NATURE

SATURDAY, MARCH 13, 1926.

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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.

NO. 2941, VOL. 117]

British Science and Invention.

OF the importance of research to the electrical industry, or of the notable improvements in machines, appliances, and processes brought about in the industry by special investigation, there can be no question. The new types of electric lamps, which give far better light at a smaller cost than those they superseded, and the new forms of submarine cables enabling speeds of working to be increased three or four times, are but two familiar instances of the happy results of successful research. Formerly progress was achieved mainly by the discoveries of inquirers working single-handed, but nowadays we speak of team work and communal research. The simple apparatus of bygone days has given place to plant of an extensive and expensive character quite beyond the pocket of the ordinary individual, and because of this, the financial requirements of industrial research have to be seriously considered. The subject crops up at the meetings of every research association, and at the annual luncheon of the British Electrical and Allied Industries Research Association on February 12 provided the president, Mr. Ll. B. Atkinson, with a theme for his address.

The position of this particular Association, which was founded in 1920, is that though it is admitted it has done fine work with good results, yet the Department of Scientific and Industrial Research has had to announce that the grant to the Association for the next five years will be only half that given during 1920–25, while in 1930 it will be stopped altogether. Many of the leading technical journals have referred to this matter, and though it is generally regretted that the Department is withdrawing its support, yet there appears to be no doubt that the industry will rise to the occasion, find the whole of its own research fund, and probably benefit itself in so doing. The *Electrical Review* declares, "Research is no mere accomplishment, something merely ornamental; it is bedrock necessity," and "the partial withdrawal of Government aid must be accepted as a challenge to greater efforts." "Those who have saved large sums of money through the work of the Association know that it is so and ought to subscribe freely to its funds."

As to the position of the industry itself, it is a really active branch of engineering, and it has not had to go through the prolonged depression of many other branches. According to one return, the value of British electrical exports during 1925 exceeded those of both the United States and Germany, the figures for the three countries being: United Kingdom, 5,762,000*l.*; United States, 3,977,000*l.*; and Germany, 2,876,000*l.* From these figures it is evident that the withdrawal of the few thousands of pounds allocated

to the Research Association by the Government can make no very appreciable difference to the volume of research if all in the industry are fully alive to the fact that research is a sound proposition commercially.

In the course of his presidential address at the luncheon at the Savoy Hotel, Mr. Atkinson referred to the lack of national interest and understanding of scientific matters, and towards the close of his remarks said: "Research Associations and research workers are not asking for charity; they are urging that the present squalid civilisation should be replaced, as it can be, by a far better one, if applied knowledge in every sphere is encouraged and developed; that instead of being a last charge upon the resources of the nation, research should be a first charge." In pressing his claims, Mr. Atkinson referred in eloquent words to the epoch-making discoveries and invention of British men of genius, and to Great Britain, "which in science has towered above all others." He remarked that "modern industrial and scientific knowledge is almost wholly the production of British effort." He mentioned the work of men such as Watt, Bessemer, Faraday, Davy, Kelvin, Lockyer, Newton, and Joule in glowing terms. Not only in practical mechanics, but also in mathematics, in chemistry and in physics, Britain had led the way. As to electricity, "the voltaic battery and the magnetic action of currents of electricity are not British discoveries, but that said we have finished," while "our fundamental discoveries have been carried forward and applied by hundreds of brilliant workers in all lands, but the claim that every great step forward in modern science is a British product cannot seriously be refuted."

No one of British birth fully aware of the achievements of the men of our race can fail to be proud of our record, but whether we are justified in regarding ourselves as the fount and origin of these things to the extent implied by Mr. Atkinson may be doubted, and some of his statements would, we think, be difficult to substantiate before an impartial tribunal. If one speaks of Dalton and Davy, it is not right to forget Lavoisier. If Perkins laid the foundation of the coal-tar colour industry, it is well to remember he gained instruction and inspiration at the hands of Hofmann, to whom English chemists owe a great debt. At one time British students eagerly sought the laboratories of Magnus and Bunsen and Liebig. What sort of history of physical science could be written without a mention of Kepler, Galileo, Huygens, Leibnitz, Euler, Lagrange, Fresnel, Fourier, Regnault, and Helmholtz?

Though we are aware of the brilliant work of Englishmen in many fields of discovery, we should be surprised to find a foreigner who would assent to Mr. Atkinson's estimate. Neither barometer, telescope, thermometer, microscope, air-pump, Leyden jar, thermopile accumulator, phonograph, or gramophone can be claimed for Britain. If we have had our Arkwrights and Cromptons, others also have had their Vaucansons and Jacquards. In practical chemistry the French can claim Berthollet and Leblanc, the Belgians Solvay, and the Germans Achard, Wöhler, and Welsbach. Our title to the steam engine and locomotive and the fundamental processes in iron and steel manufacture cannot be disputed, but once launched upon industrial development, the United States in some ways surpassed the mother country. In a well-written and balanced "Popular History of American Invention," which appeared a short time ago, the writers had evidently been to some pains to give honour to whom honour was due, but just as Mr. Atkinson claimed the carbon incandescent lamp for Swan and failed to mention Edison, so the American writer gave the credit to Edison and omitted to mention Swan!

