to continue the work of their respective research associations without direct assistance from the State. On this, two things may be said. In the first place, five years is too short a period in which to bring practical conviction of the benefits and necessity of co-operative research to industries, presumably, needing to be convinced, and the course of economic events since the War, including the long period of industrial depression, has enhanced this difficulty. In the second place, the State may well lose more of real wealth by cutting the research associations adrift than it can gain in money saved by the withdrawal of grants in aid. It is to be hoped that the Committee of Council will give further careful consideration to this aspect of the question and will not regard as an axiomatic principle the proposition that research associations must, after a limited period, "look solely to the industries they represent for their maintenance."

To obtain a just idea of the work of the Department of Scientific and Industrial Research, we have to consider, however, much more than the work of the Research Associations. In carrying out its duties, the Advisory Council gradually evolved a definite programme under four main heads: (1) the encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; and (4) the aiding of suitable researches undertaken by scientific and professional societies and organisations. It would be impossible in a single article to give even the barest summary of the work done under these heads, and the reader who is interested may be referred to the annual reports of the Department. There, for example, he will learn what has been done and attempted "in the direction and co-ordination of research for national purposes" in the records of the Fuel Research Board, the Food Investigation Board, Forest Products Research Board, Building Research Board, and so on.

The Department has also done much to co-ordinate the various scientific activities of government. In 1918 the property of the National Physical Laboratory, together with the responsibility for its maintenance and development, was transferred to the Department, and in 1919 the administration of the Geological Survey and Museum was similarly transferred. In 1919–20 on the decision of the Cabinet, Co-ordinating Boards were established, with the object of so organising all the scientific work which is of common interest to the Fighting Services of the Crown as to ensure the utmost economy of expense and personnel, and the due co-ordination of the technical work of the various naval, military, and aeronautical establishments so as to avoid overlapping, either with each other or with the research organisations of the Civil Departments of State. At present there are four such Co-ordinating Boards, for chemistry, engineering, physics, and radio research. They include technical representatives of the Fighting Services and Civil Departments.

Reviewing the work and development of the Department of Scientific and Industrial Research since its foundation, the question arises, has the experiment of governmental participation in the organisation of scientific research, especially in its relation to industry, so far as it has gone, been justified? To that question, there can be little doubt that the answer is in the affirmative. If there have been mistakes in detail, unrealised expectation here and, apparently, wasted effort there, the instances have been at least as few as, and perhaps fewer than, could reasonably be counted on, for a like period, in the early stages of development of any new government department. As to the value of the work itself, it is sufficient to quote the words of the Advisory Council: "Scientific research is, in our judgment, the main, if not the only source of fresh productivity in industry, and it is only by increased productivity that the world will find a way out of its present economic difficulties."

What, taking a broad view, has been done towards this end by the establishment and work of the Department of Scientific and Industrial Research?

We have now a Government Department as fiduciary for science, charged with the duty and responsibility of ensuring, in so far as Government can ensure, that scientific knowledge and methods play their full part in the Government services and in the trade and industry of Great Britain.

We have Research Associations in twenty-three or twenty-four diverse industries, not only engaged directly in scientific research, but also acting as scientific centres where all scientific questions affecting their respective industries can be brought to a focus, and in the solution of which the scientific worker, the manufacturer, and the user can each play his appropriate and co-ordinated part.

The scientific worker and the manufacturer have been brought into closer co-operation, the gulf between theory and practice has been narrowed, and, in greater or less degree, the manufacturers themselves have become productive partners in research.

The spirit of co-operation between individual firms in an industry and between industries generally and the Government services has been quickened and enlarged.

Researches have been initiated and prosecuted, already with appreciable success, into fundamental problems of national importance (for example, fuel, food, and building materials), which no one firm and no one industry could be expected to undertake on an adequate scale.

The man of science has been helped to come into his own, and a powerful reinforcement has been brought to the aid of those who have long sought to bring vividly to the minds of all classes a realisation of the degree and extent to which our modern industrial civilisation is based upon, and must be shaped by, the progress of scientific discovery.

Not least, a good beginning has been made in the evolution of a national scientific policy. Continuity in foreign policy has been the aim of successive governments since the days of Lord Salisbury. By wise and prudent direction, by advancing, to use a phrase of Lord Morley, "with daring caution," the Department of Scientific and Industrial Research may give us an accepted national scientific policy, definite, continuous, and consistent.

J. W. WILLIAMSON.

History of Mathematics.

History of Mathematics. By David Eugene Smith. Vol. 1: General Survey of the History of Elementary Mathematics. Pp. xxii + 596. (Boston and London: Ginn and Co., 1923.) 21*s*. net.

IT is only during the last fifty or sixty years that the history of mathematics has been systematically studied. In that time, however, the field has been gradually covered by an increasing number of students, and their output has become so extensive that it was no work of supererogation when Prof. Gino Loria thought it necessary to publish a guide to the literature of the subject, old and new, "Guida allo studio della storia delle matematiche" (Hoepli, 1916). There are indeed already in existence general histories of mathematics of all sorts and sizes, designed to meet the requirements of almost all varieties of readers. The great work of Moritz Cantor ("Vorlesungen über Geschichte der Mathematik"), which may be regarded as the inspirer of most of them, appeared in the years from 1880 to 1908 and consists of four volumes, with an aggregate of some 3800 large pages. Yet it contains no unnecessary details—in many places in the earlier volumes the reverse is the case—and it does not carry the story beyond 1799: this is a sufficient indication of the extent of the material.

Cantor's history has not been translated into English, partly, we may suppose, because it would be a formidable undertaking, but also, no doubt, because the book is, so far as the early volumes are concerned, already out-of-date, the later editions having failed to take sufficient account of the results of recent researches and of the many corrections and well-founded criticisms of details in the first edition. Among the shorter histories covering approximately the same ground may be mentioned the "Geschichte der Mathematik" designed for the "Sammlung Schubert," in two volumes, the first (1908) by Siegmund Günther (pp. 427), and the second in two parts (1911 and 1921) by Heinrich Wieleitner (pp. 251 and 220), a competent work of convenient size. Much smaller still was the "Geschichte der Mathematik" in the "Sammlung Göschen," by A. Sturm, which essayed to tell the story in 155 small pages; this has now been re-edited in two parts (1922–1923) by Wieleitner (pp. 136 and 154), and contains the very utmost that could be compressed into the small space, so much so that it can scarcely be read continuously for any length of time without inducing a headache.

The histories in French, apart from the pioneer work of Montucla (first edition 1758, second edition, completed by Lalande, 1799–1802), are of no great account. One is by M. Marie in twelve slender volumes ("Histoire des sciences mathématiques et physiques," 1883–1888); the volumes relating to antiquity are, however, untrustworthy. Another by F. Hoefer (1874) has passed through several editions, but is now out-of-date. A third, by J. Boyer (1900), is a mere sketch in 260 pages, but it has some interesting portraits. In English we have the work by W. W. Rouse Ball with the modest title "A Short Account of the History of Mathematics" (first edition 1888), an attractive book the success of which is proved by the number of editions that have been called for; there is also the slighter "History of Elementary Mathematics" by Florian Cajori (New York: The Macmillan Company, 1897).

Cantor was able to complete the first three volumes of his "Vorlesungen" himself, covering the period down to 1758; but for the fourth volume dealing with the period from 1759 to 1799, he was constrained to enlist the co-operation of other specialists, each of whom took one department or section; thus S. Günther wrote upon the works bearing on the history of mathematics which belong to the period in question, F. Cajori on arithmetic, the theory of equations and the theory of numbers, E. Netto on combinatorial analysis, probability, series and the imaginary, V. Bobynin on elementary geometry, A. von Braunmühl on trigonometry, polygonometry and tables; and so on. This devolution of the work meant a change of arrangement; whereas the earlier volumes all followed chronological order, the fourth volume abandoned this plan in favour of an arrangement by subjects. This becomes a necessity if the development of the several branches of mathematics is to be systematically set forth and properly understood. The chronological method with a proper admixture of biography and anecdote is no doubt more suitable for the ordinary cultivated reader with just a sufficient mathematical equipment to enable him to understand what he is reading; the other arrangement, according to subjects, better serves the purpose of the expert mathematician, amateur or professional.

This was seen by J. Tropfke, who in the years 1901 to 1903 brought out the two volumes of his "Geschichte der Mathematik in systematischer Darstellung" (1922 saw the commencement of publication of a second edition). This excellent work is divided into fourteen sections dealing with separate subjects, namely, arithmetical calculation, algebra, plane geometry, logarithms, plane trigonometry, sphaeric and spherical trigonometry, series, interest-calculations, combinatory analysis and probability, continued fractions, solid geometry, analytical geometry, conics, maxima and minima. Thus, whereas the earlier histories adopted, after Cantor, a chronological arrangement, Tropfke's amounted rather to a series of historical monographs on the origins and development of the main subjects included in a regular programme of mathematical instruction.

Dr. Smith, in the two volumes into which his work is divided, aims at fulfilling a double purpose. The first volume, now before us, is designed to afford a survey of the growth of mathematics by chronological periods, and to give a general historical presentation "for the purpose" (in his own words) "of relating the development of mathematics to the development of the race, of revealing the science as a great stream rather than a static mass, and of emphasizing the human element." "But this" (he continues) "ought to lead to a topical presentation by which the student may understand something of the life history of the special subject which he may be studying, whether it be the elementary theory of numbers, the methods of calculation, the solution of equations, the functions of trigonometry, the common symbolism in use, the various types of elementary geometry, the early steps in the calculus, or one of the various other important topics of elementary mathematics." This latter presentation of the subject is reserved for the forthcoming second volume. We may say therefore, roughly, that our author seeks to combine the aims of writers like Rouse Ball on one hand and of Tropfke on the other, the first volume of his work corresponding to Rouse Ball's "Short Account" and the second to Tropfke's history.

We can only wish Dr. Smith success in his undertaking. There is certainly room for a volume in English on Tropfke's plan, while the first volume is in many ways attractive. It is true that, in comparison with Ball's "Short Account," the first volume has a certain disadvantage in that, when the author would naturally give us some piece of actual mathematical work, he has (in order to avoid repetition) to break off and refer us, for details, to the forthcoming volume. While, therefore, he is able, like Ball, to give details of the lives of mathematicians and stories about them which contribute to make the volume eminently readable, some portions of certain chapters tend to become little more than lists of names of writers with a statement of the subjects on which they wrote or in which they were interested. Dr. Smith is, however, fully aware of this disadvantage. On the other hand, there are special features which add to the usefulness and attractiveness of the volume. One is the remarkably full references in the notes to the literature and bibliography of the subject, for which students who desire to pursue it further cannot fail to be grateful. Another is the large number of portraits of mathematicians (on which Dr. Smith is a recognised authority), and of facsimiles of pages from manuscripts and rare and famous printed books, as well as of extracts from letters or memoranda in the handwriting of the most famous mathematicians. The facsimiles, unfortunately, have often to be on a reduced scale, but this is rendered inevitable by the size of the page.

In a work containing so much detail it is, of course, impossible to avoid occasional slips. To take only the section dealing with Greek mathematics:—We are puzzled by the statement on p. 73 that "for the doctrines of Pythagoras we are indebted chiefly to Eudoxus of Cnidus (*c.* 370 B.C.), whose works, though lost, are known to us through extracts preserved by later writers"; is the reference, perhaps, intended to be to Eudemus of Rhodes? On p. 86 we are told, as regards Theaetetus, that "there are references in the writings of the ancient historians to show that he discovered a considerable part of elementary geometry and wrote upon loci." We know of no authority for the statement that Theaetetus wrote on loci; is it possibly due to an inadvertent mis-reading of the dictum in Proclus's "Summary" that "*Hermotimus of Colophon* carried further the investigations already opened up by Eudoxus and Theaetetus, discovered many propositions of the Elements and compiled some portion of the theory of loci"? The statements, on p. 59, that the Egyptians knew the fact relating to the square on the hypotenuse of a right-angled triangle long before Pythagoras, and on p. 72, that we have the best evidence for this, need modification since the publication of the new edition of the Rhind Mathematical Papyrus by Prof. Eric Peet; for we are assured by Prof. Peet that he has been able to find no foundation whatever for the idea that the Egyptians knew the fact in question, and that nothing in Egyptian mathematics suggests that the Egyptians were acquainted even with special cases of the Pythagorean theorem.

T. L. H.

Tissue Growth.

Growth. By G. R. de Beer. Pp. viii+120+8 plates. (London: E. Arnold and Co., 1924.) 7*s.* 6*d.* net.

THE experimental study of tissue growth is a comparatively recent branch of biological research, and as yet but a small part of this vast field has been explored. Much important work, often of tantalising suggestiveness, has already been carried out, however, and various hypotheses have been put forward to explain the forces which initiate, sustain, perpetuate and control the growth of cells. At the present time the problem of growth is being approached from many widely diverse points of view. The embryologist, the physiologist, the geneticist, the biochemist are all engaged upon its solution, and it is therefore a matter of some difficulty for the layman, or indeed for the specialised research worker, to obtain a comprehensive view of the more significant facts which recent investigation has brought to light. Mr. G. R. de Beer, in his book "Growth," has successfully summarised and discussed in popular language some of the results achieved in relation to this subject in various branches of science during recent years.

The author opens his introductory chapter with a statement of the object of his book, "to show what growth is, what it does, and how it does it"—perhaps a somewhat ambitious aim in the present state of our knowledge. If he could satisfactorily explain the third division of his text, "how it does it," he would have solved one of the most perplexing problems in Nature. He has, however, brought together a number of interesting experiments and observations relative to growth in the plant and animal kingdoms in a clear, concise, and interesting manner. It is pointed out that growth alone is not responsible for the formation of an intricate adult organism out of a simple spherical ovum, but that the many complex processes involved in embryonic development fall into two headings: increase in size and increase in complexity of structure and shape, or, in other words, growth and differentiation. A short account of the growth of animals, the development of the frog being selected as the example, is followed by a brief description of growth in plants and a short chapter containing a few special examples of growth and differentiation in animals.

Growth, it is pointed out, is not confined to embryonic life; the processes of adult existence—metabolism and expenditure of energy—entail a continual breaking down of the tissues which must be replaced if the organism is to persist. This physiological regeneration goes on throughout life and is effected by cell division, but does not necessarily cause any increase in size. A very striking example of normal regeneration is quoted, which occurs regularly among the Polyzoa. In these animals the nervous and alimentary system degenerates into a mass of decomposing matter, and at the same time a new alimentary canal and nervous system are produced by growth. As Mr. de Beer remarks, this form of regeneration "is a very convenient method of 'doing up' the organism." A short chapter is devoted to the question of asexual reproduction, illustrated by various examples from the animal and vegetable kingdom. The author then passes to the subject of abnormal growth, which he defines as growth which plays no part in the normal life cycle of the organism, but rather the reverse, and mentions various examples of galls in plants and tumours in animals. A most remarkable case of abnormal growth here described is that of a fungus *Rozites gongylophora*, "which is carefully cultivated on specially produced manure beds by the leaf-cutting ant

(Atta) in Brazil. Ordinarily this fungus produces spores, but under the treatment to which it is subjected by the ants it grows into white swellings which are used by the ant as food."

Having made a general survey of the various forms of tissue growth, the author proceeds to discuss its causes and nature. He likens protoplasm with its ceaseless metabolism to "a whirlpool which involves now one particle of water, now another"; at no time can it be said that it consists essentially of any particular portion of matter, for the essence of the whirlpool is the "whirl." The genetical aspect of growth is briefly considered along Mendelian lines. The nature of fertilisation is also touched upon, and a short account is given of the more obvious chemical processes which accompany the conversion of non-living food-material into living protoplasm.

Vitamins and hormones, "substances which speed up growth," are accorded a short chapter, which is followed by an interesting account of the effect of external factors upon growth and the relationship of certain physical conditions to the limitation of size in various organisms.

The rate of growth and the control of growth by differentiation and age are discussed, and a chapter on growing smaller or "degrowth" follows. A few pages are devoted to inorganic analogies, growth being compared with crystal formation and other physical and chemical processes. The author wisely concludes, however, that "inorganic analogies, while very instructive and illustrative of certain events in the reactions of living matter, are as yet unable to throw much light on growth itself."

In his final chapter, Mr. de Beer reviews the problem of growth in its more general aspect, and remarks that "there is no need to invoke mystical forces to explain results which in the present state of knowledge are not understood. The processes of growth most certainly have their causes, but these causes are not likely to be understood until the chemical and physical properties of living matter have been thoroughly explored."

It is always a matter for regret that science should guard her treasures from the general public by a bristling array of formidable technicalities, and Mr. de Beer is therefore to be congratulated on reducing our knowledge of one of the most important, and at the same time one of the most difficult subjects in biology, to a form in which it can be appreciated by the man in the street. The results of much important research must of necessity be omitted from a work of this scope, but the material on the whole is well selected, and the volume will be a welcome addition to the shelves of biological students and also, it is to be hoped, to members of the general public.

T. S. P. S.

Physics for All.

(1) *Our Physical World: a Source Book of Physical Nature-Study.* By Elliot Rowland Downing. With a Chapter on Radio Communication, by Fred G. Anibal. (University of Chicago Nature-Study Series.) Pp. xviii + 367. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1924.) 2.50 dollars.

(2) *Matter and Change: an Introduction to Physical and Chemical Science.* By William Cecil Dampier Whetham. Pp. vii + 280 + 3 plates. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

IT is generally admitted at the present time that science in some shape or form should be part of the general education of every boy. Whatever his main interests are to be, whether he is to be a serious student of other branches of learning, or a man of affairs, it is almost unthinkable that he should leave school without some instruction in the aims and methods of science. In particular, in these times when strange stories of fabulous inventions seem to have replaced the giant gooseberry and the sea-serpent in the columns of the ephemeral press, some knowledge of the principles of physics seems a desirable part of the education of all good citizens; though physics presents, perhaps, his greatest problem to the teacher of "science for all." There is no time, in the few hours which are all that science can claim in a curriculum of general education, for the tedious process by which the "specialist" prepares the foundations for his higher studies in science; nor does it seem desirable that time and energy should be spent on laying elaborate foundations upon which nothing is to be erected subsequently. The selection of material, from so vast a storehouse, the nature of its presentment, the degree of rigour to be aimed at, are engaging the deepest attention of many of our most enthusiastic and capable teachers. It is not surprising that books on the subject multiply rapidly. Two are before us as we write. They reflect, in their extremest form, the divergences which exist as to what is possible and desirable in the way of the teaching of physics as part of a general education.

"Our Physical World," by Prof. Downing, is dated from the School of Education of the University of Chicago, and may be taken to represent the point of view of the practical educational expert, with a vivid—possibly painful—apprehension of the difficulties of his craft, and a realisation of the limitations of the human material with which he has to deal. The schoolboy's attention is to be won, and his interest stimulated, by the proof that science has something to say about subjects which really matter—kites and tin whistles, tops and toy aeroplanes, bows and arrows, and motor cars. The scientific pill must be carefully sugared, and if the exigencies of confectionery leave little space for the operative principles which it is the purpose of the sugaring to convey, that is one of those unfortunate facts which the teacher must face and accept.

In "Matter and Change," on the other hand, Mr. Whetham has obviously found his subject of such enthralling interest that he has not conjectured the possibility that any reader should find it less so, or should need any inducement beyond the subject itself to pursue his studies with diligence and enthusiasm. Save for the delightful clarity of style, which is a distinguishing feature of all Mr. Whetham's writings, and for the humanising touches provided by illuminating biographies, one line long, which help us to realise that even scientific investigators are men, there is no concession to human weakness or boyish indolence. Probably the true method lies somewhere between these extremes.

(1) Prof. Downing's book, though very readable and well illustrated, does not strike us as one of the best of its kind. Although nominally a "source book" for teachers of the subject, the author frequently appears to be addressing the pupils themselves. We hope, at least, that there are no science teachers in the United States who require the caution that "The North Pole is not a real pole sticking up out of the earth." Nor does it seem that the younger pupils, for whom some of the very elementary portions of the book are clearly intended, could glean much of value from the account of the electron theory of matter, or from the excellent chapter on radio communication. There is a similar want of sureness of purpose in the choice of material. Instructions for making a bird kite are followed by an excellent historical account of the progress and development of aviation, and a description of a toy windmill is followed by an impassioned appeal against allowing the valuable water-power of the States to fall into private hands. A chapter on the electrical theory of matter, concluding with a two-page synopsis of chemical theory, is succeeded by an historical account (again very well done) of the development of the steam-engine. Later in the volume a chapter on devices for seeing, which might have been taken from a well-written elementary text-book on light, is followed by a chapter of detailed instructions in practical photography, reminiscent of the booklets of instructions given away with a camera outfit. Much of the book is interesting and well written, but it is doubtful whether the pupil will gain from the variety of material supplied that "elementary appreciation of those principles of science" which it is the author's object to instil.

(2) Mr. W. C. Dampier Whetham's volume (granting the existence of a class of non-scientific reader who is willing and able to follow the author in his strenuous course) is excellent. Here is to be found everything of importance which would be found in the pages of an elementary treatise on physics and chemistry, together with many things which could only be found in treatises which are far from elementary. No vital point is omitted, no difficulty slurred over, and though in scarcely more than 250 pages the author leads his readers from the very elements of mechanics to the highest flights of relativity and the quantum theory (taking in chemistry and bio-chemistry by the way), there is scarcely a subject mentioned on which valuable information is not given, and scarcely a point at which the author could fairly be charged with producing the illusion of knowledge without its substance.

"Matter and Change" is a miracle of condensation—to give a list of the subjects dealt with would be to court instant unbelief—and it is not to be expected that the book will be found easy of assimilation, in spite of the clarity of its style. It is not at the first or the second reading that the reader will extract all the marrow which it contains. We should like to see the book introduced into some of those non-scientific classes of schools for the benefit of which, in part, it has been written; expressing, however, at the same time the opinion that should any member of the class find himself thoroughly at home with it, his talents must have been seriously misjudged by his schoolmaster, and he should be transferred without delay to the science sixth.

Any reader who has mastered the contents of this little volume will have a systematic knowledge of physical science of which he will never have reason to be ashamed, and which many honours students in the university might envy him. But to master it he will have to read slowly, to re-read often, and, above all, to think hard. In spite of its brevity, it contains matter for more than one winter evening's entertainment.

J. A. C.

The People of Kilima Njaro.

Kilimanjaro and its People: a History of the Wachagga, their Laws, Customs, and Legends, together with some Account of the Highest Mountain in Africa. By the Hon. Charles Dundas. Pp. 349 + 16 plates. (London: H. F. and G. Witherby, 1924.) 18*s.* net.

KILIMA NJARO has had a varied influence on the history of East Africa. After its discovery by Rebmann in 1848, its problems and the incredulity with which European geographers received the statement that it is snow-capped led to several of the first European journeys into this part of Africa. The sentimental interest felt in the mountain by the German Emperor was one of the determining factors in the demarcation of the Anglo-German boundary. The relative accessibility of this mountain and the beauty of its scenery has led to its repeated exploration. The latest contribution to its literature is a volume by the Senior Commissioner of Tanganyika Territory, Mr. Dundas, who states in the preface that study of the district and its people was compelled by the spell of the mountain more than by his own interest in research. His first chapter summarises the history of the exploration of the mountain and its glaciers, and reports that their rapid diminution in size since they were first mapped by Hans Meyer in 1887 and 1889 still continues. There is little direct reference to the geological structure and none to the interesting rocks of which the mountain is composed. The author makes for Kilima Njaro the surprising claim that it is the highest point of the British Empire!