There have been many causes contributing to British eminence in the worlds of science and engineering. Great Britain was never cursed by such a disaster as the Thirty Years' War, neither were the industries of the country subject to the grievous taxation due to the extravagances of a Louis XIV. The success of British arms and the spread of British commerce both influenced national development, while with its freer political institutions Britain has from time to time been the asylum of many able foreigners who have added their quota to the common stock of knowledge. Of these the great Herschel is the outstanding example, but other names, such as Mond, Siemens, Dollond, De Moivre, and Sprengel will be recalled. It is most desirable that, if lessons from history are to be used to stimulate inquiry, the historical views should be broad and just, for, as Davy remarked when presenting the Copley medal to Arago, "Science like Nature, to which it belongs, is neither limited by time or space. It belongs to the world and is of no country and no age." The British share in the spread of natural knowledge was admirably set out in "Britain's Heritage of Science" by two distinguished men of science, but that review does nothing to detract from von Zittel's remark that "all civilised nations have shared in the development of the natural sciences, the history of any one of which must be to a certain extent the history of a scientific freemasonry." While this is true enough, Mr. Atkinson was perfectly correct in showing that British achievements in pure and applied science have had world-wide influence in modern civilisation, and his address should serve a useful purpose in enlightening the public as to the fertility and power of British scientific genius and purposeful invention.

Simple Natural History.

(1) *The Life Story of a Badger.* By J. C. Tregarthen. Pp. xvi+152+8 plates. (London: John Murray, 1925.) 6*s.* net.

(2) *Round about Sussex Downs.* By Frederick F. Wood. Pp. 222+8 plates. (London: Gerald Duckworth and Co., Ltd., 1925.) 7*s.* 6*d.* net.

(3) *The Natural History of Hertfordshire.* By Dr. A. Wilmore, Albert N. Wilmore, W. Graveson, Richard Morse and W. Bickerton. Pp. viii+152+16 plates. (London: G. Bell and Sons, Ltd., 1925.) 2*s.* 6*d.*

(4) *More Chats on British Mammals: Rodents and Bats.* By Dr. J. J. Simpson. Pp. 125+4 plates. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1925.) 2*s.* 6*d.* net.

(5) *The Unity of Life: a Book of Nature Study for Parents and Teachers.* By H. R. Royston. Pp. 281+16 plates. (London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1925.) 7*s.* 6*d.* net.

THE natural history of these small volumes is simple in the sense that it tends to confine itself to observations of first degree, and to avoid the more difficult ways of biological truth. This simplicity almost implies that its descriptions are of a kind made by many earlier observers, even where they have not been compiled from already existing sources of information. There is here, then, little that can be called new knowledge, but there is a great deal that is of interest to the general reader with a leaning towards natural history, and for such the books are intended. In their diversity they illustrate a noteworthy characteristic of natural science, the variety of avenues by which the subject may be approached; for although each is typical of a distinct class of treatment, any one might be taken as an easy introduction to the study of natural history.

Mr. Tregarthen's work (1) is an excellent example of the individual life-history. He traces with vividness and insight the adventures of one of the most interesting survivors of the old carnivore fauna of Britain, which he classifies in his own way—"scientists tell us that the badger belongs to the weasel tribe; to me, however, who am concerned more with its habits than its anatomy, it is a bear." In the course of his descriptions he brings out two very striking facts: the abundance of badgers in the Cornish district with which he is familiar—twenty-six earths from St. Ives to Land's End, averaging about one to every mile of coast, and eighty-one earths inland—and the extraordinary extent and ramifications of some of the century-old earths (one with forty-five holes), where many pairs of badgers repose in amicable security. It is gratifying to find that an English naturalist can avoid the tendency to a misleading anthropomorphism, which characterises a school (peculiarly American) of simple natural history, without sacrificing a whit of the interest of his story.

The nature essay is represented by (2). A series of disconnected chapters, with a geographical link, gathers up odds and ends of information which appeals to the lover of the country-side. The essays, which range from old country sayings to butterflies, bird life, foxes, dogs, hunting, coursing, etc., reveal great enthusiasm and close observation. Particularly interesting are the short chapters on tracks and tracking, and on the ingenuity displayed by hares in misleading hounds upon their scent.

A much more comprehensive treatise is the county natural history of Dr. Wilmore and his colleagues (3), in which are given simple accounts, adapted for school use, of the geology, physical geography, plant and animal life of Hertfordshire. Appendices to the sections suggest many promising experiments and exercises for the use of teachers and their pupils. The authors have wisely adopted a regional grouping of their information, for this affords an easy approach to the discussion of adaptation in both physical and biological spheres. The treatment in the latter sections, however, is unequal, and where 21 pages have been given over to mammals and 38 to birds, it is scarcely sufficient merely to mention that fishes, insects, and other invertebrates exist. The latter groups are not only of supreme importance to man, but they also form essential links in the chain of existence.

Dr. Simpson continues the systematic survey of British mammals (4), of which he has already issued one small volume. The present series of "ten-minute" broadcast "chats" contains concise yet well-balanced and wonderfully complete accounts of the appearance and habits of almost all the described species of British rodents and bats, special attention being directed to their human interest. The adoption of Latin systematic names as chapter headings is unnecessary, and must be repellent to many of the ordinary English readers for whom the book is intended.

Of our five types, "The Unity of Life" (5) is the most ambitious, for it essays to cover the field of general biology with a variety of purposes. It aims at assisting parents and teachers in imparting a systematic knowledge of nature-study, at educating the general reader who is interested in evolutionary biology, at instructing the elementary biologist in the wider principles of his science, and running throughout is the desire "to help all who are brought into close association with children to impart naturally and easily a knowledge of the main facts of the reproduction of life." The author

finds it difficult to keep his balance upon these many stools. The foundation of his work is laid on a modified type system, for he discusses in detail the relationships of a few selected examples, and here his descriptions are all that is required. But the foundation is too narrow to bear the superstructure of biological principles which he would erect upon it, with the result that the treatment of the wider aspects is sketchy and incomplete. The book will probably appeal most to teachers of school biology who wish to make plain the vital connexion between the botanical and zoological sides of their nature-study.

Physiology for Clinicians and Students.

(1) *Clinical Biochemistry*. By Dr. Ivan Maxwell. Pp. 124 (interleaved). (Melbourne: W. Ramsay, 1925.) 12*s*. 6*d*.

(2) *An Intermediate Text-book of Physiological Chemistry: with Experiments*. By Prof. C. J. V. Pettibone. Third edition. Pp. 404. (London: Henry Kimpton, 1925.) 15*s*. net.

(3) *Bainbridge and Menzies Essentials of Physiology*. Fifth edition, edited and revised by Prof. C. Lovatt Evans. Pp. viii + 508. (London: Longmans, Green and Co., 1925.) 14*s*. net.

PERHAPS the most striking development of physiological knowledge in recent years has been on the chemical side, which has been due to a great extent to new and more accurate methods of analysis. Mention need only be made of the advance in knowledge of the oxidative process in muscle, of basal metabolism, of hæmoglobin, and of the ductless glands. It is important that this knowledge should be made available for the clinician as soon as possible. The clinician, however, cannot be expected to apply to his problems the elaborate methods which are necessary for scientific research, unless he can appeal to some one with the necessary skill in a well-equipped laboratory. But since the chemical changes occurring in disease are often well-marked, methods which require but little apparatus or time for execution are sufficiently accurate to afford valuable information.

(1) The application of such methods to clinical work is well carried out in Dr. Ivan Maxwell's "Clinical Biochemistry." He has selected his methods with good judgment and has wisely refrained from making his book too large. Moreover, the book is not a mere reiteration of methods of analysis, for it is made interesting by some information about the diseases which lead to abnormalities in the blood and in the various secretions. The opening chapter on the urine is very well done, and is followed by an account of the estimations which can be made of renal efficiency. In this connexion we miss figures of urinary casts, glucosazone crystals, and of certain apparatus—in fact there are no diagrams at all. The book, however, is interleaved with blank sheets for the student to make his own drawings, and we think this is right. The chapter devoted to glycosuria is good, but might have been fuller with advantage, especially with regard to insulin. The estimations to be made in acidosis are well dealt with. There are welcome chapters on pancreatic efficiency and on hepatic efficiency, the van der Bergh's jaundice tests being given. There is also a very good account of gastric analysis—urinary sediments, calculi, variations in blood corpuscles and in hæmoglobin are all dealt with. The book can be safely recommended not only to the medical student but also to the clinician. A few slips have been left which would have been avoided by a careful revision of the proofs.

(2) Prof. Pettibone's text-book is a work of a very different character. It is divided into two parts, physiological chemistry and laboratory work. The latter part is the better, but some of the methods of analysis given are too elaborate for the clinician. The best chapters are those which deal with the proteins, the carbohydrates, the urine, and with blood analysis by Folia's well-known methods. The accounts of gastric and pancreatic digestion are scarcely adequate, for but little is given of the methods of testing gastric and pancreatic activity. The first part of the book is not well constructed; parts of it are quite elementary while other parts are highly technical and difficult. It must, however, be borne in mind that it is not easy to write a text-book on physiological chemistry, because it is almost impossible to say what processes are not chemical in the phenomena of life.