The bulk of the work consists of a valuable account of the Wachagga, who live on the lower slopes of the mountain. One of the legends of this tribe refers to fire on Kilima Njaro, which is a possible reminiscence of an eruption; but the reference is so indefinite that it may be only a coincidence, and affords no evidence of recent volcanic activity. Mr. Dundas records various legends similar to the Bible account of the Fall of Man, of the story of Cain, and of the Flood. He is satisfied that these stories have been long known to the tribe, as they were told him by the older members, and if they had been derived from the missionaries they would doubtless have included some from the New Testament. The claim by Merker that the Masai folklore includes some Biblical stories has been distrusted; but the author considers that it is supported by his discoveries of the Chagga legends.

The two chief drawbacks in the book are the absence of references and the brevity of the index; various authorities are quoted in the text, and the reader might lose time in endeavouring to trace them, especially when the names are misspelt, as in the case of Kersten (p. 20). The index is inadequate and the illustrations are sometimes far from the reference to them in the text. Thus opposite p. 192 is a figure of a "Nungu" or "Cursing Stone" dug up from ruins of a fort of the former Chagga Chief Horombo. It is referred to on p. 174, but is not mentioned in the index. The specimen is strikingly like those in South Africa which have been called Kaffir digging stones. The author considers that it was used as the medium for conveying a curse which might be removed by the submission of the offender. The Wachagga are accomplished smiths, and sell their iron work to the adjacent tribes; they buy the metal from the Pare, a tribe living south-south-east of Kilima Njaro. The volume includes a series of Chagga proverbs and an especially valuable chapter on Chagga law and political institutions. It forms a useful addition to East African ethnology.

Our Bookshelf.

Nuovi orizzonti della psicologia sperimentale. Per Agostino Gemelli. Seconda edizione riveduta ed aumentata. Pp. xiv+387. (Milano: Società Editrice "Vita e Pensiero," n.d.) 18 lire.

ENGLISH readers of these essays will be disappointed at the lack of reference to the work of the last ten years in psychology, and the book suffers from having neither bibliography nor index. But it is admirably suited by its lucid style and unbiassed criticism to the special purpose for which it was written, namely, as an introduction to experimental psychology for the use of Italian students.

In Italy, we are told, psychology has always been unduly influenced by philosophy. Whereas in Germany, England, and the United States, objective methods have been in the ascendant, experimental work has been discounted in Italy, where there are only two institutes (of Prof. Kiesow at Turin and Prof. Sante di Sanctis in Rome) for psychological research. "The field of psychology is invaded by philosophers, men of letters, dilettantes; people with the best intentions, who are always discussing general questions, but have not advanced the science of mind one jot, because they have never applied themselves to psychological research by strict methods and mental discipline."

The first essay discusses "Psychology as a Biological Science," and the inadequacy of biological explanations to solve psychological problems. Nevertheless, it is to Fechner, Wundt, and their successors that we owe the methods of experimental research by which mental activity can be described and studied. The second, on "Prejudices against 'Laboratory Psychology,'" insists that objective observation must be extended and reinforced by subjective, *i.e.* introspective, observation, as described in the third essay, on "New Methods of studying the Psychology of Will and Thought." Here the teaching of Ribot and Binet, and of Külpe at Würzburg, is contrasted with the earlier school of Leipzig.

"The Pathological Method in Psychology" is next considered, with a reminder that the relative and exceptional cannot be estimated as absolute and regular, and that psychology must not be degraded into psychiatry.

The concluding essay deals with "Psychology as the Science of Consciousness." Consciousness is a function of mental life (*vita psichica*) and not co-extensive with it—it is an autonomous synthetic activity. This theory is experimentally justified by recent researches into the origin of judgments and concepts along the lines of the school of Külpe. F. A. W.

Les Moustiques de l'Afrique mineure, de l'Égypte et de la Syrie. Par E. Séguy. (Encyclopédie entomologique, 1.) Pp. 257+29 planches. (Paris: Paul Lechevalier, 1924.) 50 francs.

ALTHOUGH the Culicidæ as a family are perhaps better known now than any other group of insects, our knowledge of all the details of their life-histories is still far from complete, especially as regards the species of certain regions. The author of the work under notice is of opinion that the mosquito fauna of North Africa and Asia Minor is less known than that of any other malarious region, which was certainly true until very recently. As shown by this volume, however, the deficiency is now to a large extent made good. The main title of the work is somewhat misleading, as it includes a fairly detailed account of nearly all the European mosquitoes, on the quite justifiable ground that many or most of them will be found eventually in the regions under consideration. The treatment is mainly from the systematic point of view, but larvæ as well as adults are discussed and distinguished, as is essential for practical purposes. The bulk of the text is a compilation from previous publications of the author and other workers in this field, but there are some 200 original and carefully executed drawings of structural details, which in themselves will render the work of much value to students. The author, like other systematists, to some extent follows his own inclination as to nomenclature and classification, but the views of others are made clear by full references. His attempt to divide the biting mosquitoes into three subfamilies is not very successful. There are a number of minor errors and inconsistencies, which appear to be chiefly due to too hasty compilation (compare, for example, the references to *Dixa submaculata* on pp. 177 and 179). The volume concludes with a catalogue of Palæarctic and Nearctic Culicidæ, together with a number of maps showing the distribution of some of the more interesting species; some of these, it must be admitted, are partly hypothetical.

Leitfossilien aus dem Pflanzen- und Tierreich in systematischen Anordnung. Von Prof. Dr. Johannes Felix. Zweite, neubearbeitete Auflage. Pp. vii + 228. (Leipzig: Wilhelm Engelmann, 1924.) 7 marks.

THIS is undisguisedly a student's text-book of fossils. There is practically no discussion of phylogenetic relationships: the organisms treated of are arranged, not according to the formations in which they occur, but according to their presumed place in the systematic arrangement. The classification adopted can only be described as antique. Thus sponges are regarded as a division of Cœlenterata. Trilobites are regarded as "Crustacea," and a picture is given of an obscure and incorrect restoration of a trilobite by Jæckel, whilst the infinitely clearer and more correct restoration given by Beecher, the discoverer of the trilobite limbs, is ignored. "Ganoidea" is still recognised as a division of Pisces, and a phylum named "Vermes" appears. Fortunately, since fossils only are described, this is practically coterminous with Annelida.

These blemishes are, however, of less importance in a book which is evidently intended merely as a handy reference manual for elementary students. Very fair figures are given of the known structure of what might be termed "difficult" fossils. Thus we have sections of Nummulina, of Stromatopora, figures of some leading types of crinoids, a longitudinal section of the brachiopod Waldheimia, and of the lamellibranch Hippurites, and of the rod-like shell of the cephalopod Endoceras.

Of course, there are numerous illustrations of vertebrate fossils; but as showing the lack of modern information, we may refer to the skull of the stegocephalous amphibian shown on p. 164, where the covering bones are shown. The names given to these are those to be found in Huxley's "Vertebrata," published in 1871. We think that even in an elementary text-book the student should learn the terms actually in use at the present day. E. W. M.

Die spezielle Relativitätstheorie Einsteins und die Logik. By Dr. J. H. Tummers. Pp. 15. (Venlo, Holland, 1924.) 1*s*.

THIS pamphlet gives a clear account of the fundamental bases of Einstein's special theory of relativity from the point of view of the logician. The author reaches the conclusion, with which relativists no doubt will agree, that Einstein's fundamental postulates of relativity and of the constancy of the velocity of light are logically inconsistent with each other so long as the absolute character of simultaneity is insisted upon. Moreover, he agrees with Einstein in his further conclusion that the two postulates together require that simultaneity be relative, in so far as two events, which happen at the same time for one observer, happen at different times for another observer in uniform motion relative to the first. But he maintains that, because the two fundamental principles are themselves merely postulates, the conclusion that simultaneity is relative is not proved, but merely postulated, and consequently its acceptance fails to remove the original contradiction between the two fundamental principles. Thus, he argues, we must reject the principle of relativity, if we accept that of the constancy of light-velocity, and admit that simultaneity is absolute, as we did before the introduction of Einstein's theory, a procedure which is tantamount to rejecting that theory as out of touch with reality.

Relativists will scarcely accept the author's sweeping conclusions; they will prefer to adopt the three admittedly consistent postulates of relativity, constancy of light-velocity, and relative simultaneity, rather than reject Einstein's theory, which, after all, has been very successful in co-ordinating many experimental facts not explained satisfactorily by any other theory—an achievement which the author seems to ignore entirely.

A Course of Instruction in Instrumental Methods of Chemical Analysis. By Prof. W. N. Lacey. Pp. vii + 95. (New York: The Macmillan Co.; London Macmillan and Co., Ltd., 1924.) 7*s*. net.

ONE of the difficulties experienced by students desirous of becoming acquainted with the technical analysis of materials is that the description of the apparatus employed is scattered throughout a voluminous literature. In this little volume an account is given of the principles underlying the use of instruments such as viscosimeters, pyrometers, refractometers, colorimeters, and so on, together with a clear statement of the utility and limitations of some of the types of apparatus. The sections are concise and to the point, and the practical work is well arranged. A valuable feature is the set of questions printed at the end of each section. These have been selected to bring out the essential features of the instruments and the value of the results to be anticipated from their use. A useful appendix gives a list of materials and apparatus needed for each instrument.

Electrometric methods are now of such importance in practice that the section on "Electrometric Analysis" is to be welcomed as an introduction to the subject. In the reviewer's opinion, the pages devoted to "fire assaying" might well be omitted in favour of an addition to the description of electrometric measurements, particularly as the art of dry assaying is one requiring long experience.

The book serves as an excellent introduction to the subject, and is well worth the attention of students of chemical technology. J. J. F.

The Philosophy of "As if": a System of the Theoretical, Practical and Religious Fictions of Mankind. By H. Vaihinger. Translated by C. K. Ogden. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xlviii + 370. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 25*s*. net.

PROF. VAIHINGER'S work, now translated into English, has been well known by philosophers almost from its first appearance in 1911. The translation is made from the sixth edition of the original, specially revised by the author to meet the case of historical references which might be obscure to the English reader. The doctrine is that "'as if,' *i.e.* appearance, the consciously false, plays an enormous part in science, in world-philosophies, and in life." The basis of the theory is Kant's doctrine of the Ideas of Reason, God, Freedom, and Immortality. These Ideas, according to Prof. Vaihinger's reading of the Critique, are not objects of knowledge the existence of which, though it cannot be proved by pure reason, is a necessity of the practical reason. He holds, on the contrary, that they are conscious fictions, and that the condition of our human activity is that we must act "as if" they were true. The same principle he holds applies not only to Ideas of Reason but also to all the categories of the understanding, in fact throughout the realms of science and philosophy.

Electrode Reaction and Equilibria: a General Discussion held by the Faraday Society, November 1923. Pp. 665-838. (London: The Faraday Society, 1924.) 10*s*. 6*d*. net.

THE general discussions of the Faraday Society continue to fulfil the useful functions which give to that Society its unique position amongst bodies pursuing similar aims in various branches of science. The discussion on "Electrode Reaction and Equilibria" was held on November 26, 1923, in the very worst of conditions as regards weather, but was attended in person by Prof. Biilmann, of Copenhagen, and by Dr. Heyrovsky, of Prague, as well as by the most keenly interested workers in Great Britain. The permanent record of the discussion forms a volume of nearly 200 pages, and contains 18 original contributions on the two related subjects of reversible and of irreversible electrode reactions, which were the subject of consideration at the afternoon and evening meetings. It is impossible to summarise these papers in a brief note; but the usefulness of earlier issues of the series of reprinted general discussions is so well known, that no further commendation of the latest publication is needed to emphasise its value to all who are interested in the subject with which it deals.

Indian Philosophy. By Prof. S. Radhakrishnan. (Library of Philosophy.) Vol. 1. Pp. 684. (London: G. Allen and Unwin, Ltd.; New York: The Macmillan Co., 1923.) 21*s*. net.

WE have undoubtedly a vast store of wisdom in the systems of Indian philosophy, and many Western philosophers in the modern period, from Schopenhauer to the Rhys Davids, have drawn inspiration from it. It differs, however, in one very essential particular from Western philosophy, both ancient Greek and modern. It aims at setting our questioning activity at rest by offering us satisfying answers to our problems; it does not stir up in us the restless Socratic spirit of inquiry. The emphasis is on what has been thought out and solved by seer and sage. The study of Indian philosophy, therefore, resembles the study of authoritative religious systems and is unlike the methodology in which our philosophy so largely consists. Prof. Radhakrishnan presents his subject in the form of an encyclopædia of systems. It is a continuous history and also specially useful as a book of reference.

An Introduction to the Practice of Civil Engineering. By E. E. Mann. Pp. xi+296. (London: Macmillan and Co., Ltd., 1924.) 7*s*. 6*d*. net.

THE author's object in preparing this volume has been to render easier the period through which young men have to pass after leaving college. This period is often exceedingly trying, both to the beginner and to those who have to look after him in the civil engineer's office. He may have had a very successful college career, and the work he will most certainly be started on is usually of such a character as to lead him to imagine that a great part of his studies have been useless. Of course, this view is quite a mistaken one; responsible work will come later, and the knowledge acquired in college will then be essential to success. The volume before us will be of great service in bridging over the transition period, and we can heartily recommend it to students still pursuing their college course, in order that they may have some idea of what lies before them when they are introduced to the practical work of the civil engineer.

A School Mechanics. By C. V. Durell. (Cambridge Mathematical Series.) Part 1. Pp. xx+186+x. (London: G. Bell and Sons, Ltd., 1924.) 3*s*. 6*d*.

MR. DURELL'S complete work is intended to cover the course required for the School Certificate and the various matriculation examinations. The part before us contains an easy introduction to the subject which should be successful in awakening the interest of the student; its contents are restricted almost entirely to vector quantities located in the same or parallel lines, and cover velocity, acceleration, moments, work, machines, energy, momentum, and the relation of force with acceleration. Gravitational units are employed in the treatment. The author has taken pains to make his subject alive, and the book will be welcomed in such secondary schools as include the systematic teaching of mechanics in their course of work.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Luminescence of Solid Nitrogen and the Auroral Spectrum.

IN a paper recently published in Proc. Roy. Soc. A. 106, p. 138, Prof. McLennan and Dr. Shrum give results showing that they have been able to produce the same luminescence effect in solid nitrogen which I discovered in January last and foretold in my earlier papers on the auroral spectrum. In their discussion of the results, however, they come to the conclusion that this effect is not applicable to the auroral spectrum.

In order to meet the argument put forward it would indeed be sufficient to refer to my previous publications,[1] from which it appears that the conclusions drawn by McLennan and Shrum are contrary to observed facts; but as their paper might give the impression that they had found new facts which disproves my interpretation of the auroral spectrum, and as their paper also, in my view, contains some other errors, a few comments upon it seem to be necessary.

First of all, it should be made clear that our difference of opinion does not originate from a difference with regard to experimental facts. As already mentioned in my previous papers, the luminescence of solid nitrogen shows two bands in the green, called N_1 and N_2. While N_2 has the appearance of a single diffuse line, N_1 has the form of a band showing three maxima, one strong ($\lambda=5555$) and two weak ($\lambda\lambda=5611$, 5649). McLennan and Shrum find the same two bands and with the same structure. For the three maxima of N_1 they give the wave-lengths 5556, 5617, 5654, in good agreement of my own values. The band N_1 extends on both sides of the auroral line (5577); but this line does not coincide with any of the maxima of the band N_1.

Now McLennan and Shrum *regard the three maxima of the band N_1 as ordinary spectral lines with a definite wave-length*, and, as the auroral line does not coincide with any of them, they regard it as proved that the band N_1 has nothing to do with the auroral line. The matter, however, is not so simple, and these two investigators do not seem to have realised that we are dealing with a light effect of a peculiar type. Their conclusion, which usually would hold for spectral lines originating from a gaseous source, is not valid for the light effect in question, which is emitted from matter in the solid state.

As a matter of fact, I have been able to show that this light effect is attached to some special crystal structure of nitrogen and that *the maxima of the band N_1 have no definite positions, and hence they cannot, as is done by McLennan and Shrum, be treated as ordinary spectral lines.*

My view is that the band N_1 is a manifestation of the same effect as that which is responsible for the auroral line, which is to be regarded as the limiting aspect of this band when the particles are reduced to molecular order of magnitude. The correctness of this view is strongly supported by the results of my experiments with mixtures of nitrogen and argon.

So long as we are unable to reproduce the conditions of the upper atmosphere, we cannot apply to the band N_1 the ordinary spectroscopic method of identification by means of exact wave-length measurements. It is possible, however, to test the correctness of my view by taking into account the whole auroral spectrum and by drawing evidence from the various cosmic phenomena connected with the upper atmosphere, and—as will be seen from my papers—my conviction of the correctness of my interpretation of the auroral spectrum is gained in this way.

In dealing with the auroral spectrum we must, above all, take into account the type and the intensity distribution of the lines. The error which we find in so many earlier attempts at interpretation is that due attention has not been paid to the *spectrum as a whole*. In spectral tables a number of lines were found, which, within the limits of possible errors, coincided with auroral lines, regardless of the question as to whether the lines so picked out formed a connected physical system and could exist as a light effect from one single source. We should not only consider the lines which actually appear in the auroral spectrum, but also regard those, often equally important, which *are not present*. Now solid nitrogen bombarded with cathode rays constitutes a simple physical system which just gives the most singular type of spectrum which is found for the auroræ, and also explains the predominance of the auroral line. McLennan and Shrum suggest that the experiments show that N_2 ought to come out stronger in the auroral spectrum than it actually does. This, however, is not so, for, as my experiments show, N_1 may be made to dominate the whole spectrum, and, under the conditions existing in the upper atmosphere, we should from my experiments expect the auroral line 5577 to be quite predominant as compared with 5230.

McLennan and Shrum are also mistaken in regard to their interpretation of the luminescence from solid argon. Thus their statement that they have found a phosphorescence with an afterglow in pure argon is not in accordance with my experiments. The green afterglow usually observed was shown to be due to minute traces of nitrogen, and the phosphorescence line was identical with N_2. Further, they regard the strong diffuse line 5607 as an argon line; but this line is no doubt the same as 5604 of my experiments, and this line was shown to be the N_1 band of nitrogen in a somewhat different position and in a transformed state. The correctness of my view was evident from the analysis of the light effect from mixtures of argon and nitrogen of varying concentrations.

Also the view taken by McLennan and Shrum with regard to the physical conditions for producing the N_1 band is contrary to my observations, details of which will be found in my papers.

In conclusion, it is perhaps worth while to suggest that differences between McLennan and Shrum's observations and my own may be partly due to the fact that their experimental material was very limited, and that their arrangements made it difficult to overlook the experimental conditions and to vary them in a known way. Instead of bombarding a layer of solidified gas with a well-defined bundle of electric rays—as was done in my experiments—they have formed the layer on the walls of the discharge tube itself, which was wholly surrounded with the cooling liquid.

L. VEGARD.

October 15.

[1] Proc. Roy. Akad. Amsterdam, 27 *C.R.* 178, p. 1153; 179, p. 35, and p. 157. NATURE, vol. 113, No. 2846, p. 716, and vol. 114, No. 2862, p. 357.

Interpretations of Primitive American Decorative Art.

MY friend Mr. G. C. Robson, the gifted malacologist of the British Museum (Natural History), has taken me to task in NATURE of September 13 over the interpretation of the Mayan sculptures which I ventured to make in the issue of August 2. Writing as a zoologist he has censured my communication more leniently than I should have done were I criticising it from the same point of view.

Mr. Robson avers that I am inaccurate in stating that in the argonaut and the Bathypolypus the two central arms are often so closely apposed as to appear a single very broad tentacle. During the writing of my communication (in April last) I examined and roughly sketched, both in the Reading Room and in the Mollusca Gallery of the British Museum, drawings and specimens of various Cephalopoda. I am to my regret unfortunately unable to give him, as I should like, specific references to these sources of information, as they have been destroyed, and being now invalided to my room, I am precluded from visiting London to re-examine them. Mr. Edge-Partington, however, well known for his album of primitive decorative art, with whom I have throughout discussed this question, agreed with me in seeing in my memoranda a broad trunk-like tentacle by the apposition of two others. If memory serves, my note on the argonaut was made in Mr. Robson's gallery at South Kensington. I am not a malacologist, and my assignation of the tentacles to a "central" position is doubtless (since Mr. Robson says so) morphologically inaccurate; but that has little or no bearing on the identification of the *motif*.

Mr. Robson nevertheless admits that the Manabi slab "looks like a conventionalised squid," but he asks: If a squid, why eight arms? And what is the meaning of the tufts on the mantle and of the circular ends of the arms? My friend has gone astray in looking too malacologically at these Mayan designs. He forgets that the Central American sculptor did not work on a zoological subject for exhibition at the R.A., or for a scientific diagram. He was a *decorative* artist with extensive spaces to adorn, while his chief aim was to depict gods of terrifying aspect.

I remember well, when a boy, searching on a beach of the North Sea for upcast treasures after a gale, the finding of a creature unknown to me, whose enormous immobile eyes and long arms studded with suckers made a lasting impression on me, and especially my astonishment when, on dissecting it, a parrot's beak was prominently disclosed which I concluded the creature had choked upon! If I were now, after sixty years, asked to sketch my recollection of this "cuttle-fish," the serpent-bird panel from Tikal (Fig. 2 of my letter August 2) would closely fit my impression of my first cephalopod. The Mayan sculptor had perhaps recalled, in his work, a vivid and more terrifying experience with one or other of the monsters of this family, or he may not improbably have worked on lines handed down to him from ancestor artists who knew such a creature too intimately.

In my letter of August 2, in trying to look at the sculptures through the Mayan artist's eyes, I made suggestions as to features of more than one cephalopod family to fix the true basis of his *motif*. None of the Mayan designs represents any one species, but here one and there another suggestion from different groups seems incorporated in the artist's scheme, but the *motif* of them all—not only of those I alluded to in my letter, but of numerous decorative designs on structures, to which space did not allow me to allude on August 2, throughout ancient Mexico—is in my opinion based on members of the Cephalopoda, incorporating likely enough the indigenous parrot, but none based on elephant trunks. The sculptor had to get in what impressed him most—eyes, tentacles, and especially prehensile suckers.

In the decorative craftsman's method of work it is of no consequence whether the arms are of the proper number, or the eyes, mouth, or suckers are anatomically correct as to position. He relied in his work on a "most generalised conception" as all primitive decorative artists do. He was not tied to anatomical details; he took from or added to his mental prepossessions as suited his space and his caprice; realism meant nothing to him. May I recall to Mr. Robson the frigate-bird design in New Guinea. "One may see designs," as Mr. Henry Balfour very aptly words it (*Journal Soc. Arts*, 1896), "representing the frigate-bird in all stages between very fair realism and complete conventionalism—tending towards a purely meaningless pattern whose resemblance to a natural object has entirely ceased. . . . *The tendency is for the more important portions of a symbolic design to persist while the rest may disappear*" (my italics).