The book opens with a chapter on physical chemistry, with an account of hydrogen ion concentration and of colloidal solutions, and then deals with the chemical properties of the various substances connected with the animal body. All this is well done. The author then gives an account of digestion, bringing in scraps of knowledge about the processes of secretion and absorption, which are inadequate and some of them loose and inaccurate. It would have been better if these bits of physiological knowledge jumbled up with purely chemical matters had been omitted. There is a good chapter on protein metabolism, with an excellent account of the experiments initiated by Horace Fletcher, who, with his son-in-law, Dr. Van Sommeren of Venice, practised the chewing craze with such good results that several physiologists, notably Chittenden, investigated the effects of the low protein diet which the chewing leads to. Basal metabolism and vitamins, among other matters, are

well dealt with, but this cannot be said of the treatment of the endocrine glands. The book will not seriously compete with those already published in Great Britain.

(3) It is gratifying to know that the editing of Bainbridge and Menzies' well-known text-book on physiology has fallen into the able hands of Dr. Lovatt Evans. This book has long supplied enough sound physiology for the unambitious medical student who has not the time or the ability to read one of the larger text-books. It is a pity that it has not been purged of some of its truly dreadful diagrams, such as that of the tracts in the spinal cord. Several other diagrams in the chapters on the nervous system are crude and inaccurate; Fig. 36, for example, is quite wrong and does not agree with the description in the text. The drawings of real structures, however, are clear and good, and several new ones have been introduced. It is difficult to decide how much histology should be introduced into a book of this kind. Yet Ranvier's drawings of degeneration and regeneration of nerve fibres are put in, without any drawings of normal nerve fibres. It would be impossible to point out the many little additions which have been made, but a notable one is the account of the work of Sir Gowland Hopkins and his school on tissue oxidations. The book has grown a little—it will defeat its purpose if it grows much more. L. E. S.

Chemistry and Atomic Structure.

Chemistry and Atomic Structure. By Dr. J. D. Main Smith. Pp. 221. (London: Ernest Benn, Ltd., 1924.) 12*s.* 6*d.* net.

TO the author of this book belongs the credit of having been the first to suggest what appears to be the correct modification of the scheme originally proposed by Bohr for the distribution of electrons among the different levels and sub-levels in the atom. For example, in the completed *M*-level, according to this modification, in place of the 6.6.6-grouping of Bohr's original scheme, a 2.2.4.4.6-grouping is to be assumed. The probable correctness of this view is indicated by physical evidence, but the original presentation of it by the author was made in connexion with chemical considerations. A full statement of his evidence and reasoning, such as might be expected in this book, would therefore be exceedingly valuable, for it would be of the greatest interest to know whether the effects of differences in the electronic sub-grouping can be recognised in the chemical properties of the elements.

The first half of the book consists of an account of the development of the atomic and molecular theory from the speculations of Hindu and Greek philosophers to modern structural and stereo-chemical theories and the co-ordination theory of Werner; the second half gives an outline of some of the principal branches of atomic physics. It is in the last chapter that the deduction of the atomic structure of the elements from their chemical properties is considered, but the manner in which the evidence is presented is disappointing. It is difficult to gather from the statement there given a clear idea of what precisely the method is which has enabled the author to deduce the sub-grouping of the electrons from chemical facts. To take an example, he says: "The detailed chemical evidence, by which it can be shown that the first two valency electrons are differentiated in energy or firmness of binding from the third and fourth electrons, and that both of these pairs are differentiated from the remaining valency electrons, is so vast that no more than a tithe of this evidence need be cited to prove the point," and this is then given in the form of a series of chemical statements. But these statements have no obvious bearing on the question at issue. Thus the first is: "Cupric salts yield characteristically insoluble and stable di-pyridino-compounds." A careful explanation would be needed to show how this fact can be interpreted so that it can be brought into relationship with the detailed structure of the uncombined copper atom, but no explanation is given either of this or of the statements which follow it.

The difficulties involved on the electron-sharing theory of chemical combination in combining the two hypotheses: (1) that the maximum number of shared electrons is eight, and (2), that a single chemical bond always consists of two shared electrons, are discussed. The conclusion is drawn that the second hypothesis is to be abandoned, and the view is advocated that atoms are frequently linked through a single shared electron. (The author has further developed this view in a recent paper in *Chemistry and Industry*.)

It is then suggested that easily hydrolysable bonds contain only one electron whatever the valency of the atoms concerned. This, however, at once raises difficulties which seem to have been overlooked. For example, if the readily hydrolysable chlorine atom in the acid chlorides is linked through a single-electron bond, how are the remaining bonds of the carbon atom of the $-CO.Cl$ group to be interpreted?