A still more suggestive example is that figured by Mr. Edge-Partington in *Man* (1902, 17), where a lizard (or other animal) is carved realistically moving on its legs with its tail coiled in a spiral; but later we find the design on a large panel degenerated to a conglomeration of spirals overspreading it, and wherever a vacant space—so abhorred by decorative artists—occurs too small for spirals, it is filled in by an endless series of the animal's legs. The cephalopod design in Mexican decorative art—of the Stela B period—was approaching the same stage as these frigate-bird and lizard designs. The tentacles and suckers—the most important portions of the symbolism—were repeated wherever they could be inserted. The Mayan artist, however, did not, as Mr. Robson suggests, throw "the structure of his model entirely to the winds," for the designs in the lower register at each corner of Fig. 3 (letter of August 2)—which of course is only half the panel—and especially the design on the back of Stela B, Fig. 7, are realistic cephalopods which I leave Mr. Robson to name. What relation can they possibly have to an elephant, and why introduced if they have no relation to that *motif*? And why are the coiled arms on Stela B, regarded by Mr. Robson as "structures that look like a tusk [of an elephant]," provided with suckers?

If in April I had possessed Prof. Elliot-Smith's "Evolution of the Dragon," I could have condensed considerably my letter in NATURE of August 2 (which rather taxed the valuable space at the disposal of the Editor), for I could have cited the extraordinarily illuminating figures (23, p. 172, and 24, p. 180) in that volume for pictorial support to my theme. In these pictures Mycenæan and Ægean potters, doubtless impressed, as were the American sculptors, with the staring eyes and the cusp-studded tentacles of cephalopods of their own seas, have pictured them in almost identically the same manner as the Copan sculptors have done. Mr. Robson will see there even circular ends to the octopus arms, about which he makes inquiry. He should also compare my Fig. 7 (August 2) with Elliot-Smith's Fig. 23 (*op. cit.*). "The position usually adopted by the resting octopus" which that author reproduces (after Tryon) on Fig. 22 supplies speaking suggestions for the cusp-studded tentacles surrounding the top of Stela B, of which two to fill suitably its front top edges, recalled from some gigantic species of the western seas, have been too confidently assumed to be elephant trunks.

Elliot-Smith's plates, 23 and 24, are interesting from another point of view. The Mediterranean artists have employed a strikingly similar method of representing the octopus as the Mayan quite *independently* of each other, and at two far separated localities. This fact gravely invalidates the moral pointed by the dogmatic sermons of Prof. Elliot-Smith and his disciples, if I understand them, that without contact no two minds have ever independently "brought forth similar products whether in social organisation, religion, or material culture." In Egypt "and nowhere else" did inventions originate! It is surprising that with his own plate 23 before his eyes Prof. Elliot-Smith failed to recognise the clue to the riddle of the Mayan indigenous symbolism, but wildly stumbled on so exotic a *motif* as a mahouted elephant's trunk in America.

HENRY O. FORBES.

Deanway, Beaconsfield, Bucks.

Active Nitrogen.

PROF. R. T. BIRGE states in his letter appearing in NATURE of November 1, p. 642, that "active nitrogen was discovered in 1900 by Prof. E. P. Lewis, . . . and was found by him to have a characteristic spectrum."

I dislike discussions about priority, but can scarcely avoid pointing out that the expression "Active Nitrogen" was coined by me to express the facts which I discovered in 1911—namely, that a stream of nitrogen in a peculiar state is able to react in the cold with certain metals to produce nitrides, with carbon compounds to form hydrocyanic acid, and so on. This was established by purely chemical methods. The luminous phenomena which gave the clue to this discovery were described by Prof. E. P. Lewis, and I was careful to make due reference to his work.

RAYLEIGH.

Terling Place, Chelmsford,
November 5.

The Mass-spectra of Cadmium, Tellurium, and Bismuth.

I HAVE now succeeded in obtaining and analysing the mass-rays of cadmium, tellurium, and bismuth. By the use of an anode containing cadmium fluoride, rays were obtained which, though feeble, gave satisfactory results with long exposures and the most highly sensitised schumannised plates. Cadmium is a very complex element, having six isotopes: 110 (c), 111 (e), 112 (b), 113 (d), 114 (a), 116 (f). The last is isobaric with the lightest isotope of tin. The intensities of the lines are in the order of the letters and agree reasonably with the chemical atomic weight 112·41. The most striking characteristic of the group is its remarkable similarity to that of tin. If we except the heaviest isotope of tin (124), which does not seem to have its counterpart in cadmium, the intensity relations between the isotopes of the two elements appear almost identical. This is a most suggestive fact and may have a deep significance in connexion with the relative stability of the nuclei of isotopes. The plates are not very favourable for accurate determinations of masses, but these seem integral with that of iodine.

The line of the latter element was extremely faint in these experiments, so I considered it a favourable opportunity to make another attempt on tellurium, which had defied all attacks during the earlier discharge tube work. A little pure metallic tellurium was ground into the anode mixture and success was at once obtained. Tellurium gives three lines of mass numbers—126, 128, 130. The intensities of the two latter appear about equal and double that of the first. I have repeated this result with an anode containing tellurium and lithium fluoride, and have no reason to doubt that these are all genuine isotopes. Comparison with other lines on the plates suggests that their masses may be less than whole numbers by one or two parts in a thousand, but it seems probable that the mean atomic weight is actually greater than 128, whereas all the later chemical determinations are less than that figure, the accepted value being 127·5. The element tellurium is unique among those so far analysed, as it seems probable that *all* its mass-numbers form members of isobaric pairs. These are shared by xenon, the element of next higher even atomic number.

The boiling-point of tellurium is not very different from that of bismuth, so that it seemed possible that the latter might yield to the same treatment. This hope was realised with an anode containing metallic bismuth, and a single line appeared in the expected position—209. This line is very faint, and owing to the great mass lies in an unfavourable part of the plate, but there seems no reason to doubt that bismuth is a simple element of mass number 209, as recent determinations of its atomic weight suggest.

F. W. ASTON.

Cavendish Laboratory, Cambridge,
November 4.

Need for the Redetermination of the Atomic Weights of Uranium, Thorium, and Radium.

IT is known that the atomic weights of such radio-elements as have been determined experimentally agree approximately with those to be expected on radioactive theory, and also that small unexplained discrepancies appear when the actual instead of the approximate values are considered. The simplest explanation of these small discrepancies is, I think, that one at least of these determinations is wrong, and I give reasons below for this view in the hope that someone versed in atomic weight work will make fresh determinations of the masses of the elements concerned.

The following are the experimental values of the atomic weights to be discussed: uranium, 238·18; thorium, 232·15; radium, 225·97; radium Ω', 206·04; thorium Ω, between 208·0 and 208·2. If the atomic weight of radium Ω' be accepted as 206·04, that of radium should be 226·08 and that of uranium 238·09, assuming that the α-particle has a mass of 4·00, and allowing for the loss of mass due to the energy of the expelled particles. Each of these values is nearly 0·1 different from the experimental values. If the allowance for the loss of mass be neglected, the calculated value for radium is within the error of the experimental value, but the calculated value for uranium is 0·14 smaller than the experimental. Several workers, including the writer, have preferred to accept this second view and to explain the discrepancy between uranium's calculated and experimental values by assuming the existence of an isotope with a greater mass than that of uranium. The new contribution to this discussion is that this will not account for the discrepancy. Such an isotope would reveal itself by its product, and it is now known that the experimental evidence, while favouring the existence of this isotope, is against its concentration in ordinary uranium to an extent that would raise the mean atomic weight more than 0·03. The close relation between groups of radioactive isotopes and those of inactive elements, lately pointed out by the writer, leads also to this view. It would therefore appear that if uranium's atomic weight is 238·18 the mass of uranium I is at least 238·15. This implies that in the transformations between uranium I and radium Ω′ a mass of 0·11 is lost in addition to the mass of the eight α-particles expelled. Whatever be the reason for this, it is probable that this small mass would be lost gradually, *i.e.* that ionium's mass would be about 230·13, radium's mass 226·11, and so on. This suggested value of radium's mass is greater than the experimental value by 0·14.

If the atomic weight of thorium is 232·15, this is also the actual mass of the radioelement thorium, for any existing or possible isotopes of greater mass-number are or would be β-ray bodies, and therefore of periods so short that their concentration in ordinary thorium could not affect measurably the mass of the principal constituent. The work of Prof. Joly on thorium haloes established in 1917 the absence of any very long-lived isotope of thorium, and confirms from an independent source this view. On present atomic weight evidence, then, there appear to be two bodies the masses of which are in excess of integers by about 0·15. So far mass-numbers in excess of integers have not been found by Dr. Aston among inactive elements. The mass of thorium Ω is uncertain to about 0·2, owing to the fact that no pure specimen of this isotope has yet been isolated.

The value of thorium's mass need have no bearing on those of uranium and radium, since thorium is a member of an independent series, unless we choose to assume that the rule discovered by Dr. Aston for the isotopes of several elements and, in particular, for those of tin, applies to the radioelements also. This rule is that differences in the masses of isotopes are approximately integral even when the masses themselves are not. Applied to thorium and ionium, it suggests the latter's mass is 230·15 if the former's mass is 232·15. This leads to masses of 238·15 and 226·15 for uranium and radium respectively. The former is within the experimental error of the accepted atomic weight, the latter is 0·18 too high.

It is, of course, obvious that there are too many uncertain factors at present to justify basing any conclusions upon these small differences. But there is a *prima facie* case, I hope I have shown, for the need of a redetermination of the atomic weights of uranium, radium, and thorium.

A. S. RUSSELL.

Dr. Lee's Laboratory,
Christ Church, Oxford,
October 22.

A New Drift Indicator.

IN connexion with research on fishery problems many investigations have been undertaken to throw light upon the water movements in the North Sea and other areas.

Schematic pictures of the current regime have been obtained in various ways, for example, by studying the isohalines of salinity distribution charts, by making direct observations of the currents by means of various instruments (current-meters, log-ships, etc.), and by setting adrift floating objects and noting where they are recovered. Each method has its obvious merits and demerits, but, when all things are considered, the use of drifting objects (usually bottles containing questionnaire papers) yields, without doubt, the most useful results for the purposes of those engaged in fishery research. The bottles are put out at a selected position, and the charting of the places where they are recovered is a relatively simple matter. The information obtained is very valuable, but it does not give the actual set away from the position of liberation.

Attempts to estimate this by means of current meter observations necessitate the computation of the residual current after the elimination of the tidal stream values from the observational data, and, in order to obtain any trustworthy knowledge of the residual currents as a result of direct measurements, a considerable amount of data is absolutely necessary. Moreover, the resulting calculations are very laborious —at any rate this is the case with any instrument known to me.

An attempt has recently been made at this laboratory to devise an instrument which will yield the necessary information as to residual currents without exhaustively intensive measurements or laborious calculations. The instrument combines certain features of the well-known Ekman current meter with others of the Robinson anemometer (Fig. 1).

A set of cups which rotate when the instrument is lowered into the sea, are connected through certain gearings with an arrangement which releases phosphor bronze balls from a hopper, and allows the balls to roll down a groove on a specially shaped pivoted magnet and so into a divided chamber. This chamber during the course of observations is orientated according to the current—the whole instrument being kept "in the current" by means of a vane on the cylinder which encloses the working parts. The hopper may hold many thousands of balls. The instrument which has been tested has been found to use about 700-800 balls per diem.

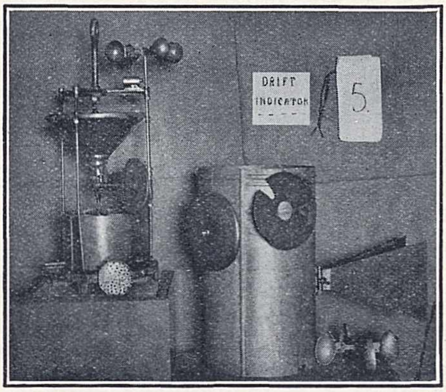

FIG. 1.—Drift indicator. To ensure that the instrument shall remain vertical when suspended in a tideway, the vanes are now shipped at the top of the cover and their after end is provided with an inclinable plane which enables the desired object to be effected.

I am indebted to the Elder Brethren of the Trinity Corporation and to their Superintendent of the Great Yarmouth depot (Capt. G. T. Thompson) for the opportunity of carrying out the necessary tests on the St. Nicholas light-vessel which is situated about $1\frac{1}{4}$ miles off Great Yarmouth. The instrument can be worked quite well by the personnel of a light-vessel, and the results given below were obtained when the indicator was left down for 24 hours in the charge of the mate of the lightship named (Mr. T. Jay).

The sectors in the divided compartment (Fig. 2) are 20°, and the figures denote the numbers of balls in the various sectors.

The use of ordinary traverse tables enables one easily to resolve the values (numbers of balls) along the four cardinal directions and to find the magnitude and direction of the residual current if the "mileage value" of the balls be known. Calibration against log-ship observations showed that 24 balls were dropped for each mile of water that passed the ship. The necessary calibration was not an easy matter at the time of the test. The movements of the ship at the time were not such as would allow the instrument to be kept near the surface without the risk of it being over-ridden and damaged. It was therefore used at a depth of about 7 fathoms. The log-ship time gave the rate of the surface stream, which rate was assumed to be also that of the water at 7 fathoms depth (though only pending further opportunities of testing the instrument near the surface).

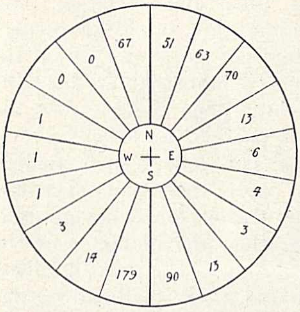

FIG. 2.—The distribution of balls in the compass box after a test of 24 hours ending 10.25 A.M., October 18, 1924.

Since the rate at the depth worked is certainly less than at the surface, it follows that the conversion factor used (24 balls per mile) is too low, and that the magnitude of the residual current calculated is too high, although the direction is correct.

The above data yield the following approximate maximal value for the residual water movement or drift:

$4\frac{1}{2}$ miles per 24 hours in the direction S *ca.* 50° E. mag.

This drift indicator can be adapted to drop balls with varying frequency, and it can be left down for a length of time depending upon the size of the hopper chosen. Improvements in shape and size are to be carried out, and it is hoped that it will be possible to add considerably to our present knowledge of the water movements in areas of interest.

J. N. CARRUTHERS.

Ministry of Agriculture and Fisheries,
Fisheries Laboratory, Lowestoft.

The Resonance Theory of Hearing.

IN reference to the recent letters of Prof. Scripture and Mr. J. Keen which have appeared in NATURE under the above heading, it seems to me that the opponents of the resonance theory rely rather too much on the assumed inherent absurdity of the theory. It is a theory which has been, and is, held by a considerable number of people whose judgment in the matter is deserving of, at all events, some consideration.

In drawing analogies from the other sense organs, Mr. Keen should bear in mind that the nature of the analysis required of them to furnish accurate information to the brain is different for each sense. To say that the retina does not analyse white light into its constituent colours is to assert what is by no means proved. It is certainly true (fortunately for our vision) that the retina does not separate these constituents of white light spacially, but that an analysis of the waves of light according to frequencies does occur is an assumption essential for the explanation of colour vision. It is generally believed that this analysis takes place in the retina and not in the brain. The analogies between tone analysis by resonance and colour vision may indeed be carried much further.

Mr. Keen's example of the senses of heat and cold seems scarcely applicable. Here temperature represents intensity, and is perceived as such. Intensity is, of course, an attribute of all sensation.

The recognition of the basilar membrane as a resonating organ is based on the regular gradation of the differentiation of its parts for length, tension, and mass, between very wide limits. So marked is this gradation, that there is no inherent absurdity in the belief that it is sufficient to account for a range of action corresponding to the audible scale, say eleven octaves. The elaboration of this differentiation is unexplained either by the telephone or the pressure pattern theory. Indeed, the differentiation that one recognises in the cochlea is sufficient to preclude entirely the possibility of such "simple" modes of action. It is better to explain the function of an organ in terms of what is actually present than to devise theories as to how it may act in spite of what is known of its structure.

GEORGE WILKINSON.

Polarised Light and Starch Content of Plants.

NEARLY two years ago (NATURE, January 13, 1923, p. 49) I was able to describe the acceleration of hydrolysis of starch under polarised light *in vitro*. It may be of interest to record that I have succeeded in confirming these results in the living plant.

Under artificially polarised light, the starch in the plastids, both in the guard-cells and in the leaf-tissue, has been shown to diminish, and the appearance in its place of a reducing substance has been demonstrated. In ordinary sunlight the starch content was increased, and in darkness the quantity remained unchanged. It is hoped to publish a full account of these experiments in the near future.

I wish to express my thanks to Prof. Neilson Jones, and to Prof. Lloyd, of McGill University, for helpful advice and criticism; also to the latter for kindly placing the facilities of his Botanical Department at my service, thus enabling me to benefit by the blue skies of Canada.

E. SIDNEY SEMMENS,
Amy Lady Tate Scholar of
Bedford College, London.

The Forces which lift Aeroplanes.

PROF. BJERKNES, in his Royal Institution lecture (NATURE, September 27, p. 472; October 4, p. 508), introduces the phenomenon of "acoustic repulsion" before going on to the accepted circulation theory of aeroplane lift. Both these are discussed in Rayleigh's "Collected Papers," Nos. 52 and 53 respectively; "Note on Acoustic Repulsion" (*Phil. Mag.*, 1878, also 1902, 1905), and "On the irregular Flight of a Tennis Ball" (*Mess. of Maths.*, 1877).

The former paper shows that the mean pressure in the interior of the cavity of a resonator is in excess of the external atmospheric pressure by the essentially positive quantity $(2\gamma t)^{-1}\int(p_1/p_0 - 1)^2 dt$. The latter establishes, for the first time, the relation, Lift = Circulation × Velocity, a quantity which may be either positive or negative.

There does not seem to be any very close analogy between the two phenomena.

A. R. LOW.

London, October 25.

The Technique of Contraception.

I VERY much value the discriminating and appreciative review by Sir Archdall Reid in NATURE of October 25, p. 601, of my book "Contraception (Birth Control), its Theory, History and Practice."

About the general technique of contraception, Sir Archdall is so kind as to say: "Dr. Stopes's experience . . . is so extensive that her opinions must necessarily carry weight." For this reason I must beg the courtesy of your space to correct his criticism that my views on cervical interlocking are a "belief." On the contrary, they are based on direct observation at the Clinic of more than forty cases. Further details will be given in the report on the first five thousand cases at the Clinic, which we are at present preparing.

MARIE C. STOPES.

Givons Grove, Leatherhead, Surrey,
November 6.

Dust in the Atmosphere.

IT is to be hoped that the publication last year of the collected works of John Aitken has led many physicists to renew their acquaintance with his writings. The main features of his work are widely known, but it is not so generally recognised that on a number of points which are still obscure, he has many suggestive observations. In 1880, without knowledge of the earlier work of Coulier, Aitken discovered the nuclei of cloudy condensation in the atmosphere. For nearly forty years he continued to make observations on these nuclei, which he generally referred to as "dust." He devised and constructed various forms of dust-counter,

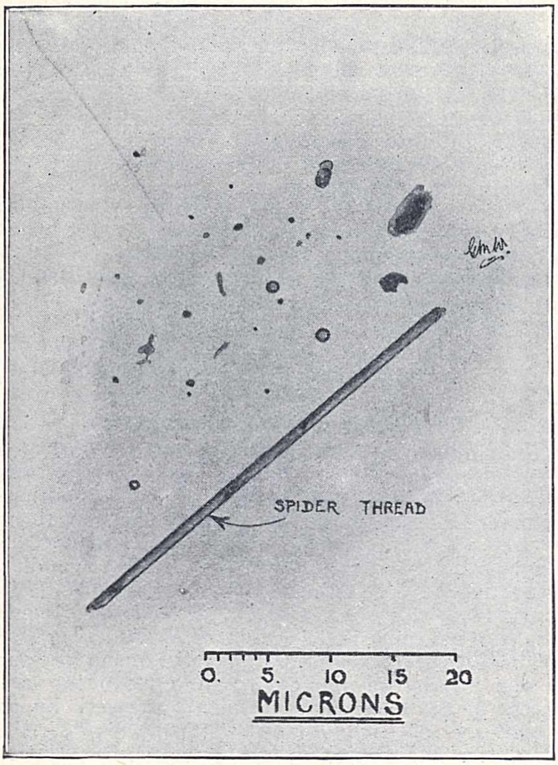

FIG. 1.—Typical smoke fog particles compared with a portion of an ordinary spider's web.
Reproduced, by permission of the Controller of H.M. Stationery Office, from the Ninth Report of the Committee for the Investigation of Atmospheric Pollution.

all characterised by ingenuity and mechanical skill of a high order, but most of them somewhat difficult of successful operation by any but the expert hand of the inventor. In his later years, writers on "large ions" caused him some uneasiness. He feared that the rôle of nuclei of cloudy condensation was being taken from his dust particles and attributed to some bodies of an electrical origin. But this fear was unfounded; what was suggested was that a certain number of Aitken's nuclei are charged and that these are the large atmospheric ions discovered by Langevin.

If this identification is correct, and it can scarcely be doubted, then we possess a considerable amount of information about Aitken's nuclei. His own work gives copious observations of the number of these bodies found under different conditions, while the experiments on large ions give us some clue as to their form and constitution. We may first note the very high values for the concentration of nuclei found by Aitken. In cities such as London, Paris, and Glasgow, he obtained values of the order of 100,000 to 400,000 particles per c.c. In the pure air of the Scottish Highlands and in Switzerland his values frequently came down to a few hundred per c.c., but even on the Rigi Kulm he has observations of more than 15,000. The electrical observations on large ions suggest that the particles are, for the most part, of uniform size. If it be assumed that in the atmosphere each nucleus does not normally carry more than one electronic charge, and there is good reason for believing that this assumption is correct, then the diameter of the nucleus should be about 10^{-5} cm. The great numbers in which these bodies are found, their small and regular size, and the fact that they are produced so copiously from such a source as a Bunsen flame, suggest that they are not dust in the ordinary sense, that is, not irregular fragments of solid matter. Their behaviour and the manner in which they are produced indicate rather that they are spherules of water, each formed about some kind of primary nucleus, very often of a hygroscopic character. Assuming that the greater number of Aitken's nuclei are so constituted, in what form does the grosser mechanical impurity exist in the atmosphere? The answer will be found in the very interesting report of the Advisory Committee on Atmospheric Pollution referred to below.[1]

Three methods of estimating atmospheric impurity, representing successive stages in the development and improvement of methods of observation, have been employed by the Committee. In the method longest in use, the material precipitated by rain or otherwise on a standard area is collected. The monthly deposit is measured and analysed as soluble and insoluble, tarry, carbonaceous, sulphate, chloride, etc. The original gauges employed for this purpose were made of enamelled iron and did not prove resistant to atmospheric action. A new pattern constructed of stoneware has been employed and found satisfactory. It appears from the report that in the year which ended on March 31, 1923, there was a distinct improvement in the purity of the atmosphere as compared with the average of previous years. At 23 stations out of 27, the total solid deposited was lower than the normal, while the rainfall on the whole was about average. It is interesting to note that, comparing the deposit of chlorine in summer and winter, 19 stations show a higher figure for winter. This is in accordance with the view that the chlorine in the atmosphere is derived from sea-spray, the rougher seas in winter furnishing greater quantities of spray.

In the second method of observation, an automatic record is obtained on a sheet of filter-paper of the dusty impurity of the air by Dr. Owens' apparatus. From two to four samples of dust can be obtained per hour, and thus the variation in the impurity of the air can be followed through the twenty-four hours.

[1] Meteorological Office: Air Ministry. Advisory Committee on Atmospheric Pollution. Report on Observations in the Year ending March 31st, 1923: Forming the Ninth Report of the Committee for the Investigation of Atmospheric Pollution. (M.O. 260.) Pp. 59. (London: H.M. Stationery Office, 1924.) 4s. 6d. net.

Some striking records are obtained by means of this instrument. At night the air is very pure. In the early morning, earlier in summer than in winter, the pollution recorded at the London stations increases rapidly, maintains a fairly high figure during the day with indications of a subsidiary minimum about 3 o'clock, and then falls off in the late afternoon. Here we note a distinct difference between the true dust and the Aitken nuclei. It does not appear that either Aitken or Barus, who did much work on the subject in America, took records of nucleation during the night. But it is clear from the observations of M'Clelland and Kennedy in Dublin that the large ions, that is, the charged fraction of the nuclei, are not noticeably fewer at night than during the day. Apparently the relatively large particles of true dust coagulate rapidly and are quickly deposited. The nuclei of Aitken are more persistent, but it is nevertheless surprising that, when their production has ceased, and when the air is being renewed rapidly on windy nights, they should not show a marked decrease. The dustiness shown by the automatic recorders in London is greater in winter than in summer and greater on foggy than on clear days. While in summer the atmosphere is cleaner on Sunday than on other days, there is no difference during the winter. The inference is that the greater part of the pollution in London is due to ordinary domestic fires. The same result is found to hold for the residential districts of Glasgow.

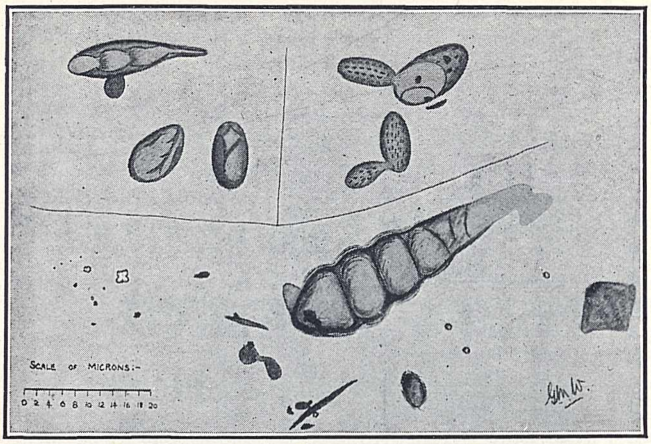

FIG. 2.—Organic particles of definite structure, collected from the air of Cheam, Surrey, on January 29, 1923, by means of the jet instrument.
Reproduced, by permission of the Controller of H.M. Stationery Office, from the Ninth Report of the Committee for the Investigation of Atmospheric Pollution.

Much the most interesting part of this report is the record of results obtained with the jet dust counter. With this apparatus, the impurity in a limited quantity of air, say 50 c.c., is thrown on a glass slide, where the particles may be counted and scrutinised microscopically. The dust consists largely of irregular particles of a crystalline character, but occasionally organic bodies of a definite structure are found. A good idea of the appearance of the dust may be gathered from the illustrations, some of which are here reproduced (Figs. 1-3). The particles are of various sizes from 1 or 2μ down to the limit of visibility. A puzzling feature of some of the samples obtained has been the presence of transparent spherical bodies, for the origin of which no satisfactory explanation has as yet been obtained. Crystals of sodium chloride have been found in the air near the sea-shore, and other hygroscopic crystals have occasionally been recorded. The total number of particles found is surprisingly large considering the character of the material, but small compared with the number of nuclei found by Aitken. For example, an average figure for London would be about 10,000 dust particles per c.c. The average number of condensation nuclei is about ten times this figure. If the ultra-microscope could be employed, as has been done with success in the examination of smokes, no doubt a considerable number of particles which are beyond the optical limits of the present method would be detected. But as, according to de Broglie, the ultra-microscope fails to show up the large ions, we can scarcely anticipate that any optical method will disclose the bulk of Aitken's nuclei.

Now it is not at all clear that the Aitken nuclei may not have effects in some respects more important than those of the visible nuclei. For example, the connexion between the concentration of nuclei and haze was pointed out by Aitken. Some part of the reduction in visibility in polluted air may be due to scattering by the large numbers of nuclei. Again, in the phenomena of atmospheric electricity dealt with recently in these

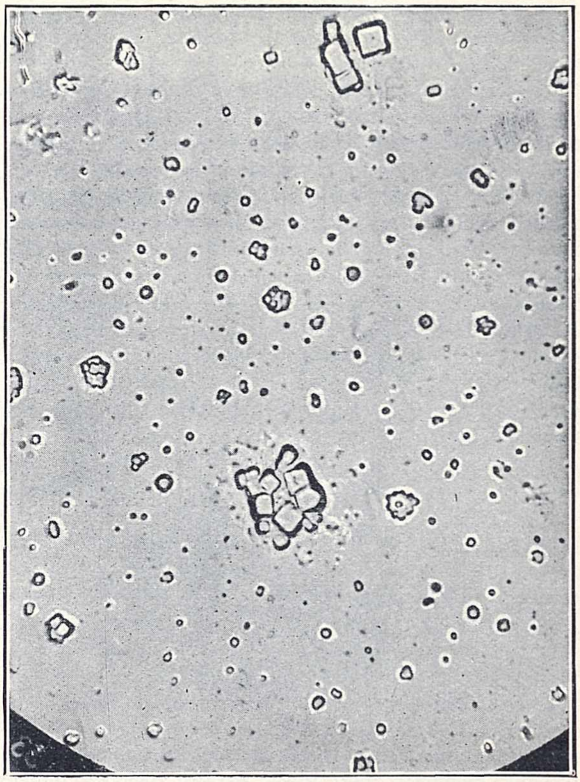

FIG. 3.—Record of suspended matter from the air in Algarve, Portugal, taken on a hot, sunny day. The particles consist mainly of crystals of common salt. Photograph. Magnification 1000 diameters.
Reproduced, by permission of the Controller of H.M. Stationery Office, from the Ninth Report of the Committee for the Investigation of Atmospheric Pollution.

pages by Dr. Chree and others, the nuclei, owing to their large numbers, have possibly a greater effect than the visible particles.

The effect of impure air on visibility has been investigated by the Committee and two photometric methods of measuring the obstructive power of polluted air have been perfected. Approximate proportionality has been established between the light obstruction and the quantity of pollution present as measured by the filter and jet methods. But the Committee finds that "some factor other than the simple obstruction of area of the light source is responsible for the loss of light in passing through the air." It might elucidate this point and help to a fuller examination of the whole problem of contaminated air if observations of the total condensation nuclei were taken after the manner of Aitken. It would be unsafe to assume a proportionality between the visible dust and the nuclei. Many sources of large particles may yield few nuclei and certain rich sources of nuclei, Bunsen flames, for example, may be expected to give few large particles. In this connexion the writer noticed some months ago that during a three weeks' gas-strike in Dublin, the number of large ions was much below the normal. Irregular variations are so common that it may be difficult to decide if the reduction is a genuine effect unless a further opportunity for investigation—otherwise undesirable—should present itself. The Committee has already achieved such a high level of success in the development of methods of observation and in the perfecting of instruments, that if it can be induced to undertake the observation of condensation nuclei, those of us who are interested in atmospheric nucleation may expect to see instruments developed of a far higher standard of efficiency than those available at present.

It should be stated that the automatic dust-recorder and the jet dust counter are now in use in many countries. They are available for purchase, and full instructions for their operation can be obtained. There is no doubt that they will prove of great value in dealing with a multitude of problems relating to impure air.

The chief evil of a polluted atmosphere is not the æsthetic horror of the smoke canopy, the grimy buildings and the stunted vegetation. It is not even the inspiration of dirty air—and we learn from this report that in the course of twenty-four hours of a heavy smoke fog, the dweller in London breathes in 500,000,000,000 particles of suspended matter. The real crime is the cutting off of sunlight. We have yet to learn in detail how the impure atmosphere of cities operates to abstract those elements in sunlight which appear to be necessary for health, and we have yet to test the possibility of minimising the evil. Meanwhile it is to be hoped that the Committee on Atmospheric Pollution may be enabled to extend and develop the fruitful work it has undertaken.

J. J. NOLAN.

The "Terrella."

THE name "Terrella" appears to have been first used towards the end of the sixteenth century to describe a sphere of loadstone used as a miniature replica of the earth for the study of terrestrial magnetism. Seventeenth century writers mention terrellas fairly frequently but there are not many descriptions of particular specimens, and although considerable numbers must have been in use during the seventeenth century, very few indeed appear to have survived. Rounded loadstones had been used from very early days. Peregrinus, for example, in the thirteenth century, mentions a method of making them and of finding the poles, but he does not give any particular scientific use to which they could be turned.

It was not until Gilbert of Colchester, in the prosecution of his studies in magnetism, etc., found that a miniature of the globe constructed of a suitable piece of magnetic ore would be of great assistance in his researches, that the rounded loadstone of earlier investigators was developed into a more or less scientific instrument. Dr. Gilbert, early in his great work "De Magnete" (1600), gives details for the manufacture of an instrument "Called by us a Terrella," this being described as a "physical Corpuscle imbued with many virtues by means of which many abstruse and neglected truths in philosophy burried in piteous darkness may more readily become known to men."

Many chapters of "De Magnete" are wholly devoted to details as to manufacture, graduation and the experimental use to be made of the finished article. Chapter XVII., Book II., giving details of methods of arming to "increase the virtue" of the instrument, is of special interest in connexion with the three specimens to be described. In order to show the opinion of his successors the following extract from Sir Kenelm Digby's (1644) "Two Treatises, on the Nature of Bodies: and, the Nature of the Man's Soule is looked into" will be of interest—

"But to come to some experimentall proofes and Obseruations on the loadstone by which it will appeare that these causes are well esteemed and applyed, we must be beholdin to that admirable searcher of the nature of the loadstone, Dr. Gilbert; by means of whom and of Dr. Haruey, our nation may claim euen in this latter age as deserued a crowne for solide Philosophicall learning as for many ages together it hath done formerly for acute and subtile Speculations in Diuinity. But before I fall to particulars, I thinke it worth warning my Reader, how this great man arriued to discover so much of Magneticall Philosophy; that he, likewise, if he be desirous to search into nature, may, by imitation, aduance his thoughts and knowledge that way. In short, then, all the knowledge he gott of this subject was by forming a little loadstone into the shape of the Earth. By which means he compasses a wonderful designe which was to make the whole globe of the earth maniable; for he found the properties of the whole earth in that little body; which he therefore called 'Terrella' or 'Little Earth'; and which he could manage and trye experiences vpon att his will. And, in like manner any man that hath an ayme to aduance much in naturall sciences, must endeavour to draw the matter he inquireth of, into some such modell, or some kinde of manageable methode; which he may turne and winde as he pleaseth. And then lett him be sure, if he hath a competent vnderstanding, that he will not misse of his marke."

The following references to definite instruments may be found in seventeenth-century records.

1. John Evelyn, July 1655, in his diary mentions a "pretty terrella with the circles and showing the magnetic deviations."

2. Pepys under October 2, 1662, states he "received a letter from Mr. Barlow with a Terrella."

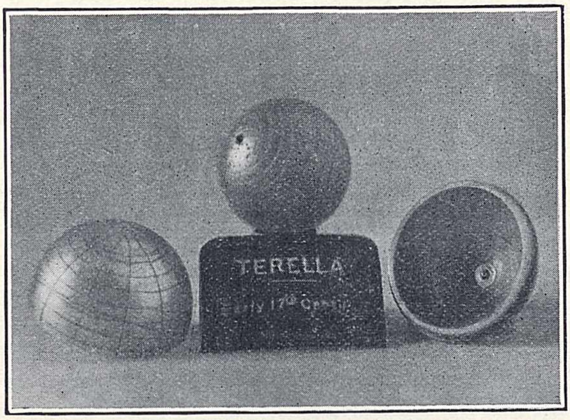

FIG. 1.

3. A terrella, $4\frac{1}{2}$ in. in diameter, was presented in 1662 by King Charles II. to the Royal Society.

4. In Grew's catalogue and description of the rarities belonging to the Royal Society, and preserved at Gresham College (London, 1681, p. 364), is mentioned a terrella contrived by Sir Christopher Wren with one half immersed in the centre of a plane horizontal table.

5. In Sir John Pettus's "Fleta Minor," London 1683, in the "Dictionary of Metallick Words" at the end, under the word "Loadstone" occurs the following paragraph:

"Another piece of curiosity I saw in the hands of Sir William Persal (since deceased also), viz. a Terrella or Loadstone, of little more than 6 in. diameter, turned into a Globular form, and all the imaginary lines of our Terrestrial Globe, exactly drawn upon it, viz. the Arctick and Antarctick circles, the two Tropics, the two Colures, the Zodiac and Meridian: and these lines, and the several countryes, artificially painted on it."

So far as can be ascertained, only three instruments which can be strictly included under the term "Terrella" can now be traced, and as all three are at present in the Admiralty Compass Department Museum at Ditton Park, a brief description of their characteristics and the little that is known of their history is possible.

1. *Compass Department Terrella.*—This is by far the most finished and efficient instrument of the three; in fact, it is the only one which might be termed a scientific instrument, and which carried out Gilbert's practice to the utmost. Its history prior to the early years of the nineteenth century is unknown, but then it hung as a curiosity in the shop window of the well-known compass makers, Messrs. Grant Preston, Barr Street, London, and is mentioned as being seen there in 1844. It came into the personal possession of Captain W. Mayes, R.N. (Superintendent of Compass Department), in 1887, and has remained in the Museum since that date.

General Description.—The instrument (Fig. 1) consists of three parts: (*a*) the terrella of highly magnetic ore 1·7 inch in diameter, (*b*) and (*c*) two brass hemispheres which when screwed together form the arming and casing. Great circles and parallels of latitude are engraved on both the sphere and its case, and a very special feature of the latter is the iron cap ($\frac{1}{3}$ inch in diameter) let into the north pole forming one piece with the projection inside; the efficiency of this arrangement in collecting the lines of force is obvious from the increased lift given below, and the results would probably be better if the pin and depression in the north pole of the terrella were not considerably worn and the fit therefore loose, and also if suitably designed weights were used. The small pin at the south pole appears to be simply intended to hold the sphere firmly in place. The terrella itself weighs $6\frac{3}{8}$ oz., and unarmed lifts $1\frac{3}{4}$ oz.; with the case in place, however, this lift is increased to $9\frac{3}{8}$ oz.

2. *Royal Society Terrella* (R.S. No. 80).—This is a roughly turned sphere of loadstone $4\frac{3}{8}$ in. in diameter, and marked with a cross at each pole. No method of arming is provided. It weighs 7 lb. $2\frac{1}{2}$ oz., and has a lift of 6 oz.

3. *Royal Society Terrella, 3 in.*—Sphere of loadstone (Fig. 2) slightly flattened at the south pole. Faint red markings show that meridians and equator have been roughly drawn. For "arming"—the sphere is loosely held between two iron cups joined by a silver bridge. It weighs 2 lb. $1\frac{1}{2}$ oz., and lifts when armed, 3 oz.

The summary of all the available information past and present on particular instruments is remarkably meagre, and, when it is considered that many must have been in use during the seventeenth century, it is surprising that more specimens have not survived in museums and private collections; it is possible that the publication of this short article will result in bringing to light a few more of these interesting instruments.

Dr. Gilbert's work evidently aroused the interest of many of the great investigators of his time, and there appears to have arisen a demand for "armed" loadstones as scientific curiosities which fetched high prices. Galileo especially brought their manufacture to a high pitch of perfection if the records of his achievements can be credited; his loadstones were not, however, terrellas, as is clear from the very interesting paper entitled "Galileo and Magnetism, a Study in Loadstones," by J. J. Fahie, published in the Journal of the Institution of Electrical Engineers, vol. 56, p. 246.

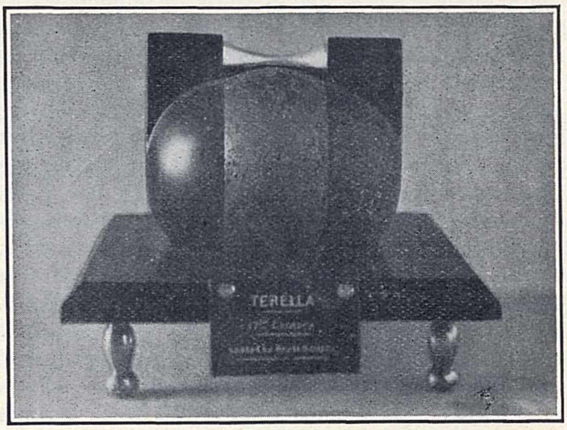

FIG. 2.

F. C.-O.

Obituary.

PROF. J. E. CREIGHTON.

NEWS reaches us from America of the death on October 8, after a long illness, of Prof. James Edwin Creighton, Sage professor of logic and metaphysic in Cornell University since 1895. The United States lose in him one of their most influential and deeply respected teachers. It is only a short time ago that Prof. Creighton's old pupils published a volume of essays in his honour. He was better known as a tutor and lecturer than as an author, though his "Introductory Logic" is widely used by students in Great Britain as well as in the United States. He was engaged on an important work, "The Rise of the Historical Method in Philosophy," when illness compelled him to set it aside. Outside his own university, he was widely known as editor of the *Philosophical Review*, one of the leading American journals devoted to philosophy, and representative of the idealist theories, also as American editor of "Kant-Studien."

Prof. Creighton was one of the founders of the American Philosophical Association, and its president in 1902 and 1903. He was a member of the permanent committee of the International Congresses of Philosophy and took great interest in the European meetings. It was one of his most ardent wishes to arrange an international meeting in the United States, and his death occurred just at the time when his Association is sending out its invitation to the VIth Congress to be held at an American University in 1926.

Prof. Creighton was born at Pictou, Nova Scotia, on April 8, 1861. He was educated at Dalhousie College, Halifax. The terrible explosion which occurred in that city during the War occasioned the loss of many friends and relatives, and he never completely recovered from the sorrow and shock which he suffered at that time.

H. WILDON CARR.

WE learn with deep regret that Sir Archibald Geikie died on Monday, November 10, at the advanced age of eighty-eight years. The world of letters as well as that of science has thus lost a leader of the highest distinction, whose work has had a profound influence upon intellectual progress and the advancement of knowledge. A few months ago (NATURE, July 26) we published an appreciative survey of his activities in a review of his autobiography, and in our issue of January 5, 1893, his portrait appeared in the NATURE Series of Scientific Worthies, with a sketch of his career by Prof. A. de Lapparent. It is unnecessary to mention now his untiring activities in scientific fields or the many academic honours which came to him, but we are voicing the thought of the whole scientific world when we say that his death leaves a blank in the lives of all who are stimulated by human achievement.

WE regret to announce the following deaths:

M. L. E. Bertin, for many years director of naval construction in France, and an honorary member of the Institution of Naval Architects, who, in addition to his technical studies, contributed to our knowledge of the theory of waves, aged eighty-four.

Col. H. D. Love, from 1880 until 1907 principal of the Civil Engineering College at Madras, who was also a student of Anglo-Indian history, aged seventy-two.

Mr. R. W. M. Thomson, assistant lecturer in chemistry at King's College, University of London, on November 5, aged twenty-five.

Current Topics and Events.

THE following is a list of those recommended by the president and council for election to the council of the Royal Society at the anniversary meeting on December 1:—*President:* Sir Charles Sherrington; *Treasurer:* Sir David Prain; *Secretaries:* Mr. W. B. Hardy and Mr. J. H. Jeans; *Foreign Secretary:* Sir Richard Glazebrook; *Other Members of Council:* Sir Frederick Andrewes, Prof. J. H. Ashworth, Dr. F. W. Aston, Sir William Bragg, Prof. S. Chapman, Sir Dugald Clerk, Dr. H. H. Dale, Prof. F. G. Donnan, Prof. A. S. Eddington, Prof. E. S. Goodrich, Sir Thomas Holland, Prof. J. B. Leathes, Prof. T. R. Merton, Dr. G. C. Simpson, Prof. J. F. Thorpe, and Prof. F. E. Weiss. The Earl of Crawford and Balcarres and Sir Otto Beit have been elected fellows of the Royal Society under the Statute which permits of elections on the grounds of conspicuous services rendered to science.

H.M. THE KING has approved of the following awards this year by the president and council of the Royal Society:—A Royal Medal to Sir Dugald Clerk for his application of scientific principles to engineering problems, particularly to the development of the internal-combustion engine; and a Royal Medal to Dr. H. H. Dale, for his researches in pharmacology and physiology. The following awards have also been made by the president and council:—The Copley Medal to Sir E. Sharpey-Schafer, for his valuable work in physiology and histology; the Rumford Medal to Mr. C. V. Boys, for his invention of the gas calorimeter; the Davy Medal to Prof. A. G. Perkin, for his researches on the structure of natural colouring matters; and the Darwin Medal to Prof. T. H. Morgan, for his valuable work in zoology, especially his researches on heredity and cytology.

MRS. TYNDALL, widow of Prof. John Tyndall, has made a donation of 500*l.* to the Royal Society to be used at the discretion of the Tyndall Mining Bequest Committee, as a fund to meet out-of-pocket expenses incurred by the Tyndall Research Student in carrying out his investigations. This gift is additional to the sum of 1000*l.* entrusted to the Royal Society in 1910 for the purpose of encouraging and furthering research in all matters pertaining to mining, including such questions as ventilation, temperature, diseases incidental to miners, and so forth. The income of the former gift is utilised to promote research relating to mining, and much valuable work has been done in connexion with the physiological condition of miners and their safety in mines.

THE art of radio communication continues to make marvellous advances. Amateurs have now established communication with New Zealand. To Mr. Goyder, of Mill Hill School (2SZ), must be given the credit of being the first to establish two-way communication with that country. Before 1923, there was a ban on amateur radio in New Zealand, but after that date two kinds of licenses were issued. Those who have a first-class license can use 50 watts for transmission; that is the power taken by an ordinary electric lamp. Those who have second-class licenses are restricted to 5 watts. To obtain a license it is necessary to pass an examination in theory, in the Morse code, and in the regulations. The reception of the signals in Great Britain is erratic. The signal strength is weak at the start, increases gradually, and finally fades away. The period of audibility is between 6.15 A.M. and 7.30 A.M., G.M.T. One interesting fact is that the only New Zealand stations heard are two in the town of Dunedin and one about fifty miles away. The stations in the North Island have not yet been heard in Great Britain.

IN communicating with the Antipodes, the radio waves must travel in both directions round the earth. It is probable that they interfere with one another, producing nodes and loops, and it is possible that the wave-lengths of the two sets of incoming waves may not be exactly the same. It is curious that the two-way working with New Zealand has apparently not been intercepted by any of the numerous workers in America. In the *Radio Review* for Nov. 5, Mr. Orbell gives an interesting account of the phenomena he noticed in a voyage from New Zealand. For example, the United States amateur signals were constantly heard. They reached a maximum strength about halfway across the Pacific, then reached a minimum when rounding Cape Horn. Finally, near Las Palmas in the Atlantic, they regained their maximum strength. The continent of South America seemed to screen them very efficiently. The amateurs of Great Britain and New Zealand are to be congratulated on having made a notable step forward in our knowledge. We venture to predict that short wave-length transmission will play a notable part in long distance transmission in the future.

THE Tokyo correspondent of the *Times* has given in the issue for November 8 an interesting account of the scheme for rebuilding the city. The old narrow alleys, down which no fire-engine could pass, are to be abolished, practically every street is to be widened, and there will be several entirely new main thoroughfares. The total area of all the widened streets will be nearly 13 square miles, but this includes one very large market and numerous parks and open spaces. To obtain the land required for these improvements, every owner is compelled to yield up to one-tenth of his present holding without compensation. Open spaces to act as refuges in case of fire are to be provided by building all the primary schools of the city within spacious playgrounds. It was proposed that there should be numerous small parks each with a pool in it to serve as an emergency water-supply, but this plan has been abandoned. Instead of this, some of the canals are to be widened and the water-mains are to be made, so far as possible, earthquake-proof. They are to be constructed on a new elastic principle and supported in conduits without coming in actual contact with the ground.