The mechanism of electron-sharing is considered in an appendix. The possibility that the sharing is effected through the revolution of the electron in an orbit which encircles both nuclei is discussed in a passage that contains several errors, though in fairness to the author it should be stated that in the views which he expresses he is, in the main, following Prof. Morgan. The passage contains the following statements:

(1) "Obviously as such orbits have two foci of attracting nuclear charges, electrons cannot describe elliptic orbits." But it is well known that the ellipse is a possible and stable orbit for a particle revolving about two fixed masses situated at the foci.

(2) "The sections of equipotential surfaces about two equal similar charges [are] Cassinian ovals." (This statement is attributed to Clerk Maxwell.) Cassinian ovals, as is correctly stated, are curves in which the *product* of the distances of a point on the curve from the two foci is constant. But sections of the equipotential surfaces would only have this form in a field where the force varied inversely as the *first* power of the distance (as in that due to two parallel, infinitely long, straight, similarly charged wires). In the case under consideration it is the *sum of the reciprocals* of the two distances which is constant.

(3) If such a curve "is an orbit of constant potential [it is] consequently, a possible Bohr orbit for an electron." This inference is, of course, entirely unjustified. The simplest considerations show that neither Cassinian ovals nor the true equipotential curves are possible forms for the orbits.

There are other similarly unsatisfactory excursions into pure physics, including a theory of the ether which is claimed to elucidate the exchange of energy between electrons and radiation and the non-emission of radiation by an electron revolving in a Bohr orbit, discussions of the loss of mass associated with the loss of energy of a system, and a proposal that the orbital precession of an electron in the neighbourhood of other electrons should be regarded as taking place at right angles to the radius vector and the direction of motion. The ideas put forward in these passages are not in harmony with the spirit of modern physics, and in the opinion of the reviewer the author would have been well advised to have omitted them.

The treatment of the more purely chemical subjects is much less open to objection—though Werner's co-ordination theory is very doubtfully simplified by its presentation in the form of nineteen generalisations, and a good deal of space is devoted to the mechanical task of enumerating the types of isomerism that could occur among the derivatives of elements of the co-ordination number six.

Although there is thus much in this book which cannot be passed over without criticism, there is also much that is of merit and can be read with interest provided that the reader is already familiar with the subject. It gives a useful survey of several branches of chemistry, and some of the matter is presented in ways that are to a certain extent unusual and may provoke thought.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature and Art during the Session 1924–1925 by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-second Annual Issue. Pp. vii+407. (London: Charles Griffin and Co., Ltd., 1925.) 15*s.* net.

IT is a pleasure to be able again to extend a welcome to this valuable reference work. The issue before us, the forty-second, is about the same size as its predecessor, and its contents are arranged on the plan which has now become familiar: namely, the societies are grouped into fourteen main groups according to the subject of their activities, and under each group the London societies come first, followed by the provincial bodies, and finally those in Scotland and Ireland. Under each item are given details of the society's activities, publications, officers, address, and similar essential information. The word 'society' is interpreted very broadly, as the publishers are able to include Government institutions such as the Royal Observatory, Greenwich, the National Physical Laboratory, and so on, and in each case a brief but comprehensive account of the year's work and publications is given. It adds to the value of the work that the information given is compiled from data supplied by officers of the bodies concerned, and the fact that few entries are followed by the words "No Return" shows that these officers appreciate the labours of the publishers in the service of learning.

The proof of the value of an annual reference work such as this, however, is in the hands of those who are constantly using it, and we shall not be alone in affirming repeated indebtedness to its pages. For that reason, and to enhance its usefulness, we do not hesitate to refer to some omissions we have noted. The majority of the research associations are still omitted, and also we have found no reference to the Society for the Preservation of the Fauna of the Empire, the British Institute of Philosophical Studies, the Institution of Welding Engineers, or the newly-formed Electroplaters' and Depositors' Technical Society. Nevertheless, we have no doubt that a year hence the volume will show similar signs of honourable service to those which now mark earlier issues.

The Essentials of Mental Measurement. By Dr. William Brown and Prof. Godfrey H. Thomson. (The Cambridge Psychological Library.) Third edition. Pp. x+224. (Cambridge: At the University Press, 1925.) 17*s.* 6*d.* net.

THE latest edition of this book contains a new chapter dealing with the present position in the controversial question of the relation between general and special abilities. In many respects this is the most interesting chapter in the book. Following a critical survey of Prof. Spearman's two-factor theory, Prof. Thomson enunciates his well-known sampling theory of ability, and proceeds to show that the two theories are not mutually destructive, that, on the contrary, in certain circumstances the differences between them are not nearly so fundamental as might be thought. It will be a source of encouragement to the non-mathematical

student of these problems to learn that, while there are still vital differences between the various views, there is a movement towards agreement. The results of present investigations which are expected to settle some outstanding differences will be awaited with interest.