THE ground floor of the Main Hall of the new Science Museum at South Kensington is at last so far advanced that in a short time it will be thrown open to the public. The six fine old steam engines representing the work of Newcomen, Smeaton, Watt, and others, together with the historic locomotives Puffing Billy, Agenoria, Sans Pareil, and Rocket, were re-erected in the Main Hall some time ago, but now the smaller engines and models are being transferred from the older galleries. When this work is completed, for the first time in the history of the Science Museum the visitor will see the main engineering collections in a proper setting. The increase in floor space is all the more welcome inasmuch as for many years some of the finest collections in the Museum, such as the textile and mining exhibits, have had to be withdrawn from exhibition. As originally planned, the new building—which is but a third of the scheme proposed in 1911—should have been ready for occupation in 1915. The War, however, brought building operations to a standstill, and since 1918 other causes have hindered the progress of the work. With the opening of the New Hall we trust that the Office of Works will do something to improve the so-called temporary entrance as approached by the passage leading from Exhibition Road. Its present state is a standing reproach to those responsible for the upkeep of our national buildings.

ON November 5 the members of the Geological Society Club dined together as usual after the meeting of the Society. The occasion, however, was a special one, being the exact centenary anniversary of the first dinner of the Club in 1824, and a number of distinguished guests were invited to take part in the celebration of the event. Sir William Boyd-Dawkins, who was already a member of the Club fifty years ago when its jubilee was celebrated, proposed the toast of kindred clubs, which was responded to by Sir Charles Sherrington, president of the Royal Society. Sir Arthur Smith Woodward then proposed the guests, to which Sir Richard Gregory and Prof. Schaffer of Vienna responded. The latter remarked that the century of comradeship typified by the existence of the Club dinner appealed more to his imagination than anything else in the geological past. Sir William Bragg proposed the toast of the Club, and Dr. J. W. Evans, in replying, reminded those present of the great changes in geological science since the Club was founded. Then there were no Cambrian, Ordovician, Silurian, or Devonian periods, and the Tertiary had not been subdivided by Lyell, one of the founders of the Club, who survived to take part in its jubilee. There was no glacial period, prehistoric man, or evolution—no rock sections or petrological microscopes. Dr. Evans referred to the importance of the office of treasurer, and proposed the toast of past holders of that post, and more especially of the present treasurer, Mr. G. W. Lamplugh, who, in responding, remarked his indebtedness to Prof. W. W. Watts, and on the curious coincidence that both at the jubilee and the centenary dinners the president was a John Evans. Letters expressive of good will and regret at their absence, were despatched to Sir Archibald Geikie, Mr. William Whitaker, and Mr. E. T. Newton, honorary members of the Club. They were signed by practically all those who were present at the dinner. An interesting list of the membership of the Club since the beginning was prepared by Mr. Lamplugh and presented to the members and guests.

In our issue of September 13 we dealt with the centenary of the Franklin Institute. We have now received a copy of the booklet published in connexion with the commemoration of that event. It contains a chronicle of some of the most important events in the history of the Institute, an interesting series of illustrations of Philadelphia old and new, some portraits, and also photographs of scientific apparatus, among which we notice Franklin's electrical machine, an air-pump once belonging to Priestley, and Saxton's early magneto-electric machine. The Institute has always encouraged exhibitions of inventions, and to the initiative of its members was due the inauguration of the famous Centennial Exposition of 1876 and the Electrical Exhibition of 1884, both of which had far-reaching results. "For the encouragement of invention and discovery no method is more efficacious," the authors of the booklet appropriately write, "than an exhibit of what has already been done. Two purposes are served. The exhibits stimulate interest and lead to efforts to improve upon what has been accomplished, and show those who are inclined to enter upon invention or discovery in any field what is the 'state of the art,' knowledge that saves many an hour otherwise wasted in going over ground already covered." Franklin's own work as a scientific investigator commenced about 1746, and seven years later he received the Copley Medal of the Royal Society. During his second stay in England he became the friend of Canton, Priestley, Wilson, Maskelyne, and Watson, and he had a share in placing his own lightning conductors on St. Paul's Cathedral. There are many memorials of him in Britain, in France, and in the United States, but none more worthy than the great Institute bearing his name, which was founded thirty-four years after his death.

In the *Empire Review* for November, Dr. R. P. Scott argues that the Bill to release China from further payment of instalments of the Boxer Indemnity, which has been before Parliament since May last, should be amended by defining the undertakings beneficial to both countries, to which the money is to be diverted under the provisions of the Bill, as "Educational or Cultural." Those who know China are agreed that the claims of medicine and surgery for support are valid and obvious, and that the term "cultural" should cover these chiefly, if not entirely. The Chinese national character, both in its strong as well as its weak points, indicates unmistakably the great need of assisting and supplementing the efforts made by the Chinese to reform their educational system. The co-operation of the Chinese themselves is essential, and efforts should be directed towards securing a system of education which, while thoroughly in accord with Western standards, should at the same time be national, unlike at least one of the attempts at reform from outside which has brought disillusion by denationalising the students. Existing institutions, whether Chinese or foreign, should be subsidised, and those which are outside the national system should be kept abreast of it in grade by a system of inspection and advice worked through a conjoint central and local system. It might then be possible to convince China of the value of institutions engaged in developing a Chinese stock which had assimilated Western culture without becoming denationalised. Granted an effective co-operation between British and Chinese workers, it should be possible at the end of twenty-three years, when the payments on account of the indemnity will cease, to judge the experiment on its merits. If it has been successful it should, by that time, be self-supporting.

Sir Alfred Ewing, president of the Royal Society of Edinburgh, in an address on November 3, remarked that in this, the centenary year of Lord Kelvin's birth, it was fitting that the Society should call to remembrance one who was for long its most distinguished fellow, who first became its president at the age of thirty-nine, and was repeatedly re-elected to that office, which he held for twenty-one years in all, and who used the Society as a medium for the publication of many of his most brilliant discoveries. It was to this Society, in 1849, that he gave the account of Carnot's theory which marks the beginning of his study of thermodynamics, and it was also in the Edinburgh Transactions that he published his epoch-making series of papers on the dynamic theory of heat. It was there too that he propounded the doctrine of the dissipation of energy in 1852, and in 1865 briefly refuted the doctrine of uniformity in geology. It was to the Royal Society of Edinburgh that he brought his long series of papers on vortex motion and vortex atoms and his work on the molecular constitution of matter, and his last paper of all, on the problem of a gaseous nebula, was published there posthumously in 1908.

Important and valuable as Kelvin's practical inventions were, continued Sir Alfred Ewing in the address referred to above, and the work in discovery which he continued to do to the end of his life, his very greatest contributions to science were made before he was thirty, when he was engaged in developing the science of energetics. Founding himself on the earlier work of Carnot, he gave to the world the conception of an absolute scale of temperature, and once he succeeded in reconciling the principles of Carnot with the later work of Joule, he pressed forward at an amazing pace, applying the new ideas to one group after another of physical phenomena, and showing that the first and second laws of thermodynamics together formed a master-key to unlock every door. After setting on a sound basis the theory of the production of the motive power by the agency of heat, he went on to give the principle of the reversible cycle many fruitful applications in other fields. In thermo-electricity it led him to discover what is now known as the Thomson effect. In the theory of electrolysis he used it to infer the electromotive force of the galvanic cell from the known energy of the chemical action. His next step was to discuss the mechanical values, or as would be now said, the potential energy of distributions of electricity and magnetism, and he showed how at every instant of the process of discharging a conductor the strength of the current might be deduced by applying the equation of energy, and how it followed that the discharge would be oscillatory, provided the resistance fell short of a certain limit depending on the self-induction and the capacity. This investigation of transient currents was the first step towards wireless telegraphy, though it was left to Clerk Maxwell to recognise, years afterwards, that Thomson's equation omitted one term, namely, the energy of electromagnetic waves, which, as a consequence of the oscillation, are radiated into space.

MR. T. MARK HOVELL delivered a Chadwick Public Lecture on November 10 on "The Rat Menace: its real significance and how it may be minimised." It was stated that although rats are costing Great Britain alone 1,000,000*l*. per week, continuous war is not waged against them. There is a Rats and Mice (Destruction) Act, 1919, which authorises fines to the extent of 20*l*., but it is not put in force. "Rat weeks" do a great amount of good, but there will be no decided diminution in the number of rats until continuous trapping is enforced. The presence of a "few" rats is usually disregarded; it is not always realised that a pair and their descendants, at a low computation, will produce in eleven months 1130, and in thirteen months 3050 individuals. Farmers usually allow their stacks to be rat-infested, but in six months 1132 rats will eat and waste wheat to the equivalent of 2329 quartern loaves, 306 bushels of sharps and 723 bushels of bran. Mr. Mark Hovell also stated that rats convey trichinosis (measly meat), foot-and-mouth disease, infectious jaundice, mange, ring-worm, distemper, rat-bite fever, and last, but not least, plague, which during last March in the Punjab alone caused 25,000 deaths. Plague is conveyed to human beings by the rat-flea, and, contrary to general belief, the flea of the brown rat transmits plague as readily as the flea of the black rat. Careful supervision at the ports prevents serious outbreaks of plague in Great Britain. For destroying rats, it appears that virus has no advantage over the recognised poisons, and its use is strongly deprecated because it disseminates virulent microbes which the medical profession is trying to eradicate. The next Chadwick Public Lecture will be delivered by Prof. J. B. Cohen on Wednesday, November 19, at 8 P.M. in the Gallery of the Royal Institute of British Architects, 9 Conduit Street, on "Smoke: Cause, Nature, Effects and Methods of Prevention." Further particulars of Chadwick Public Lectures may be obtained of the Secretary, Mrs. Aubrey Richardson, at the offices of the Trust, 13 Gt. George Street, Westminster.

SIR OLIVER LODGE has been elected an honorary member of the Institution of Electrical Engineers.

THE Huxley memorial lecture of the Royal Anthropological Institute for the present year will be delivered at 8.30 on Tuesday, November 25, at the Royal Society, by Prof. René Verneau, who will take as his subject "La Race de Néanderthal et la race de Grimaldi: leur rôle dans l'humanité."

NOTICE is given that applications for the Government grant for scientific investigations must be sent to reach the Royal Society, Burlington House, London, W.1, not later than January 1, on a form obtainable from the clerk to the Government Grant Committee, c/o the Royal Society.

PROF. E. P. CATHCART, professor of physiological chemistry in the University of Glasgow, has been appointed to the vacancy in the membership of the Medical Research Council caused by the retirement of Prof. D. Noël Paton.

WE learn that Senatore Marconi has returned to London after an absence of about three months, during which time he has been further developing his new beam system. He is now able to state that this system will be effective for efficient telegraph service over any distance by day as well as by night.

THE first of the Christmas Lectures at the Royal Institution, "Concerning the Habits of Insects," to be delivered by Mr. F. Balfour Browne, will be given on Dec. 27, and will be concerned with insect collecting and what it leads to. Succeeding lectures will deal with the habits of bees and wasps (Dec. 30), habits of caterpillars (Jan. 1), habits of the dragon-fly (Jan. 3), habits of the water-beetle (Jan. 6), and the habits of insects and the work of man (Jan. 8).

PROF. WILLARD C. THOMPSON, head of the Poultry Division of the New Jersey State Agricultural Experiment Station, U.S.A., has been appointed Director of the National Poultry Institute (Harper Adams College Section), and has agreed to act in that capacity for two years. Prof. Thompson has done work that has greatly benefited the industry in America, and brings to his new task considerable experience in teaching and research, and a wide knowledge of the problems that confront practical producers.

A TEMPORARY inspector is required by the Ministry of Agriculture and Fisheries mainly for work in connexion with the Young Farmers' Club Movement. Candidates must have a general knowledge of agriculture, and the possession of a University degree and acquaintance with county organisation and educational work is desirable. Application forms (returnable by November 22 at latest) can be obtained from the Secretary to the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

APPLICATIONS are invited for the post of an experimental physicist at the Building Research Station of the Department of Scientific and Industrial Research. Candidates must be honours graduates in physics with research experience, and have a sound general knowledge of physics, with, preferably, specialised acquaintance with heat and properties of matter. Applications, on a form supplied upon request, should reach the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1, by, at latest, November 24.

THE Home Secretary has appointed a committee to consider and report whether any, and if so what, modifications of the existing statutory regulations governing the use of artificial humidity in cotton cloth factories are desirable and practicable. The members of the committee are: Mr. J. Jackson (chairman), Mr. L. Bates, Mr. J. Cross, Dr. A. W. Crossley, Mr. G. Green, Prof. Leonard E. Hill, Mr. J. Hindle, Mr. H. Roberts, Mr. F. Scarisbrick, Mr. C. Speak, Mr. John Stuttard, and Mr. D. R. Wilson. The secretary of the committee is Mr. T. P. Threlkeld, of 72 Bridge Street, Manchester, to whom any correspondence should be addressed.

ON October 18, Sir Archibald Garrod delivered the Harveian Oration before the Royal College of Physicians. His subject was "The Debt of Science to Medicine." Like all Sir Archibald's work, his Oration was distinguished by great accuracy and wide learning. He traversed the field from Hippocrates to Sir Edward Sharpey-Schafer and strove to show that science in the pure sense has been greatly enriched by medical men in different ages. Sir Archibald thinks that the marvel is that medical men have contributed so much, not that they have failed to contribute more, considering that clinical medicine is an art as well as a science and that the successful practice of medicine calls for qualities which are often unconnected with science. He pleaded for greater unity between science and practice for those who have the beneficent aims of medicine at heart. The Oration, which will be found in the *British Medical Journal* for October 25, is well worth a careful perusal.

WE have received from the British Museum (Natural History) ten recently issued sets of postcards of butterflies and moths. They are all admirable reproductions by the three-colour process, made from actual specimens, and are among the most perfect examples of that art which have come to our notice. The series of British Butterflies (Nos. 2 to 7), together with their accompanying letterpress, form an excellent guide to those insects which will enable any one readily to identify the various species found in the British Isles. The series No. 2 of British Moths illustrates some of the less common and other species, including the recently detected *Anaitis efformata*. Series Nos. 4 to 6 of Exotic Moths include a number of striking or otherwise remarkable forms. The cards are sold in sets of five (with separate explanatory letterpress) at the low price of 1*s*. per set, and are to be specially commended to all interested in nature study and insect life in particular.

APPLICATIONS for grants from the Chemical Society Research Fund must be received, upon a prescribed form, by the Assistant Secretary of the Society not later than December 1. The Selection Committee of the Harrison Memorial Prize will meet shortly to consider the award of the prize, which is of the value of about 150*l*. The award will be made to the chemist of either sex, natural British born and not more than thirty years of age, who, in the opinion of the committee, has during the previous five years conducted the most meritorious and promising original investigations in any branch of pure or applied chemistry and published the results. Applications must reach the president of the Chemical Society, Burlington House, Piccadilly, W.1, not later than December 1.

Our Astronomical Column.

CALENDAR REFORM.—Mr. G. Marvin, of the U.S. Weather Bureau, read a paper on this subject at the Madrid meeting of the Geodetical and Geophysical Union. He dwelt chiefly on the need of more uniform months for the purpose of meteorological records, and the desirability of keeping the date of the equinox as nearly as possible the same. He recommends the system of 13 months of 4 weeks each, and one day each year (two in leap year) outside the month and week.

Taking account of the shortening of the year due to solar acceleration (Mr. Marvin does not give any details of the amount that he adopts or its source), he notes that the best rule would be to drop 4 leap years in 500 years, instead of 3 in 400 as at present, or 7 in 900 as in the new rule of the Greek Church. He suggests making 1928 a common year to bring the equinox back to March 21, and then to make the centennial years leap years only when divisible by 500: thus 2000, 2500, 3000, etc., would be leap years, the other years ending in 00 common years.

THE BAADE PLANET.—The arc of observation for this planet is now sufficient to deduce approximate elliptical elements, which result as follows:

T	1894 Sept. 27·7609 G.M.T.
ω	130° 0′ 24″
Ω	217 4 35
i	25 27 32
ϕ	30 0 9
Period	3^y·8047
log q	0·0858.

The perihelion distance is somewhat greater than that of Eros, and the eccentricity much greater, the aphelion distance being 3·66. The orbit is of the same type as those of Albert and Alinda; the brightness is, however, much greater.

The planet is getting fainter, but is still an easy object for ordinary telescopes. It will be too faint for easy detection at aphelion oppositions, so it is important to observe it over a long arc to secure its recovery in 1928.

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R.A.	Decl.	log r.	log Δ.
Nov. 16	22^h 57^m 23^s	1° 36′ N.	0·1247	9·7783
20	23 13 39	0 4 N.	0·1304	9·8016
24	23 29 10	1 15 S.	0·1362	9·8253
28	23 43 51	2 18 S.	0·1423	9·8501
Dec. 2	23 57 53	3 11 S.	0·1485	9·8745

Research Items.

MOUND EXPLORATION IN CALIFORNIA.—Observations made in the course of levelling two mounds for city improvements at Richmond, Ca., have afforded several additions of interest to the accumulating evidence relating to the early culture and history of man on the American continent, which is being obtained from archæological investigations in California. The two mounds in question, the Stege mounds, are situated on the Oakland-Richmond beach immediately opposite the outlet of San Francisco Bay in an area about 6 miles long and $3\frac{1}{2}$ miles wide, which includes some of the largest shell mounds of the region, and where the shallow waters provided a favourable ground for fishing in primitive times. The objects found in the course of the demolition of the mounds are described by Mr. Ll. L. Loud in vol. 17, No. 6, of the University of California Publications in American Archæology and Ethnology. They included human remains, some showing signs of incineration, implements of bone and stone, net sinkers, pestles and mortars, the former of several types, hammer stones, and charmstones. The larger of the two mounds afforded abundant evidence that it had been the site of manufacture of objects made of greenstone schist, for which no doubt it had acquired a reputation, and had become a manufacturing and distributing centre according to what appears to have been Indian custom. Of greater interest, however, is the distinction in culture to be drawn between the two mounds, which distinctly points to somewhat different modes of subsistence and may indicate a difference in date.

EARLY DEVELOPMENT OF THE HUMAN EMBRYO.—Prof. T. H. Bryce's "Observations" on this subject have just been published as a separate memoir in the Transactions of the Royal Society of Edinburgh (vol. 53, Part 3, 1924). They should be studied in conjunction with Prof. Teacher's paper on the implantation of the ovum, which was recently noticed in NATURE (Sept. 6, p. 367). Indeed the two memoirs deal largely with the same material, but from different points of view, and so supplement one another. Prof. Bryce, however, besides describing the two Teacher-Bryce ova, includes an account of an entirely new early embryo obtained by Dr. Donald M'Intyre from a uterus removed surgically by sub-total hysterectomy. The memoir contains a number of important observations, some of which are confirmatory of former discoveries and some of which are new. In dealing with the primitive extra-embryonic mesoderm, it is shown that this is primarily an angioblastic tissue. All round the young chorion the formation of vascular channels has begun in it (in the second Teacher-Bryce ovum) before there are any vessels in the yolk-sac and apart from the formation of blood corpuscles. The embryo is afterwards linked up with this system of vascular channels through vessels developed in the allantoic stalk. The author also describes the primary connexions of the yolk-sac and chorion, and points out that the observations support the view that the small size of the yolk-sac in the primates is a secondary condition, its recession being very precocious, but agreeing essentially with what occurs at a later stage in many of the lower mammals. The yolk-sac duct, which is described, is regarded as a vestigial structure reminiscent of a phylogenetic phase when the organ was of larger size. The memoir contains also new and interesting facts relating to the amnion and its duct, the primitive streak and the archenteric canal. It is illustrated by nine plates containing nearly fifty well-executed figures.

OBSERVATIONS ON COLEOPTERA.—*The Entomologist's Monthly Magazine* for October 1924 contains several short articles and notes of interest to coleopterists. Mr. Horace Donisthorpe discusses the European species of the genus Euryusa, the species of which are mymecophilous and live in trees inhabited by ants of the genus Acanthomyops. The exact relations between these beetles and their hosts is still in need of elucidation. Mr. Donisthorpe admits five species and provides a key for their identification. Messrs. J. W. Allen and G. W. Nicholson add a new beetle, *Tachys micros* Fisch., to the British fauna on the strength of taking a considerable number of examples near the coast in Dorsetshire. They also record the occurrence of *Chlaenius schranki* Dufts. in the same situation: this insect was thought to have become extinct since its disappearance from its habitat in the Isle of Wight many years ago. Notes on two beetles recently added to the British list are also included in the same issue of the journal. Mr. B. S. Williams records *Anthicus bifasciatus* from Wicken: it may be added that the insect was first recognised as British in 1914 from Chatteris. Messrs. Allen and Nicholson record *Sitones gemellatus* from Branscombe, S. Devon, where it occurred in some numbers under shoots of *Ononis arvensis*. This insect has only recently been recorded as British, the first examples being found at Sidmouth.

HETEROTHALLISM IN PHYTOPHTHORA.—This problem is carried one step further (see NATURE, Vol. 111, p. 61, 1923) by a paper by C. H. Gadd in the Annals of the Royal Botanic Gardens, Peradeniya, vol. ix. Part I., which gives the results of a comparative study of strains of Phytophthora isolated from cacao, papaw, Hevea, Dendrobium, Odontadenia, and bread-fruit in Ceylon. All these strains are regarded by the author as biological varieties of *P. Faberi*. None of them formed oospores so long as grown in pure culture, but they could be divided into two groups, + strains on cacao and papaw and − strains on the other hosts, and oospores were formed when any representatives of these two groups were mingled in cultures. Gadd also confirms the curious earlier result reported by Ashby, that oospores are formed when a pure culture of a strain of *P. Faberi* is mixed with a pure strain of *P. parasitica*. These oospores are of the size characteristic of *P. Faberi* and not of the other species.

THREAD BLIGHTS.—Under this title Mr. T. Petch, botanist and mycologist to the Department of Agriculture, Ceylon, describes (in the Annals of the Royal Botanic Gardens, Peradeniya, vol. ix. Part I.) a number of fungi which have the habit of forming well-defined, narrow strands of mycelium like coarse white threads ramifying over the branches and leaves of plants to a considerable height above the ground. These fungi are frequently seen in the tropics, attention having naturally been attracted to them when they are found on economic plants, as most of them seem to be parasitic, though usually doing little damage except to leaves and young stems. In two or three examples of these thread blights the hyphæ belong to a Corticium. In this case, the hyphæ usually remain thin-walled, and the threads composed of them are more transparent and less conspicuous; but in the majority of the specimens examined by Mr. Petch, in which the hyphæ are derived apparently from gill fungi, apparently species of Marasmius, though adult fructifications have only been described for two species, the bulk of the hyphæ in the threads of the superficial strands are thickwalled or even solid, so that the threads are white and solid-looking and can withstand desiccation.

Breeding Experiments with Antirrhinum.—Prof. Erwin Baur has now published a very full account of his studies of the different races of *Antirrhinum majus*, which he has had under investigation since 1904 ("Untersuchungen über das Wesen, die Entstehung und die Vererbung von Rassenunterschieden bei Antirrhinum majus." Von Erwin Baur. Bibliotheca Genetica, Band 4. Pp. iii+170+8 Tafeln. Leipzig: Gebrüder Borntraeger, 1924. 39*s*. 6*d*.). The large number of forms of this species available in cultivation and the self-fertility of these garden forms have enabled the author to pay especial attention to the origin of mutations in progeny which had remained fixed in type for several generations of selfed parents. Many cases of such mutations are described at length, and Prof. Baur concludes that many of the distinct forms of Antirrhinum occurring in Nature are to be regarded as forms in which a number of different single-factor mutations occurring at different times have been accumulated, environment having then provided the opportunity for the isolation of such as local races. On the other hand, Baur points out that the forms selected in horticulture, on the contrary, usually show a single rather striking mutation that has appealed to the grower, and has been selected and maintained by the efforts of the breeder to keep it genetically pure.

Fixation of Atmospheric Nitrogen by Green Plants.—This much-discussed problem comes to the fore again with the publication by Messrs. C. B. Lipman and J. K. Taylor of a full report of their Californian experiments, in the Journal of the Franklin Institute (October 1924, pp. 475-506). It will be recalled that, following in recent years close upon the paper by the late Prof. Benjamin Moore and his colleagues (Proc. Roy. Soc. 91B., 1920), in which nitrogen fixation by Algæ was claimed, but the significance of associated bacteria ignored, Wann published (*Amer. Jour. Botany*, 8, 1921) a series of chemical data which seemed to establish the same fact. Recently, however, the Rothamsted workers Mrs. Roach (Dr. Muriel Bristol) and H. J. Page, working with pure cultures of Algæ, have shown that Wann's claims are invalidated on questions of experimental method, whilst their own careful experiments give negative results. Messrs. Lipman and Taylor have worked with water cultures, especially of wheat and barley, and whilst it will be conceded that their chemical data leave no doubt that plants grown with no other nitrogen supply or with known additional amounts of nitrogen have gained further nitrogen when all other sources except gaseous atmospheric nitrogen seem to be excluded, yet at the same time critics will still argue that the inability to keep the culture solution sterile opens the door to alternative explanations. The writers, however, argue their case very cogently for rejecting the assumption that the gaseous nitrogen is assimilated and handed on to the green plant by bacteria.

Permian Insects.—Hitherto few insects have been found in deposits of Permian age, but Sellards and Dunbar (*Amer. Journ. Sci.* vii., 1924, p. 171) have now discovered some thousands of specimens, many in a remarkably perfect state of preservation, in the Lower Permian (Artinskian) of Elmo, Kansas. They include may-flies, cockroaches, dragon flies, etc. This discovery is likely to be of great importance in phylogeny, since during Permian times the later orders of insects seem to have developed out of the more ancient Palæodictyoptera. The collection is being worked out by Dr. R. J. Tillyard. Up to the present he has described a new genus, Dunbaria, which is closely allied to forms found in the Upper Coal Measures of Commentry and is the first example of the Palæodictyoptera to be recorded from the Permian. Protohymen is the type of a new order, the Protohymenoptera, which is ancestral to the Hymenoptera, known first in the Upper Jurassic (*Amer. Journ. Sci.* viii., 1924, p. 111). The insects are found in a marly limestone and are associated with abundant land-plants and with the merostomes Palæolimulus and Eurypterus. The deposits underlying the insect bed contain thick layers of rock salt and other evidence of arid conditions, but the climate became ameliorated during the formation of the insect bed, which seems to have been the marly deposit of a freshwater lake.

Landslips in Italy.—The second number of the new journal *Matériaux pour l'étude des calamités* contains an interesting article by R. Almagia on landslips in Italy. They occur throughout the country, but especially in the sub-Apennine districts, Calabria, etc. The geological formations in which they are most prevalent are the clay strata of the tertiary period. They are most frequent during, or immediately after, periods of exceptionally heavy rainfall, the effect of which may be increased in spring by the melting of the snow, though some landslips may also be due to earthquakes and to deforestation. Some idea of the seriousness of landslips as a calamity may be gathered from the fact that more than three hundred villages in Italy are threatened. The Government has already voted funds for the protection of nearly half of these villages, but for many it is recognised that no adequate protection can be given, and that the only alternative is the removal of the inhabitants. This transfer seems inevitable in as many as seventy-seven villages in Calabria.

Nature of Isostatic Compensation.—A paper of interest to students of isostasy has recently been issued by the United States Coast and Geodetic Survey (Isostatic Investigations and Data for Gravity Stations in the United States established since 1915, by William Bowie, Spec. Pub. 99, 1924). Gravity determinations have been made at 94 new stations in addition to the 219 already completed at the beginning of 1916 (Spec. Pub. 40). In the light of all the results now accumulated, Bowie presents his matured views on the nature of isostatic compensation, the processes involved and the geological problems associated with them. He points out that the depth of compensation is not necessarily the same everywhere, but that for the United States the best average value is 96 km. The conclusion recently reached by Nansen in his book "The Strandflat and Isostasy," that movements restoring and maintaining equilibrium can take place within areas only a few hundred kilometres wide, is accepted, and a mechanism suggested. Briefly, the depression of geosynclines in which long-continued sedimentation takes place is ascribed to contraction and consequent increase of density of the block beneath the sinking area. Presumably diagenesis and pressure metamorphism, tending to the production of minerals of small specific volume, is the underlying physical cause. At a later stage, however, rising temperatures gradually reverse the volume changes, and the area begins to be uplifted owing to the expansion of the material of the underlying column. Few geologists are likely to agree with Bowie in his further deduction that mountains have been produced almost wholly by vertical uplift, and not by regional horizontal thrusts. The latter are said by Bowie to be inconceivable from an engineering point of view. Field evidence is nevertheless conclusively in favour of horizontal thrusts;

and for the geologist the two types of movement—vertical uplift and lateral thrusting—are by no means rivals. Both are required to explain the facts, and both are probably due to temperature changes in the depths, expansion providing the local uplift, and the concomitant weakening and fusion of the crust localising the forces of lateral compression set up by the general contraction of the earth.

CLIMATOLOGY OF THE INDIAN OCEAN.—An interesting series of charts of the Indian Ocean showing atmospheric pressure, winds, and currents has been compiled by Dr. P. H. Gallé and published by the Royal Dutch Meteorological Institute (*Mededeelingen Ven erhandelingen*, 29 *a*). The data have been obtained from the log-books and meteorological registers of the Dutch Navy and Dutch merchant vessels. The author has entered the mean values for January and July in one degree squares. In view of the number of observations, the results in most cases are fairly satisfactory, but Dr. Gallé admits that more accurate mean values could be obtained by further data, and one of his objects in publishing the charts is to invite wider co-operation. Observations are very scanty in some areas, particularly about lat. 30° S., between long. 60° and 90° E., and in winter about lat. 50° S. A comparison of mean values for pressure at land stations around the Indian Ocean, as given by Hann, Lockyer, Braak, and others, with the oceanic pressures, shows a fair agreement, but in places there are striking differences. These the author thinks are due in cases to prevailing local onshore winds and in other cases to a failure to apply accurate corrections for altitude on shore stations. In some of the coast regions two values are given where the divergence was found to be considerable. In regard to winds, these observations show that in the west wind belt of the "forties," the strength and stability of the air currents is not so marked as generally supposed. Further papers in this series are promised.

THE INVERSE STARK EFFECT.—Dr. R. Ladenburg, in the *Zeitschrift für Physik* of September 20, describes the behaviour of the D absorption lines in a strong electrical field. A new form of quartz sodium lamp enables the D lines to be produced with great intensity, and with a breadth of only 0·1 Å, without reversal, so that, using a large Lummer Gehrcke plate, broad interference maxima are obtained. The light from the lamp is passed through an absorption bulb, between two parallel metal surfaces a short distance apart, across which an electric field so high as 160,000 volts per cm. can be produced. The bulb is evacuated in an electric furnace, and pure sodium vapour is introduced. The D_1 and D_2 absorption lines then appear on the continuous background of the interference maxima, and when the light passes perpendicular to the lines of force, the absorption lines are shifted by the field towards the red. The shift amounts to 0·025 Å at 160,000 volts per cm., and is proportional to the square of the field intensity. The phenomena form a typical example of the purely unsymmetrical quadratic effect, which is to be expected according to Bohr's theory with lines unlike those of hydrogen, when the external electric field is small compared with that due to the electrons of the atomic kernel.

SPECTROSCOPY AND ATOMIC STRUCTURE.—The progress made during the past three or four years in the endeavour to discover a structure for the atom of each element which would, on the quantum theory, give a spectrum identical with that found experimentally, has been so rapid that none but specialists have been able to follow it in detail. An article of forty pages in the September and October issues of the Journal of the Franklin Institute by Dr. Paul D. Foote, of the Bureau of Standards, giving an account of the atomic models which have been suggested, will be welcomed by many who have not the opportunity to consult the original memoirs. He deals in turn with the "hydrogenic" atoms, the atoms with several electrons, the assignment of quantum numbers, *i.e.* integers, the necessity for the introduction of "effective" quantum numbers not integral, the orbital and precessional frequencies, and the representation of the orbits of luminous and X-ray frequencies. Figures of the orbits conceived by Bohr for helium, lithium, neon, sodium, argon, copper, krypton, xenon, and radium are reproduced with the warning that they are based on questionable assumptions.

VISCOSITY OF GLASS.—In a recent note on the viscosity of glass (*Comptes rendus*, Paris Academy of Sciences, 1924, p. 517) M. Henry Le Chatelier has shown that the law of the phenomenon can be represented as a function of the temperature by the very simple formula $\log(\log \eta) = -Mt + P$, where η is the viscosity, t the temperature, and M and P constants for a particular glass. Fifteen days later, S. English published in the Journal of the Society of Glass Technology (1924, p. 205) an extensive paper giving numerous viscosity data for different kinds of glass for temperatures ranging from 500° to 1500° C. Applying the formula given above to these data, M. Le Chatelier (*Comptes rendus*, 1924, p. 718) shows that for each glass the results can be expressed by two straight lines meeting at an obtuse angle, the temperature of inflexion varying from 750° C. to 950° C. according to the nature of the glass. To explain these facts, it is assumed that there are two allotropic varieties of each glass possessing different laws for the viscosity variation. This hypothesis was put forward by M. Le Chatelier in his first paper as affording the best explanation of his experiments: it explains equally well the results given by English, which are more numerous and cover a wider range of temperatures.

THALLOUS THALLIC HALIDES.—In the Proceedings of the Cambridge Philosophical Society, vol. xxii, part 3, Mr. A. J. Berry describes some experiments on the sesqui-halides of thallium, $TlX_3,3TlX$, no definite proof of the individuality of which had formerly been given. Solutions of thallous and thallic chlorides containing the two halides in varying proportions were prepared and the composition of the crystals deposited from such solutions determined. It was found that while the composition of the liquid phase could be varied over a wide range, the composition of the solid phase deposited was practically constant. The solution of thallic chloride was prepared by dissolving thallic oxide, obtained from the recrystallised sulphate by oxidation with alkaline potassium ferricyanide, in normal hydrochloric acid. After prolonged heating, the excess of thallic oxide was removed by filtration, and the ratio of thallium to chlorine found to be 1 : 3·1. The compound $TlBr_3,TlBr$ was easily obtained, but $TlBr_3,3TlBr$ was difficult to prepare in a state of purity. $TlBr_3,3TlCl$ was prepared. No evidence of the existence of complex ions was found. The substances, mostly red, become very much lighter in colour on cooling in liquid air, and the phenomenon is very strongly marked.

ERRATUM.—In the paragraph referring to "A Biochemical Basis to Disease Resistance" in NATURE of November 1, p. 657, line 11, the sentence "immune forms are comparatively high in total nitrogen and total ash" should read "susceptible forms are comparatively high in total nitrogen and total ash."

Effect of Artificial Light on the Growth of Plants.

THE effect of light on plant life has been the subject of many scientific investigations. So long ago as 1880 Siemens showed that continuous exposure to arc lamps promoted luxuriance of foliage, greater intensity of colouring, and more rapid ripening of fruit. It is common knowledge that plants grown in partial shade are apt to be weakly, and that the flowers, if produced, have in general a fainter shade of colour. Other examples were mentioned by Schübeler in a communication to the British Association in 1881. The extraordinary rapid growth of vegetation in the Arctic regions during the period of uninterrupted daylight has been the subject of comment; likewise the rapid ripening of corn in regions of Norway and Sweden where the summer does not exceed two months, but where, during this period, the sun scarcely sets.

It therefore seems somewhat surprising that greater use has not hitherto been made of the use of artificial light in horticulture. There have, in the past, been intermittent experiments, but results have been somewhat discouraging, and the probable reason is not far to seek. It is only within recent years, when convenient methods of measuring light have become general, that the great disparity between the intensity of full daylight and artificial light has come to be properly understood. The illumination derived from direct sunlight in summer may attain 10,000 foot-candles, and even with a cloudy sky a value of several thousand foot-candles is quite usual. On the other hand, the average illumination in an artificially lighted building is frequently less than three foot-candles; a general illumination of ten foot-candles would be considered exceptionally bright. The marvellous power of adaptation of the eye enables it to utilise these extreme variations in illumination. But it can be readily appreciated that unless an artificial illumination of at least several hundreds of foot-candles can be provided, the effect on the growth of plants would not be marked.

Until a few years ago there were few sources of light that could be conveniently applied to produce such high intensities, and the cost was commercially prohibitive. But the advent of such sources as the electric gas-filled lamp, furnishing 1000 c.p. or more, and capable of being equipped with suitable reflectors to concentrate the available light within a narrow area, has improved the position considerably. For some time experiments have been in progress at various agricultural experimental stations in the United States, and some results of these researches were recently summarised in a series of papers read before the American Illuminating Engineering Society.

The light was provided by electric gas-filled lamps, and values of illumination varying from 300 to 1500 foot-candles were furnished. The exposure to artificial light was supplementary to the natural lighting and had a material effect in hastening the growth of seedlings. Provided that proper attention was paid to the conditions which are ordinarily observed in horticulture—for example, the provision of sufficient space for normal development of each plant, proper soil, maintenance of correct conditions in regard to moisture and temperature, etc.—the more rapid growth was not attended by weakness. On the contrary, the plants were exceptionally robust and, it is stated, less liable to the ravages of fungus and other diseases.

The most striking effect of the increased light, however, was in hastening the time of blooming. On the average, flowering plants came into bloom eight days earlier than when no artificial light was used. Mr. R. B. Harvey, recording tests made at the Minnesota Experiment Station, mentions that the effect of continuous illumination is to cause the accumulation of large quantities of starch in the plants; thus, buckwheat was so full of starch that the grains may be pulverised in the hand. Apparently the desirable illumination varies for different plants. Strawberries, for example, did not bloom at 500 foot-candles, but set fruits at intensities of more than 1500 foot-candles. Prof. H. Findlay, of Columbia University, reports similar experience. The development of bloom in most plants was accelerated by about eight days; marguerites came into bloom eighteen days after the lights were turned on, when similar plants, grown only under sunlight, were scarcely showing bud.

Another question, apart from effect of intensity, is the influence of *colour* of light. It would seem that light from the electric gas-filled lamp may, as regards its effect on vegetation, be regarded as broadly similar to daylight, and probably the same would apply to other illuminants giving continuous spectra and approximately white light. Early experiments on the effect of colour seem to have been somewhat inconclusive, owing to uncertainty regarding the relative intensity. Thus, the effect of inserting a pane of blue glass is naturally to diminish the brightness of the light very considerably, besides restricting the rays to the blue end of the spectrum. Some remarkable results have, however, been recorded by M. Camille Flammarion,[1] who attempted the culture of the sensitive mimosa plant under light of different colours. Plants placed in blue light scarcely gained in growth at all, and also appeared to be in a comatose state, showing none of the sensibility to touch characteristic of the mimosa. Plants grown under red light were, on the other hand, four times as big as those grown under white light, developed well-marked flower balls, and were in an extremely sensitive state. From these and other experiments the conclusion has been drawn that red, orange, and yellow rays, by building up complex organic chains of molecules, stimulate plant life, whereas blue rays have an arresting effect. Ultra-violet rays, when present in excess, undoubtedly may have a prejudicial effect, causing shrivelling of the leaves and ultimately the death of the plant. In judicious proportions, they may, however, prove beneficial, as is believed to be the case in regard to the human body. Instances of their use to destroy greenfly and similar pests have been recorded.

Here, therefore, is a good field for experiment. We have still much to learn regarding the effects of sustained exposure to strong white light, whilst the effect of light of specific wave-lengths has been only very imperfectly studied. It would be very desirable for corroborative investigations, similar to those conducted at research stations in the United States, to be undertaken by leading horticulturists in Great Britain. At present it is not anticipated that artificial light could be economically applied to the production of common foodstuffs on a large scale; but it is believed that its use may prove extremely valuable for the purpose of raising scarce fruits and flowers out of season. It is even possible—though apparently this requires confirmation—that the work might be conducted entirely by artificial light in a well-heated and ventilated cellar in cases where no garden is available, thus bringing this field of investigation within the scope of the town-dweller in congested districts.

[1] Bulletin de la Société Astronomique de France, Aug. 1897.

The Origin of Limestones.

LIMESTONE takes high rank among those common things the proper understanding of which leads one into a wide circle of the sciences. In a British Association lecture at Norwich in 1868 "On a piece of chalk," Huxley declared that any one who acquired a knowledge of the history of a piece of chalk had a far truer conception of the universe, and man's relation to it, than one well-read in human records and ignorant of those of Nature. This statement by Huxley concerning a piece of chalk applies with added force to the natural history and uses of limestones as a whole; for it should be emphasised that the use of limestone contributes very largely, and in ways too numerous to mention, to the well-being of civilised communities. It was therefore fitting that, in his recent presidential address to the Washington Academy of Sciences (Journal, 1924, vol. 14, No. 14), Dr. T. W. Vaughan gave a prominent place to a consideration of the origin of limestones.

Limestones occur among the sedimentary rocks, and must have been comparatively scarce, in the bedded form in which we know them, during the early stratigraphical history of the earth. R. A. Daly, indeed, thinks that the ocean-waters of pre-Cambrian times were limeless, and to that condition attributes the absence of fossil remains of calcareous organisms in strata of pre-Cambrian age. It is more probable, however, that any precipitation of calcium carbonate that took place in the earth's primeval ocean-waters left the ocean far from limeless; and it seems more reasonable to attribute the absence of calcareous fossil remains in pre-Cambrian strata either to the evolution time-factor, or to metamorphism of the limestone, rather than to the limeless condition of pre-Cambrian ocean-waters.

Igneous rocks represent the ultimate source from which the lime now found in limestones has been largely derived. The average igneous rock of the earth's crust contains about 5 per cent. of lime. The disintegration of rocks by atmospheric agents is accompanied by the solution of the lime in surface waters, chiefly as bicarbonate and sulphate. The precipitation of calcium carbonate in the sea is effected chiefly by the action of calcareous organisms such as foraminifera (especially globigerina), corals, molluscs, and calcareous algæ.

The importance of globigerina as limestone builders was amply proved by the *Challenger* Expedition, from the results of which it was estimated that globigerina ooze covers an area of about 50 million square miles of the ocean floor, *i.e.* about a quarter of the total surface of the earth. The globigerina ooze passes gradually at greater depth into the red-clay deposits which also cover an area of about 50 million square miles. The globigerina ooze itself contains on an average only about 65 per cent. of calcium carbonate, and incorporates within itself a considerable amount of "colloidal mud" similar in character to the red clay of greater depths. Dr. Vaughan enumerates four sources from any or all of which this "colloidal mud" of globigerina ooze and other oceanic deposits may be derived, namely, (1) outwash from the land; (2) volcanic and other dust precipitated from the atmosphere; (3) the residue from the tests of dead pelagic organisms after these tests have been more or less completely dissolved while falling to the bottom; and (4) the mineral residue from the decomposed soft parts of organisms, some of which may be plankton.

Recent analyses of bottom samples of globigerina ooze collected off the American coasts show that the percentage of calcium carbonate decreases as the depth increases, a fact established previously, in a general way, by the work of the *Challenger* Expedition. The rule is not invariable, however; for, as shown by J. Chumley in a recently published paper (Trans. Roy. Soc. Edin., 1924, vol. 54, pt. 1), the amount of calcium carbonate increases with the depth in some areas. In this connexion, Dr. Vaughan emphasises the fact that limestone of a high degree of purity, containing 95 per cent. or more of calcium carbonate, is usually formed either in shallow or only moderately deep water, and states that the purest limestone is deposited in very shallow water. The statements made in some text-books to the effect that globigerina ooze consists of pure calcium carbonate, and that pure limestone is a deep-sea deposit, are misleading.

The degree of purity of shoal-water limestones depends on the amount of outwash from the land. Where there is no outwash of terrigenous material, a beach deposit may contain more than 95 per cent. of calcium carbonate. The oolites of Key West and the Bahamas, which have been formed in shallow water, contain more than 99 per cent. of calcium carbonate. According to Dr. Vaughan, none of the deep-sea oozes approximate to this degree of purity; but J. Chumley records in one instance 97 per cent. at a depth of 2492 fathoms.

Pure shoal-water limestones appear to be chemical precipitates. They are deposited extensively as particles of "colloidal" size in the vicinity of Florida Keys, where storms give rise to a milky appearance in the water, due to the stirring up of the calcareous precipitate. The calcareous matter of the precipitate consists chiefly of fine particles and aggregates of aragonite. Some coarser foraminifera and molluscan shelly matter are present, but it is characterised chiefly by its minute acicular crystals of aragonite.

Such chemically precipitated calcium carbonate is formed only under peculiar conditions. It is deposited in shallow and relatively stagnant water which is at times heated by the sun above the normal temperature of the freely circulating ocean-water. A sample of water from the west side of Andros Island, Bahamas, showed a salinity more than two parts per thousand higher than that of the normal ocean-water of the region; and there is a considerable amount of organic matter in the mud. An analysis by E. T. Erickson of the calcareous mud at this locality showed the presence of 89·62 per cent. of calcium carbonate, 1·39 of magnesium carbonate, 0·93 of strontium carbonate, and 0·68 of calcium sulphate. The presence of such a considerable amount of strontia (0·63 per cent.) is a feature worthy of special mention.

Efforts have been made by various workers to prove that the calcareous muds of Florida Keys, and other such deposits, have been precipitated by the action of bacteria. The investigations of Drs. G. H. Drew, K. F. Kellerman, and N. R. Smith appear to have established the fact that bacteria are present and very active in the muds of the Great Bahamas Bank and Florida Keys. These bacteria include *Pseudomonas calcis*, which is denitrifying in its action, and vibrios, some of which are strong ammonifiers, the latter being regarded as the more important as agents of precipitation. Dr. Smith inferred from his elaborate investigations that calcium carbonate is formed from calcium sulphate as a result of the growth of bacteria; and that calcium carbonate is formed in natural sea-water by pure cultures if organic matter is added.

It seems reasonable to admit, as Dr. Vaughan does, that the association of ammonifying bacteria with others producing carbon dioxide may result in the formation of ammonium carbonate, which, reacting with calcium sulphate in solution, causes the precipitation of calcium carbonate. Dr. Vaughan points out, however, that the surface layer of ocean-water in tropical and subtropical regions is saturated with calcium carbonate, and that evaporation during the summer months is sufficient to account for the precipitation of calcium carbonate, without the agency of bacteria. Taking the evidence as a whole, it seems legitimate to infer that, although bacterial precipitation is possible, it is quite unimportant as a cause of deposition of calcium carbonate even under the most favourable conditions, and that bacteria cannot compare with foraminifera, corals, molluscs, and nullipores as limestone builders. THOMAS CROOK.