Meanwhile, it is perhaps significant to note that in some quarters there is an increasing tendency to approach the question from other directions. One feels that the study, with the aid of elaborate mathematical devices, of data derived from comparatively crude experimentation, is useful only within certain limits. This is, to some extent, confirmed by the note of caution maintained by the authors in regard to conclusions to be derived from the statistical study of mental measurements, especially from correlation coefficients. In this connexion it would be useful if the note on Kelley's *coefficient of alienation* were further developed in a later edition. In the main, however, the book remains unaltered, and contains, besides a well-developed statement of Prof. Thomson's own views, sections on the psycho-physical methods and the theory of correlation. Some new footnotes bring the book up-to-date.

Aphrodite aculeata. By Mahalah G. C. Fordham. (Liverpool Marine Biology Committee Memoirs on Typical British Marine Plants and Animals, 27.) Pp. viii+96+10 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1925.) 5*s.* net.

A SYSTEMATIC description is given of the external features of Aphrodite, of its respiration, and of the circulatory, digestive, muscular, excretory, reproductive, and nervous systems. The lobules of the 'cephalic nerve centre' (*i.e.* the cerebral ganglia) and the associated nerves are described in some detail, but there is no figure illustrating the external topography of the centre. A giant cell from the ventral nerve cord is figured without any comment as to whether any other giant cells occur and whether giant fibres are present. A short account of the structure of the eye might have been added. In our opinion, too much is made of small differences between the types of cells in the cæcal epithelium; there are said to be eleven types, but it would be difficult to justify more than half of them. We note that many of the papers cited under "Literature" are not referred to. We must enter a dissent against 'plexi' as the plural of 'plexus,' and 'nuchal' is better than 'nucal,' which is used in the work.

The eight plates contain a useful series of figures. The text-figure of a parapodium of Nereis was evidently intended to show the outlines of the setal sacs, for reference letters are given in the text below the figure, but the outlines have been omitted. An indication of the magnification of the setæ shown in text-fig. 3 would have been helpful.

The examination of the external features and internal anatomy of Aphrodite forms part of the second year course in many laboratories, and hitherto no comprehensive account has been available. Miss Fordham has put a good deal of work into the preparation of the memoir, which will serve as a helpful guide to the study of an interesting polychæt.

Recent Advances in Physiology. By Prof. C. Lovatt Evans. Pp. xi + 364. (London: J. and A. Churchill, 1925.) 10*s.* 6*d.* net.

IN a book covering recent advances, it is interesting and important to observe how the space has been allotted between the different fields of work. In this case Prof. Lovatt Evans has made a dull beginning with 90 pages on blood. The work on muscle by A. V. Hill and Meyerhof has been given 80 pages; work on circulation rate (Barcroft, Douglas, Krogh) and Starling's heart-lung preparation, 40 pages; Hopkins and Warburg on tissue oxidations, 30 pages; Krogh and Dale on capillary circulation, 30 pages; Magnus on postural reflexes, 30 pages; Pavlov on conditioned reflexes, 30 pages; finally the cheaper sensations of the endocrine world have some 20 pages.

It will be clear that this small volume is astonishing in its scope, yet there is much evidence that the author has carefully digested his sources of information, so that the presentation is logical and interesting. Even amid the technicalities of the mechanics of muscular contraction, he writes in such a way as to make it comprehensible to the reader. The accounts of the work of Pavlov and Magnus are particularly valuable, as there is no other general account of these in English.

It is difficult to exaggerate the importance of a book of this type, if it is short and good, for it plays a considerable part in deciding the questions to be asked in honours examinations during most of the next decade. By its means the habitual examiners bring themselves up-to-date, and it soon is responsible for the subjects studied by the students. Prof. Lovatt Evans' book will play an extremely valuable part in this direction, and it is fortunate that Messrs. Churchill should have persuaded a scholar at once so fundamental and clear-headed to write it.

A Graduated Course in Strength and Elasticity of Materials. By Edward Percy Coston. (Broadway Engineering Handbooks, Vols. 37 and 38.) Vol. 1. Pp. xii+264. Vol. 2. Pp. xii+436. (London: Scott, Greenwood and Son, 1925.) 10*s.* 6*d.* net each.