The German Scientific and Medical Association Meeting at Innsbruck.

THE German Scientific and Medical Association—Gesellschaft deutscher Naturforscher und Ärzte—held its eighty-eighth meeting in Innsbruck, Austria, on September 21-27. Many former members are now technically foreigners, domiciled in places once Germany, now called by other names. Hence a curious sort of superimposed internationality on a German-speaking basis, a formal recognition of foreign members, and a need for passports. The Austrian embassies and consulates offered visas free of charge from Berlin, Rome, Prague, Belgrade, Budapest, Buckarest, Bern, Danzig, Copenhagen, Stockholm and Christiania. A very emphatic welcome was given in Innsbruck by the Austrian President, Dr. Hainisch, in the name of the republic, and by Dr. Schneider, Minister of Education, for the Government and by others. There were more than 7000 ticket-holders, including a very few Englishmen, among whom were Prof. G. H. Hardy from Oxford and Prof. G. Barger of Edinburgh. The organisation arrangements seemed excellent. The programme was a pamphlet of 24 quarto pages with a very long list of papers, well cross-referenced to joint sessions, and mutual invitations between the 33 separate sections. The ground covered was similar to that of a British Association plus a British Medical Association meeting. The professors of the University of Innsbruck have fitly inaugurated their new buildings. All who co-operated with them, not forgetting the schoolboys who handed out programmes or wore ribbons and met travellers at the station, are to be congratulated highly on the success of their efforts.

The more popular addresses, corresponding to British Association evening lectures, were taken on the first three mornings of the week. These included Dr. Penck on the aspect of the Alps, Dr. Sommerfeld and others on the Bohr atom model, Dr. Porsch on the pollination of flowers by birds, and Dr. von Frisch on the senses and "language" of bees. Experiments have been made in training bees to feed on coloured paper. They appear to recognise colours, including violet, but scarlet is as black to them. The flower-birds visit bird-flowers with the same range of colours as their own plumage; these include red, yellow, and blue. Dr. Knoll has been watching the humming-bird hawk-moth by a proboscis-track method. He finds that after visiting one flower it leaves tiny traces of sugar water on the next object it touches. Dr. Frisch has followed the bees more exactly in an observation hive where each separate insect was marked and numbered consecutively. He says that bees finding honey report their luck to the hive by a special waddling dance. Their comrades are then stimulated to go out and hunt for flowers with the same scent as the honey brought home.

Among numerous communications to the sections were papers on cellulose, the rôle of alkaloids in the life of plants, sweet taste and chemical constitution, fractional distillation and the non-separation of chlorine isotopes, electrolytic conduction in molten alloys, the fine structure of fibre stuffs, on cyanamides, cyanogen compounds, the electric iron industry in the Tyrol, rapid telegraphy in ocean cables, the Siemens band-microphone, electric conductivity in rock salt and calc spar at high temperatures, quantitative spectrum analysis, the measurement from aeroplanes of radioactive decay products in the air, the formation of nitric oxide in the electric arc, the structure of the earth at different depths deduced from earthquake wave velocities, earth currents in mountains, deformation of individual crystals, microchemical detection of complex iron compounds in living plant tissues, and so on.

A joint meeting of Section I., Mathematics, and Section XV., Mathematical and Scientific Instruction, has considered the Denkschrift (Memorandum) of the Prussian Ministry of Education on the reorganisation of higher school education in Prussia. The Union of German Mathematical Societies and the German Committee for Mathematical and Scientific Instruction have also assisted. The hours allotted to mathematics and science, out of a weekly total of 29, are, in the higher forms of the Gymnasium, 3 and 2; in the Real-Gymnasium, 3 and 4; in the Reform-real-gymnasium, 3 and 3. A minimum of 4 hours weekly for mathematics is demanded. Since the days of Kant, a Weltanschauung without mathematics is impossible; it is a training in conscientiousness and fidelity in detail. Science is not merely necessary for all higher specialised work, but is a necessary element of culture. It is a discussion about hours in the curriculum such as we knew in England a generation ago. In Berlin the history teachers are also perturbed about the Memorandum. It is a matter of rescuing humanity in the largest sense from the humanities in their narrowest meaning. Both aims and methods in education need humanising.

The interest of the meeting was intensified by simultaneous gatherings of other societies in association with particular sections. Such were the German Mathematikervereinigung, the Gesellschaft für angewandte Mathematik und Mechanik, the Gesellschaft für Epidemiologie, the Kolloid-Gesellschaft, the Gesellschaft für Kinderheilkunde.

A long series of excursions, especially for geographers and geologists, had been arranged for the days before and after the meeting. For some of these, early notice had to be given, as numbers were limited and clear instructions necessary—"only for good walkers . . . 7 hours a day . . . bring food . . . climbing boots . . . hotel meals only in evening . . . perhaps only hay-shed."

There were several exhibitions, the exhibits being chiefly by German and Austrian firms, a large collection of new scientific books, scientific and medical apparatus especially for Röntgen rays and synthetic drugs. The schools showed some exceptionally good geometrical drawing, a subject to which great importance is attached. The most attractive exhibit was a film showing the movements of growing plants by the Badische Anilin- und Soda-Fabrik. Photographs had been taken at 20 minutes' intervals and the film speeded up. There are plotted diagrams in Darwin's "Movement in Plants," but none of us had ever seen such extraordinary gesticulations before.

Funds did not allow of printed abstracts in advance, but very successful arrangements were made by the Press Bureau. Proof sheets containing the more popular parts of the day's work were ready at the end of the afternoon and were widely distributed to the press. More technical papers were represented by typed abstracts.

The Chemist and the Fermentation Industries.

STREATFEILD MEMORIAL LECTURE.

THE annual Streatfeild Memorial Lecture was delivered at the Finsbury Technical College on Nov. 6 by Mr. Julian L. Baker, who selected as his subject "The Chemist and the Fermentation Industries." It was pointed out that the revenue from beer and spirits accounts for about one-sixth of the total expenditure, and the materials from which beer and spirits are made are almost wholly derived from agriculture and for the major part from materials grown in Great Britain. It will, therefore, be apparent that the commercial products of fermentation are derived from biochemical industries of vast extent and of enormous economic value. The very small amount of exact knowledge concerning the changes which starch and proteins undergo during the preparation of malt from barley and the mashing process was referred to, also the difficulties which underlie such investigations. An outline was given of work being conducted under the auspices of the Research Scheme of the Institute of Brewing. Much of this is being done at the Rothamsted, Wye and East Malling Research Stations under the direction of Sir John Russell, Mr. Salmon and others. Prof. Pyman, of the Municipal School of Technology, Manchester, is responsible for the chemical work on the constituents of hops, and the direction of other researches is entrusted to certain other college laboratories.

It is not easy to convince the principals of an industry which is essentially empirical in character that, as knowledge increases, the old order *pari passu* changes. The British instinct is to leave well alone. The endowment of research should be regarded by manufacturers as an insurance. Neither is it reasonable for an industry to expect results from scientific researches which will affect immediately manufacturing operations, or an improvement of output. The success of a brewer is gauged by his product, and, as he is essentially a craftsman, his reluctance to experiment on anything but a small scale can be understood. Such considerations as these militate in no small degree against the generous financing of research.

Reference was made to the manufacture of alcohol and to the "Amylo" process, which cannot be used in England owing to regulations enforced by the Board of Customs and Excise; also to the products, such as glycerol, formed by *S. cerevisiæ* from sugar under certain abnormal environmental conditions, and the production of lactic and butyric acids from sugar by bacterial fermentation. The industries based on the activity of micro-organisms are of profound importance to the community, and the fields of investigation both academic and technical in such industries are limitless.

At the conclusion of his lecture, Mr. Julian Baker referred to the recent decision of the City and Guilds of London Institute to close the College in 1926. The withdrawal of the London County Council grant of 10,000*l*. per annum, to take effect in 1926, was largely responsible for the position. He thought the decline in the number of students, given as a reason for the grant withdrawal, had been unduly exaggerated and was no greater than might be anticipated in view of the action taken in 1920 to close the College and admit no new students in the session 1920–21. Immediate action was necessary on the part of those who valued the real and practical educational facilities offered by the College for the last 46 years, due in the first instance to the curriculum provided in chemistry and engineering by its first teachers, Armstrong, Perry and Ayrton. The practical courses unfettered by any particular examination syllabus should be continued, and it was to be hoped that an influential deputation of manufacturers and educationists would find a way to enable the College to continue its work.

Mr. A. Chaston Chapman considered that the sound practical training, with freedom from examination syllabuses, the great tradition of its past students and teachers, and the service it has rendered should assure the continuance of Finsbury, while Prof. G. T. Morgan pointed out that the goodwill of the College and traditions associated with it could not be continued elsewhere.

Prof. H. E. Armstrong gave an account of his early work at Finsbury with Perry and Ayrton, and emphasised the value which the training had always had in promoting the application of science to industry. The College started under the influence of men like Sir Frederick Bramwell, Lord Halsbury and Sir Owen Roberts, and the courses for training chemists and engineers were unique. Chemical engineering was no new subject at Finsbury. All its chemists received training in the principles of engineering as part of the ordinary course.

Prof. F. G. Donnan, who was unable to be present, sent a letter, in the course of which he said: "The whole cause of higher education in London is suffering at present from the want of autonomy in the principal colleges as regards the examination for the B.Sc. Degree. The old Finsbury system was and is the only one which produces good results, and is in fact the method employed by other civilised countries with the exception of England." Mr. F. H. Carr, who also spoke, agreed that the training offered at Finsbury was of great value to the industries. He considered that we are suffering greatly from what he termed the respectability of degrees.

Mr. A. J. Chapman, president of the Old Students Association, gave an interesting account of the work now being done by the Association to save the College.

University and Educational Intelligence.

CAMBRIDGE.—The Botanic Garden Syndicate reports that with the aid of a further generous gift from Mr. Reginald Cory, it is proposed to provide a house for the Director of the Garden. The Local Lectures Syndicate has presented its fifty-first and last report, it having been superseded by the new Board of Extra-Mural Studies. The report makes reference to the loss suffered by the cause of adult education through the death on Mount Everest of Mr. Leigh-Mallory, Assistant Secretary for Lectures, and also through the death of Prof. H. V. Stanton and Prof. R. G. Moulton.

The Lees-Knowles lectures on military science are being given by Lieut.-Col. F. Nosworthy, on Russia before, during, and after the Great War.

Mr. D. R. Hartree and Mr. E. A. Watkins have been elected to fellowships at St. John's College.

The following have been elected to serve on the

Council of the Senate:—The Master of Corpus Christi and the Master of Sidney Sussex, Sir Ernest Rutherford (Trinity) and Prof. A. E. Brooke (King's), Mr. J. F. Cameron (Gonville and Caius), Mr. F. A. Chase (Trinity Hall), Mr. J. M. Keynes (King's), and Dr. P. H. Winfield (St. John's).

For the fifth year in succession Trinity College announces the offer of a Research Studentship open to graduates of other universities who propose to come to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be so much as 200*l*. a year if the pecuniary circumstances of the successful candidate require so large a sum. Applications must reach the Senior Tutor of the College by July 25, 1925. The College is also offering, as usual, Dominion and Colonial Exhibitions of 40*l*. or (in cases of special need) about 72*l*. to students of Dominion and Colonial universities who wish to come to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. Candidates must apply through the principal authority of their University, and applications should reach the Senior Tutor of the College (from whom further particulars may be obtained) by July 1, 1925.

GLASGOW.—Prof. H. H. Dixon, whose appointment by the Crown to the Regius chair of botany in the University was recently announced, has intimated to the Secretary for Scotland that, for private reasons, he is unable to accept the appointment. The chair is therefore still vacant, and steps will be taken in due course to make another appointment.

OXFORD.—On November 4, Convocation approved the nomination of Dr. H. Eltringham, New College, as a Curator of the Hope Collections.

A decree has passed Congregation authorising the expenditure of 3000*l*. towards the expense of providing a joint lecture-room, library, and workshop for the Departments of Physiology and Biochemistry.

ST. ANDREWS.—At a meeting of the University Court on October 31, Mr. A. M. Adamson was appointed assistant in the Department of Zoology at St. Andrews, in succession to Mr. D. R. R. Burt.

APPLICATIONS are invited by the Birmingham Education Committee for the headship of the Engineering Department of the Birmingham Municipal Technical School. The necessary form of application, with particulars of the appointment, may be had from the principal of the school, or the Chief Education Officer, Education Office, Margaret Street, Birmingham.

AN article on "Safeguarding the Health of University Students in Europe," by Jean Willems, Secretary of the University of Brussels, appears in the July number of the Review of that University. Brief accounts of what is being done in this matter in other countries are followed by a somewhat fuller description of the work of the German university students' mutual-aid associations and other organisations with which they co-operate. One of the questions they have taken up is that of annual medical examinations. In Dresden, Tubingen, Giessen, Heidelberg, Stuttgart, and Münster-in-Westphalia, schemes for promoting such examinations have been established, generally on a voluntary basis. Students whose health has suffered through being obliged to engage in manual work in order to support themselves while studying, have been sent during the past year to the number of some hundreds for rest cures to rest-homes established for the purpose, where they are treated free of charge by the local physicians. Tuberculous students have been the object of special solicitude. In the autumn of 1923, 160 were lodged in sanatoria for consumptives at the expense of mutual-aid associations and with the collaboration of the German Red Cross Association.

THE Calendar for 1924–25 of University College, London, includes in a thirty-page section devoted to post-graduate courses of lectures a prospectus of work in the new Ramsay Department of Chemical Engineering, the object of which is "to enable young graduates in Chemistry *or* Engineering, who have already obtained a good training in the fundamental sciences of Chemistry, Physics and Mathematics, to direct their studies and investigations towards the application of the principles of Physical Chemistry to the scientific design and operation of the apparatus and processes of chemical industry in general." The second year of the two-year course will be devoted to original research in the laboratories or at industrial works, and will include lectures dealing with the lay-out of plants and factories, factory administration, and industrial economics. The Provost's report mentions that a record of the achievement of a hundred years of work is being prepared for the celebration to take place in 1926. Some strong comments are made by the Dean of the Faculty of Medical Sciences, and endorsed by the Provost, on the present organisation of medical examinations in the University of London: "We are fettered by a rigid system of examinations which was devised to ensure the attainment of a least common standard in a number of different schools; unfortunately this system, with even greater certainty, checks any advance beyond such a minimum standard." A movement within the University for bringing these examinations more closely into line with modern teaching is in progress. Appended to the report is an address by the Rt. Hon. Edward Wood on the effect of education on public opinion.

WRITING on "Pioneer Medical Women" in the *Fortnightly Review* for November, Mrs. Fenwick Miller recalls the fact that when the first British Register of Medical Practitioners was established by Act of Parliament in 1858, there was no medical examination open to women in Great Britain, and that the one woman whose name appeared in that register, Elizabeth Blackwell, had obtained her medical education in the United States, at the University of Geneva in the State of New York. After taking her degree she came to England to study at St. Bartholomew's Hospital, where she was admitted to all departments except that of the diseases of women, the professor of which subject "entirely disapproved of a lady studying medicine." She returned to the United States and founded a hospital there and a medical school for women. Miss Elizabeth Garrett (Mrs. Garrett Anderson) qualified for the Licentiate of the Apothecaries Society in 1865, but shortly afterwards the Council of the Society took measures to prevent any other women from following this example. The true pioneer of medical women in Great Britain was Sophia Jex-Blake, born in 1840, and the greater part of the article is devoted to an appreciation of her career—one which fulfilled de Vigny's definition of "une grande vie," namely "une pensée de la jeunesse exécutée par l'âge mûr." She early formed a determination "not to seek a medical career for herself alone, but to open the road to an equal medical standing with men for all other women who wished to follow." The story of her indomitable persistence in pursuing this aim is a stirring one—painful, too, by reason of the discreditable character of much of the opposition she encountered. Her greatest achievement was the establishment of the London School of Medicine for Women, which has this year celebrated its jubilee.

Early Science at the Royal Society.

November 16, 1664. The Secretary produced a small French book, written by father Charles Burgonis against Monsieur Pascal's treatise of the equilibrium of liquors and the weight of the air. The president took it home for his perusal, in order to give an account of it to the society.

1667. Mention being made, that a security might be provided for such inventions or notions, as ingenious persons might have, and desired to secure from usurpation, or from being excluded from having a share in them, if they should be lighted on by others; it was thought good, if any thing of that nature should be brought in, and desired to be lodged with the society, that, if the authors were not of their body, they should be obliged to show it first to the president, and that then it should be sealed up both by the small seal of the society, and by the seal of the proposer; but if they were of the society, then they should not be obliged to shew it first to the president, but only to declare to him the general heads of the matter, and then it should be sealed up, as mentioned before.

1676. Mr. Oldenburg communicated a third letter to himself from Signor Cassini, acquainting the Society with some of the astronomical observations made in 1672, by Mons. Rocher, at Cayenne in America, whither he had been sent by the Royal Academy of Sciences at Paris.

1681. The president (Sir Christopher Wren) discoursing concerning the library of the Society, promised to give five pounds to be expended on books of geometry.

November 18, 1663. Mr. Palmer presented the society with a very artificial gun of Caspar Calthof's contrivance, lodging at a time seven bullets and powder in proportion, and discharging them at seven several times. He had the thanks of the society; and it was ordered, that he should be registered as a benefactor. Sir Robert Moray mentioned, that prince Rupert had contrived a gun exceeding all that had hitherto been invented of that kind, discharging several bullets with ease and without danger. Sir Robert Moray was desired to request prince Rupert to send his powder-tryer with a loose and fixed ferrel to the society, to try his experiments of the force of powder therein.

November 19, 1662. Dr. Charlton gave an account of making the powder for embalming birds, and preserving them and their feathers to the life. He was desired to communicate in writing the whole process, according to the relation made by him.

1668. Mr. Oldenburg read a letter from the vice-chancellor of the university of Oxford to Mr. Boyle, importing, that he would endeavour to procure an exchange of the manuscripts now in the possession of the society, for such books as were proper for their purpose.—Mr. Oldenburg produced the curiosities sent from the Bermudas which he had lately retrieved, after having been missing for several weeks, the captain of the ship, to whom they had been recommended, not remembering what was become of them.

November 20, 1673. The lord bishop of Salisbury acquainted the Society, that those eminent citizens of London, who had been formerly deputed by the City and the Mercers' company to invite the Royal Society to return to Gresham College, viz., Sir John Laurence, Sir Richard Ford, Sir Thomas Player, and Mr. Rowland Wynne, had, upon occasion expressed, that they should esteem it as an honour to be elected into the Royal Society: whereupon his lordship now proposed them all four as candidates.

Societies and Academies.

LONDON.

Royal Society, November 6.—T. R. **Merton**: On ultra-violet spectro-photometry. A "neutral wedge" of platinum can be used for measurements of radiations so short as $\lambda = 2100$A. These "wedges" require to be calibrated, both as regards the thickness of the platinum as a function of the distance from the thin end of the wedge, and as regards the density gradient for a given change in the thickness of the platinum as a function of the wave-length. The density gradient is sensibly constant from $\lambda = 4000$A to $\lambda = 2500$A.—W. L. **Bragg** and S. **Chapman**: A theoretical calculation of the rhombohedral angle of crystals of the calcite type. The structure of calcite found by X-ray analysis is built on a series of rhombohedral cells, the edges of which meet at an angle of 101° 55′. Other carbonates and sodium nitrate have a very similar form. The rhombohedral angle of about 102° which is present in all cases is not fixed by the symmetry. The angle has been calculated by a consideration of the equilibrium of the calcite structure. It is assumed that the electrostatic forces correspond to those between a charge of $+2e$ at the centre of the calcium atom, $-2e$ at the centre of the oxygen atom, and $+4e$ at the centre of the carbon atom, and that the force of repulsion is directed from the electrostatic centre of each atom. The crystal is given a deformation which does not alter the distance between neighbouring atoms, so that the forces of repulsion do no virtual work. The electrostatic energy for each configuration is then calculated and a value for the rhombohedral angle found which makes the energy a minimum. This is the condition for equilibrium. The rhombohedral angle so calculated differs by 3° or 4° from the observed value. The alteration in rhombohedral angle, when one metal is substituted for another, is very exactly explained.—O. W. **Richardson** and T. **Tanaka**: (1) The striking and breaking potentials for electron discharges in hydrogen. There are three types of discharge from a thermionic electron-emitting cathode in hydrogen at pressures below 1 mm. The striking and breaking potentials for the discharge which sets in at the lowest voltages have the following properties: (*a*) They fall to a limit as the electron emission of the cathode increases; (*b*) these limiting values have a minimum for a pressure which depends on the electrode distance; (*c*) as the electrode distance is diminished the minimum values of the breaking potential approach a lower limit asymptotically. This limit coincides with the strongest ionisation potential of hydrogen. Spectroscopic evidence is adduced in favour of the view that the type of ionisation which occurs at this point is the splitting of an electron from the hydrogen molecule with the formation of ionised H_2. A considerable number of the lines in the secondary spectrum are selectively affected as regards intensity in the different types of discharge. (2) On a P, Q, and R combination in the many-lined spectrum of hydrogen. Starting from a study of the lines of the secondary hydrogen spectrum which are selectively weakened in a thermionic discharge tube at pressures less than 1 mm., we have been able to arrange 24 lines of this spectrum as members of series, with the designations $P(1) \ldots P(9)$, $Q(1) \ldots Q(5)$ $Q(7)$ $Q(8)$, $R(1) \ldots R(9)$; 15 of the lines satisfy the combination principle

$$P(m+1) + R(m\ 1) = Q(m+1) + Q(m)$$

to within 0·38 wave-number or less. Two others satisfy it to within 0·86. One of these is known to be a blend, and probably the other is also. The term numbers are not accurately represented by the theoretical formulæ of Kramers and Pauli. The calculated initial and final values of the moments of inertia of the emitters of these lines are $6 \cdot 24 \times 10^{-41}$ and $4 \cdot 80 \times 10^{-41}$ gm. cm.^{2} respectively, and it is probable that the emitter is something heavier than H_2, perhaps H_3.—J. D. **Bernal**: The structure of graphite. The structure of graphite has been examined by the method of the rotating single crystal. The structure is essentially that of Hull, but with all the carbon atoms lying in the cleavage plane, as in the Debye and Scherrer model.—P. L. **Kapitza**: α-ray tracks in a strong magnetic field. Photographs by the Wilson cloud method of α-ray tracks have been taken in magnetic fields of 40,000 to 80,000 gauss. The tracks are curved, and give values for the ratio of the average charge to the velocity of an α-particle at various points along its range. The differences in curvature between individual tracks are probably due to the natural curvature of α-particle tracks.—C. N. **Hinshelwood** and R. E. **Burk**: The homogeneous thermal decomposition of nitrous oxide. The bimolecular nature of the thermal decomposition of nitrous oxide into its elements has been confirmed by a more conclusive method than that previously used by Hunter. The reaction is homogeneous from 838° abs. to 1125° abs. and uncatalysed by platinum or rhodium. The observed rate of reaction can be interpreted in terms of simple thermal activation of the molecules by collision.—C. N. **Hinshelwood**: The kinetics of the interaction of nitrous oxide and hydrogen. The rate of interaction of hydrogen and nitrous oxide has been investigated in the absence of catalysts and in the presence of platinum. The rate of reaction on a platinum wire was followed by measuring the change in the thermal conductivity of the gas mixture as the reaction proceeds. Hydrogèn forms a film on the platinum which retards the reaction. Nitrous oxide reacts with hydrogen when it enters the gaps in this film. The latent heat of evaporation of the film of adsorbed hydrogen, inferred from the effect of temperature on the rate of reaction, is about 25,000 calories per gram molecule.—A. T. **Doodson**: Perturbations of harmonic tidal constants. An examination of the results of analyses of tidal records, as expressed in the so-called "harmonic constants," shows the influences of tidal friction, while one of the perturbations examined has importance in connexion with the dynamical theory of tides in oceans. Some secular changes show that the tides are diminishing in range at some places and increasing in range at other places; changes in the basins of the seas are suggested in explanation.—K. R. **Ramanathan**: The structure of molecules in relation to their optical anisotropy. Pt. I.—R. W. **Wood**: Controlled orbital transfers of electrons in optically excited mercury atoms. Mercury vapour, *in vacuo* at room temperature, is optically excited by illumination by radiation of wave-length 2536. This raises the electrons from the $1S$ orbit to the $2p_2$ orbit. Simultaneous illumination by one or more monochromatic radiations raises the electrons to high levels. From these levels they return to the inner orbits, the vapour radiating wave-lengths corresponding to the orbital transitions involved. By comparing the intensities of the spectrum lines obtained in this way, statistical data regarding the probability of definite transitions under specific conditions may be obtained. Remarkable effects have been observed when helium, nitrogen, and other gases are mixed with the mercury vapour. The addition of nitrogen at 2 mm. pressure causes a thirty-fold increase in the intensity of the green light ($\lambda = 5461$) emitted by the vapour. In this case the phenomenon was found to be associated with the absorption of the line 4046, which is not absorbed at all by optically excited mercury vapour *in vacuo*. The nitrogen apparently brings the electrons on to the $2p_3$ orbit (instead of $2p_2$), for all lines corresponding to transfers from outer orbits to $2p_3$ are powerfully absorbed by the mercury vapour when it is simultaneously illuminated by the 2536 line. Other lines and bands appear with the arc lines of mercury, when other gases are present, notably the great "water-band" in the vicinity of the mercury lines 3125-3131.