THESE two volumes were left in MS. by the late E. P. Coston, of the Engineering Department of the University of Liverpool, and were prepared for publication by students and colleagues upon the staff. It was a work worth undertaking, for the two volumes reflect the thought and experience of a good teacher. Most treatments of strength of materials incline either to be a practical compendium of engineering data more or less critically connected, or a mathematical analysis of the elastic properties of simple geometrical forms more or less divorced from reality. Both these snares are here avoided. In preparing this book, the author had in mind the average engineering student and his growth in knowledge of the subject. The work is arranged so that the elementary part is covered in vol. 1, in which the simple theory is interwoven with a critical discussion of elastic data. Each part of vol. 1 is developed to a more advanced stage in vol. 2. Copious examples graduated in difficulty and many of them worked out in detail are a distinct asset to the work.

Letters to the Editor.

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The Motion of Radiating Masses and the Effect of Radiation Pressure.

THE equation of motion of a body which is losing mass by the emission of radiation is

$$m\frac{dv}{dt}=F, \quad . \quad . \quad . \quad . \quad (1)$$

where m is the momentary mass of the body and F the applied force. The simplest justification for this equation is found in the principle of relativity, which requires that v shall be constant when $F=0$.

In NATURE of February 27, p. 300, Sir Joseph Larmor suggests that considerations of inertia would seem to require the equation

$$\frac{d}{dt}(mv)=F, \quad . \quad . \quad . \quad . \quad (2)$$

and finds an apparent paradox in the incompatibility of this with my equation (1). The paradox disappears as soon as it is noticed that equation (2) ignores the momentum carried away by the shed mass. In time dt the momentum mv experiences a gain Fdt from the action of the force F, and a loss $-v\frac{dm}{dt}dt$ through the shedding of the mass $-\frac{dm}{dt}dt$. Thus

$$\frac{d}{dt}(mv)=F+v\frac{dm}{dt},$$

which is equivalent to my equation (1).

Either of these quite simple arguments appears to decide the question in favour of my equation (1), and this by a conclusive verdict, not the mere "adequate practical settlement" of Sir Joseph Larmor.

Sir Joseph further suggests that the aberration effect of radiation pressure may be of importance in the dynamics of binary systems. Calculation scarcely supports this view. In the average binary orbit the force exerted by radiation pressure is about 10^{-15} times that exerted by gravitation, and the tangential force is v/C times this, or say 10^{-19} times the force of gravitation. The cumulative effect of this force might become serious as the number of revolutions of the system approached 10^{19}, but binaries do not live long enough for this to happen, and the actual effect must be negligible.

Consequently I adhere to the solution I originally gave (*Monthly Notices*, November 1924 and October 1925) for the orbit of a radiating binary. The orbit is an ellipse, the shape of which undergoes no change but the dimensions of which steadily increase as the mass wastes away, the product of the mass and the diameter of the orbit remaining constant. For example, the sun's wastage of 250 million tons a minute to produce radiation must result in an expansion of the whole solar system; the diameter of the earth's orbit increases by two centimetres per annum, those of the other planets, comets, and meteorites expanding in exact proportion. If higher accuracy than this is called for, dynamical factors arising from tidal friction and elongation of mass seem likely to have more importance than pressure of radiation.

J. H. JEANS.

February 27.

The Spectra of the Neutral Carbon Monoxide Molecule.

WE can now claim to have a fairly extensive knowledge of the radiation of the ionised carbon monoxide molecule CO^+. The three associated spectra, namely, Deslandres' first negative bands, the comet-tail bands, and the associated system (*vide Proc. Roy. Soc.*, A, vol. 108, p. 349) have been discussed by Prof. R. T. Birge and others, and in particular by Dr. Mulliken in an excellent comparative study with other typical one-valence electron emitters (*Phys. Rev.*, ii. 26, p. 561).

With regard to the spectra of neutral CO, I have recently been investigating some carbon spectra, arranging them in series, and assigning vibrational quantum numbers, and the results of this are presented in the present communication. About the time I had discovered the relationships referred to below, I had a communication from Prof. Birge in which he informed me of the substance of some of his work (published since in NATURE of February 13, p. 229). As my own findings are related to those of Prof. Birge, I am able through his kindness to correlate some of these results with mine; and these, together with a discussion of their significance, are given in this letter.

In a paper entitled "The Effect of Neon on Certain Spectra" to be published shortly in the *Phil. Mag.*, Mr. Cameron has given the wave-lengths of a new band-spectrum associated with carbon, the conditions for the production of which seemed to be peculiarly favourable in high-pressure neon. The spectrum lies between about λ2100 and λ2600, and falls into three or four groups having about five bands in each. Each band, however, is complex, being composed of five distinct sub-heads, and resembling the complex bands of the third positive carbon system or the fourth positive nitrogen system. I have made a quantum analysis of the above system and give it below (where only the second member of the quintuple heads is recorded for simplicity; *vide* Table I.).