Aristotelian Society, November 3.—Prof. A. D. Lindsay, president, in the chair.—Presidential address: What does the mind construct? Many attempts have been made to describe knowing as a process in which the mind is passive, but all have broken down before the fact that at least in error there is something which the mind itself has brought into being. There is, however, a type of mental constructing done in the service of knowledge which alters neither knower nor what is known. The map of a country is a physical reality in the same meaning as the country it represents, and apprehended in the same way, yet it is a mentally constructed thing. This kind of mental construction is possible because there are parts of reality, our bodies, for example, which we control and vary, and other parts over which we have little or no control. These mental constructions which aid us to understand are not copies of the reality they represent; they are diagrams containing in an apprehensible form the elements we want to study. The same is true of mental images, which are the work of constructive imagination. They are of the same kind as models or maps or words. Images involve for their existence a body with a mind and objects external to and acting upon that body. Wherever there is anything of which we can ask whether it is true or false, there is something made by the help of our body, of which we can be aware in the same way as we are aware of the reality to which it refers and to which, if true, it corresponds.

SHEFFIELD.

Society of Glass Technology, October 15.—Col. S. C. Halse, president, in the chair.—Prof. W. E. S. **Turner**: The present position of the glass industry in North America. The cut glass industry has almost entirely died out in America, but coloured glass is growing more important. Pot furnaces are disappearing in favour of tank furnaces. The latter are now being used even for the manufacture of green and blue signal lights, and for selenium ruby glass. Electric light bulbs are practically all made by machines fed from tank furnaces, the glass being the soda-lime-magnesia type. The tubing required for the completion of the lamp is still of the lead glass variety. An epoch-making process for the manufacture of sheet glass is that developed at the glass works of the Ford Motor Company. The glass is melted in tanks, and there is continuous rolling between a pair of rollers, the sheet passing down a lehr about 440 ft. long and afterwards, in sheets, traverses long tables on a continuous belt, where the grinding and polishing are done. The average life of a tank furnace operated by machines is 11 to 13 months. Several factories can show a ratio of fuel consumed to glass produced so low as 0·6.

PARIS.

Academy of Sciences, October 20.—M. Guillaume Bigourdan in the chair.—Henry Le **Chatelier**: The allotropy of glass (p. 731).—Jules **Andrade**: The hypothesis of practical chronometer makers and the method of Résal-Caspari.— **Berloty**: The total eclipse of the moon of August 14, observed at the Ksara Observatory (Libau). Details of results obtained with the 20 cm. equatorial and with an 11 cm. telescope.—Edouard **Imbeaux**: The great artesian basins of the United States.—Johs **Schmidt**: The immigration of the larvæ of the eel, in the Mediterranean, by the Straits of Gibraltar (*v.* NATURE, January 13, 1923, p. 51, and January 5, 1924, p. 12).—Jules **Drach**: The movement of a heavy solid with one point fixed. Determination of the group of rationality of the differential equation of the problem.—René **Garnier**: The uniform functions defined by the inversion of total algebraical differentials.—G. **Valiron**: Complements to the Picard-Borel theorems.—Serge **Bernstein**: The quasi-analytical functions of Carlemann.—Bertrand **Gambier**: A generalisation of the polygons of Poncelet.—J. **Grialou**: Plane vertical movement of liquids possessing viscosity, the state being permanent.—Benjamin **Jekhowsky**: The elements of the planet Algiers N (1924 QL).—J. **Guillaume** and Mlle. **Bloch**: Observations made at the Lyons Observatory during the eclipse of the moon, August 14, 1924.—W. **Abbott**: The breaking-up of the southern polar cap of Mars.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the first quarter of 1924.—R. **Jouaust**: The amplification of the current of photoelectric cells and its application to precision astronomy. It is possible with simple arrangements to determine on a photographic recorder the time of transit of a bright star if the telescope is of sufficient size. If very sensitive photographic galvanometers are used, such as a string galvanometer, smaller telescopes may be used for observations on less bright stars.—Nicolas **Perrakis** and Pierre **Bedos**: A law connecting the ionisation potential of an element with its boiling point. A formula is given for the relation between the ionisation potential and boiling point and the values calculated for fifteen elements. The calculated and experimental values are in fair agreement, with the exception of the two elements oxygen and nitrogen.—A. **Dufour**: The wave-length of maximum energy of the sound spectrum of an explosion. Analysis of the records of the sound wave of the Courtine explosion gives results in agreement with the theory of M. Villard, that the wave-length of maximum energy in the sound spectrum of an explosion varies with the mass of explosive employed.—Mlle. Irène **Curie** and Nobuo **Yamada**: The distribution of the length of the α-rays of polonium in oxygen and in nitrogen. From the results described, it follows that the difference of form between the Bragg curves in oxygen and in nitrogen must be attributed to the law of variation of ionisation along an α-ray.—Georges **Chaudron** and Hubert **Forestier**: The allotropy of the oxides of iron, chromium, and aluminium.—C. G. **Bedreag**: Physical system of the elements.—A. **Duboin**: The silicate compounds of cadmium. The compounds $K_2O . CdO . 4SiO_2$, $2CdO . SiO_2$, and $3CdO . SiO_2$ have been isolated.—M. **Risco**: Spectrum analysis of the meteorite of June 19, 1924. The meteorite was shown to contain magnesium, aluminium, silicon, potassium, calcium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, strontium, and possibly barium.—David **Rotman-Roman**: Some volcanic rocks of the Yémen. Analyses and descriptions of comendite and plagitrachyte.—Gustave **Rivière** and Georges **Pichard**: Contribution to the study of the immediate principles contained in apple leaves and the epidermis of apples. The *malol* extracted by Sands from the skin of apples is an acid-alcohol, and is re-named by the authors maloloic acid.—F. **Picard**: Contribution to the study of the physiological rôle of the tannins. Their importance in the ripening of the shoots of the vine.—Marc **Bridel**: The fermentation hydrolysis of gentiacauline. Preparation of a xylo-glucose, primeverose. Two ferments have been prepared capable of hydrolysing gentiacauline, one prepared from the seeds of *Rhamnus utilis*, the other from *Monotropa Hypopitys*. Both give the same products, gentiacauleine and a new xylo-glucose probably identical with the primeverose of Goris, Mascré, and Vischniac.—H. **Lagatu** and L. **Maume**: A remarkably regular evolution of certain physiological ratios (lime, magnesia, potash) in the leaves of a well-manured vine.—L. **Léger**: An organism of the parasitic Ichthyophone type in the digestive tube of *Lota vulgaris*.—G. **Guittonneau**: The utilisation of mineral nitrogen by the Microsiphoneæ of the soil.—Auguste **Lumière**: Contribution to the study of normal sera.

Official Publications Received.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 8: Het Klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies). Door Dr. C. Braak. Deel 1 (Vol. 1), Algemeene Hoofdstukken (General Chapters), Aflevering 6 (Part 6). (With English Summaries.) Pp. iv+343-415+159-198. (Batavia: Javasche Boekhandel & Drukkerij.)

Journal of the Chemical Society: containing Papers communicated to the Society. 1924, Vol. 125, October. Pp. iv+1971-2197+xii. (London: Gurney and Jackson.)

Monographs of the Rockefeller Institute for Medical Research. No. 20: Experimental Studies of Yellow Fever in Northern Brazil. By Dr. Hideyo Noguchi, Dr. Henry R. Muller, Dr. Octavio Torres, Dr. Flaviano Silva, Dr. Horacio Martins, Dr. Alvaro Ribeiro dos Santos, Dr. Godofredo Vianna, and Dr. Mario Bião. Pp. 36+5 plates. (New York City.)

Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association. Entomological Series, Bulletin No. 16: The Introduction into Hawaii of Insects that attack Lantana. By R. C. L. Perkins and O. H. Swezey. Pp. iii+83. (Honolulu, Hawaii.)

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University, for the Years 1922 and 1923. Vol. 16. 47 papers, unpaged. (Cambridge, Mass.: Harvard University.)

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 4: Some Digestibility Trials on Indian Feeding Stuffs. By Dr. P. E. Lander and Pandit Lal Chand Dharmani. Pp. 77-100. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1*s*.

The Parliament of the Commonwealth of Australia. Meteorological Service: Report to the Right Honorable the Minister for Home and Territories in the Meteorological Service of the Commonwealth for the Year 1922–1923. Pp. 18. (Melbourne: H. J. Green.) 9*d*.

Memoirs of the Asiatic Society of Bengal. Vol. 6: Zoological Results of a Tour in the Far East. Edited by Dr. N. Annandale. Part 9: Fish of the Talé Sap, Peninsular Siam (Part 1), by Dr. Sunder Lal Hora; Fish of the Tai-Hu, Kiangsu Province, China, by Henry W. Fowler; Revision of the Japanese Species of the Genus *Corbicula*, by Dr. B. Prashad. Pp. 461-530. (Calcutta.) 3.6 rupees.

Battersea Polytechnic. Report of the Principal for the Session 1923–24. Pp. 36. (London: Battersea, S.W.11.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 46: Four new Species of Coccidæ from Egypt. By W. J. Hall. Pp. ii+8+6 plates. (Cairo: Government Publications Office.) 5 P.T.

Proceedings of the Royal Irish Academy. Vol. 36, Section B, No. 12: The Glacial Geology of the North-West of Ireland. By Prof. J. Kaye Charlesworth. Pp. 174-314+plates 8-9. 8*s*. 6*d*. Vol. 36, Section B, Nos. 13, 14, 15, 16: Dichromone and Dibenzyldichromone, by Dr. Joseph Algar, Francis Fogarty and Dr. Hugh Ryan; The Condensation of Aldehydes with Butylacetoacetic Ester, by Dr. Hugh Ryan and Mary J. Shannon; The Condensation of Aldehydes with Methylethylketone, by Dr. Hugh Ryan and Patrick J. Cahill. Pp. 315-339. 1*s*. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Methods and Problems of Medical Education. (First Series.) Pp. 151. (New York City: The Rockefeller Foundation.)

Diary of Societies.

SATURDAY, NOVEMBER 15.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11.—Dr. W. Robinson: Conditions controlling Growth and Reproduction in Sporodinia.—A. W. Exell: Hymenial Structure in Three Species of Stereum.—W. J. Dowson: A Die-back of Rambler Roses caused by *Gnomonia Rubi* Rehm.—Miss Clara A. Pratt: The Staling of Fungal Cultures.—J. Ramsbottom: Fragmenta Mycologica.

PHYSIOLOGICAL SOCIETY (at London Hospital Medical School), at 4.—I. Sands: Self Oxidation in the Blood of the Earthworm.—Dr. J. M. H. Campbell, G. O. Mitchell, Dr. M. S. Pembrey, and A. T. W. Powell: The Effect of Muscular Work upon Digestion.—Dr. M. S. Pembrey: The Weight of the Heart in Different Conditions.—Dr. W. Cramer: Self Control and Inhibition in the Adrenal.—Dr. A. V. Anrep and Prof. E. H. Starling: Central and Reflex Regulation of the Circulation.—Prof. H. E. Roaf and W. A. M. Smart: Some Equations based on the Application of the Mass Law to Oxyhæmoglobin Dissociation Curves.—J. R. Marrock: Comparison of Chloride and Iodide Excretion in

Nephritis.—I. de Burgh Daly: A Closed Circuit Heart-Lung Preparation.—Dorothy Patrick: Some Effects produced by the Hooding of Birds.—N. Burgess: The Comparison of Maternal and Fœtal Blood Sugar after the Second Stage of Labour.—Dr. C. S. Myers: A Theory of Sensory Adaptation.

MONDAY, NOVEMBER 17.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. D. Cockcroft, R. T. Coe, J. A. Tyacke, and Prof. Miles Walker: An Electric Harmonic Method of Analysis.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Major E. G. Beaumont: The Maintenance of Commercial Vehicle Fleets.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. Bagenal: Planning for Good Acoustics.

SOCIETY OF CHEMICAL INDUSTRY (London Section, Joint Meeting with the Institution of the Rubber Industry) (at Engineers' Club, Coventry Street, W.), at 8.—Dr. A. van Rossem: Latex: its Chemistry and the Development of its Industrial Applications, followed by a discussion opened by B. D. Porritt.

FARADAY SOCIETY (at Chemical Society), at 8.—R. W. E. B. Harman and F. P. Worley: The Hydrolysis of Alkali Cyanides in Aqueous Solution.—Prof. A. P. Laurie: Note on the Expansion of Water while freezing.—S. S. Joshi: The Viscosity of Reversible Emulsions.—D. B. MacLeod: (*a*) The Viscosities of Liquids at their Boiling Points; (*b*) The Kinetic Theory of Evaporation.—J. T. Howarth and F. P. Burt: New Design for Apparatus to measure the Coefficient of Deviation from Boyle's Law, and the Determination of this Coefficient for Acetylene.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. M. W. Hilton-Simpson: The People of the Aures Massif.

TUESDAY, NOVEMBER 18.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—G. Udny Yule: The Growth of Population and the Factors which control it (Inaugural Address).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of October 1924.—L. C. Bushby: Exhibition of Specimens from the Caird Insect House.—A. N. Rankin: Exhibition of Photographs taken during the Oxford Spitsbergen Expedition.—M. Burton: A Revision of the Sponge Family Donatidæ.—P. R. Lowe: The Anatomy and Systematic Position of the Madagascan Bird Mesites.—Sir Frederick Mott: Notes on the Gibbon Larynx made during Dissection.—Dr. Ekendra Nath Gosh: The Anatomy of *Parallepipedum* Klein (Mollusca).

INSTITUTION OF CIVIL ENGINEERS, at 6.—W. J. Hadfield: Notes on Modern Practice in Road-making.

ROYAL SANITARY INSTITUTE, at 6.—Miss J. B. N. Paterson and others: Discussion on the Economic Value of the Healthy Infant and the New Zealand Welfare Work to the State.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. McGovern: The Influence of Internal Combustion Engines on the Design of Merchant Ships.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45.—W. Lawson: General and Technical Ideas from the Experience of a Meter Engineer.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at 17 Albert Square, Manchester), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. P. H. Trivelli, E. P. Wightman, and S. E. Sheppard: Note on the Relationship of Photographic Emulsion Fog to Grain Size.—S. E. Sheppard: Grain Size and Distribution in Emulsions.—L. F. Davidson: Conditions governing the Behaviour of the Silver Bromide Grains during Development.—Cambridge Instrument Company, Ltd.: Demonstrations of the Cambridge Photographic Ophthalmoscope and the Cambridge Record Measuring Machine.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Star and Garter Hotel, Wolverhampton), at 7.30.—Major E. G. Beaumont: The Maintenance of Commercial Vehicle Fleets.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Discussion on paper entitled A Proposed Form of Bow Construction, by E. F. Spanner.—G. Austin: A New Electric Drive for Ship and other Auxiliaries.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Reports on Important Events during the Vacation (World Power Conference, Conference on Illuminating Engineering at Wembley, Meeting of International Illumination Commission, International Conference on Industrial Hygiene, etc.), and Developments in Lamps and Lighting Appliances.

ROYAL ANTHROPOLOGICAL INSTITUTE (at London School of Economics, Houghton Street, W.C.), at 8.15.—Capt. M. W. Hilton-Simpson and J. A. Haessler: Native Life in the Algerian Hills.

WEDNESDAY, NOVEMBER 19.

SOCIETY OF GLASS TECHNOLOGY (at Leeds), at 2.30.

BRITISH CAST IRON RESEARCH ASSOCIATION (at Institution of Mechanical Engineers), at 3.30.—Annual Meeting.

MEDICAL SOCIETY OF LONDON, at 5.—Dr. H. Spencer: The Renaissance of Midwifery (Lloyd Roberts Lecture).

ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Gilbert Walker: Note on Bjerknes's Contribution of 1921 to the Mechanics of the General Circulation.—W. H. Dines: The Correlation between Pressure and Temperature in the Upper Air, with a suggested Explanation.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.

INSTITUTION OF CIVIL ENGINEERS (Students Meeting), at 6.—P. W. Thomas: Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.

ROYAL SOCIETY OF ARTS, at 8.—L. B. Atkinson: The Scientific Principles of Artificial Incubation.

INSTITUTE OF CHEMISTRY (London Section), at 8.—Dr. J. J. Fox and V. Stott: Discussion on the Standardisation of Scientific Glassware, with Particular Reference to Units of Volume.

INSTITUTE OF CHEMISTRY AND SOCIETY OF CHEMICAL INDUSTRY (at Caledonian Station Hotel, Edinburgh), at 8.—Prof. G. G. Henderson: The Profession of Chemistry.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.), at 8.—Dr. C. W. Saleeby: Heredity and Degeneracy—some New Discoveries (to be followed by a discussion).

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—G. R. de Beer: Comparative Histology and Cytology of the Pituitary Body.—Miss J. Latter: Pollen Development in Lathyrus.—Dr. W. N. F. Woodland: Some Remarkable Caryophylloeids from Siluroid Fishes of the Sudan.

THURSDAY, NOVEMBER 20.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at 11 Chandos Street, W.), at 2.30.—Dr. G. de M. Rudolf: Malarial Treatment of General Paralysis—some Psychological and Physical Observations.

ROYAL SOCIETY, at 4.30.—Prof. J. Barcroft, M. L. Anson, A. E. Mirsley, and S. Oinuma: The Correlation between the Spectra of various Hæmoglobins and their Relative Affinities for Oxygen and Carbon Monoxide.—H. R. Hewer: Certain Abnormalities occurring in the Pituitary of the Frog.—*To be read in title only*:—A. Howard: The Effect of Grass on Trees.—Dr. J. W. Pickering and Dr. F. E. Taylor: Blood Coagulation, Anti-Coagulants and Hæmolysis.—R. J. Ludford: The Distribution of the Cytoplasmic Organs in Transplantable Tumour Cells: with special reference to Dictyokinesis.—E. Ponder: The Balloon-like Structure of the Mammalian Erythrocyte.—V. B. Wigglesworth: Uric Acid in the Pieridæ: a Quantitative Study.—Dr. G. Lindsay Johnson: Contributions to the Comparative Anatomy of the Reptilian and the Amphibian Eye, chiefly based on Ophthalmological Examination.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. F. W. Oliver: Then and Now; Photographs taken after Several Years' Time.—C. J. Wills: Eobuthus, a Fossil Scorpion.—J. R. Norman: Blind Cave Fishes.—Miss E. M. Blackwell: *Cytisus Adami*.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—G. Rogers: Automatic and Semi-Automatic Mercury-Vapour Rectifier Substations.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates Meeting) (at Watergate House, Adelphi), at 7.30.—D. S. D. Williams, H. G. Harris, and others: Discussion on the Motor Cycle Show.

CHEMICAL SOCIETY, at 8.—F. Challenger, J. R. A. Jinks, and J. Haslam: The Sulphur Compounds of Kimmeridge Shale Oil. Part I.—F. Challenger and T. H. Bott: The Interaction of Thiocyanogen and of Hydrogen Sulphide with Insaturated Compounds. Part II.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at London School of Hygiene and Tropical Medicine, Endsleigh Gardens) (Laboratory Meeting), at 8.15.—Demonstrations by Major Austen, Dr. Broughton-Alcock, Dr. H. B. Day, Capt. W. H. Dye, Dr. Drbohlav, Dr. H. M. Hanschell, Dr. W. E. Haworth, Col. S. P. James, Col. Clayton Lane, Mr. Ll. Lloyd, Dr. Manson-Bahr, Dr. H. B. Newham, Col. Marrian Perry, Dr. J. Harvey Pirrie, Dr. H. H. Scott, Surgeon Commander T. B. Shaw, and A. L. Sheather.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Section) (at Birmingham).—F. W. Suffield: The Design of an Up-to-date Factory.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Section) (at Manchester).—W. S. Burge and P. J. Chittenden: Reducing or Pass-out Turbines.

FRIDAY, NOVEMBER 21.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—J. L. F. Vogel: Notes on Alloy Metals used in Alloy Steels.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Report of the Marine Oil-Engine Trials Committee.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—W. H. Ashbee: Photographic Exhibitions and the Public.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. G. Hopcraft: Stainless Steel.

INSTITUTE OF METALS (Sheffield Local Section) (at 198 West Street, Sheffield), at 7.30.—A. Marks: Non-Ferrous Metals in the Foundry.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Cleveland Institute, Middlesbrough), at 7.30.—R. H. Dealtry: Motor-Cycle Carburation.

INSTITUTION OF MECHANICAL ENGINEERS (Liverpool Section) (at Liverpool).—W. S. Burge and P. J. Chittenden: Reducing or Pass-out Turbines.

PUBLIC LECTURES.

SATURDAY, NOVEMBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Evolution and Darwinism.

TUESDAY, NOVEMBER 18.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. Bickerton: The Forces of Nature.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Philosophy of the Absolute in English Thought (1). Bosanquet's Philosophy of Reality and Value.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on November 19, 20, 21.)

WEDNESDAY, NOVEMBER 19.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Prof. J. B. Cohen: Smoke (Chadwick Lecture).

THURSDAY, NOVEMBER 20.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. J. S. Edkins: The Causation of Sex.

KING'S COLLEGE, at 5.30.—O. V. Salomón: Peru, Old and New (1). The Ancient Civilisation of Peru.

FRIDAY, NOVEMBER 21.

KING'S COLLEGE, at 5.30.—Prof. E. G. Coker: Scientific Method.

SATURDAY, NOVEMBER 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour-Browne: Social Life among Insects. II. Butterflies and Moths.