TABLE I.

n'/n''	0	1	2	3	4	5	6	7	8
0	..	Present	44,244	42,160	40,102	..	..	..	..
1	..	..	Present	43,875	41,809	39,770	..	..	..
2	..	..	..	Present	Obsc.	41,457	39,444	..	..
3	..	..	..	..	..	..	41,099	39,113	..
4	..	..	..	..	..	..	..	40,739	$3^{8},783$

Even under the most favourable conditions the system is not very strong, and Mr. Cameron suggests that his errors of wave-length may perhaps be so much as 0·5 Ångström units. I find that the system can be represented by

$$\nu=K+(1728{\cdot}2\,n'-14{\cdot}6\,n'^2)-(2151{\cdot}7\,n''-12{\cdot}7\,n''^2),$$

where n' and n'' are initial and final quantum numbers, and K has the values 48534·3, 48496·5, 48478·2, 48461·0, and 48431·2.

Prof. Birge has informed me that the fourth positive carbon bands are completely represented by the formula

$$\nu=64721+(1499{\cdot}28\,n'-17{\cdot}24\,n'^2)-(2147{\cdot}74\,n''-12{\cdot}703\,n''^2),$$

and that they are the 'resonance' band system of CO as shown by Leifson's absorption work in the extreme ultra-violet.

It is clear, therefore, that within the limits of experimental error Cameron's bands and the fourth positive carbon bands have the same final electronic state, which is the normal state of the carbon monoxide molecule.

Prof. Birge has informed me further that the Ångström bands are represented by

$$\nu=22162+(2158\,n'-76\,n'^2)-(1499{\cdot}28\,n''-17{\cdot}24\,n''^2),$$

so that we have the interesting relation that the final state of the Ångström band emitter coincides with the initial state of the fourth positive carbon emitter.

I have discovered an analogous relationship by a quantum analysis of the third positive carbon bands, namely, that the final state of the third positive band emitter is coincident with the initial state of the emitter of Cameron's bands. The available measurements of the third positive carbon system are not good, so that any formula representing them is necessarily very approximate. I have, however, calculated roughly

$$\nu = 35300 + (2258{\cdot}5\ n' - 48{\cdot}5\ n'^2) - (1728{\cdot}2\ n'' - 14{\cdot}6\ n''^2)$$

for purposes of the completion of Table II. The main series, which is $n' = 0$, $n'' = 0$ to 5, permits of no

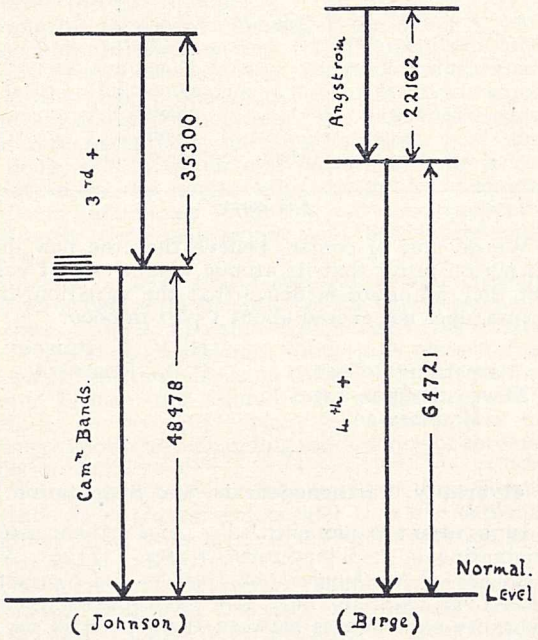

FIG. 1.—Energy levels of the neutral CO molecule.

doubt whatever of the above identification of the initial electronic state of Cameron's bands and the final electronic state of the third positive system. The multiplet structure of the common vibration levels is very conclusive. The best values of the separations in wave-number units are :

Cameron's bands : 37·8, 18·3, 17·2, 29·8
Third pos. carbon : 36·4, 17·4, 17·8, 29·6.

This agreement is well within the limits of error. The relative intensities of the sub-heads correspond in both systems. It seems just possible that there may be six levels in reality, making the intervals in the case of the third positive system 8·8, 27·6, 17·4, 17·8, 29·6, but this head being fainter than the others would not be visible in the Cameron system. The question is important from the point of view of discussion of multiplicity in band spectra. It may be that the quintuplet is a characteristic of 2-valence electron emitters. We have the analogous fourth positive nitrogen structure in the case of N_2. With this in view I have examined Dr. Jevons's reproduction of the spectra of silicon oxide and aluminium chloride (*Proc. Roy. Soc.*, A, vol. 106, p. 174), which should present analogies, but I have not been able to arrive at any definite conclusion. The spectrum of silicon chloride shows doublet separation characteristic of the 1-valence type.

In view of Birge's work on the energy levels of the neutral nitrogen molecule (NATURE, November 1, 1924, and January 16, 1926), we now have the material for an interesting comparative study of two very similar molecules, CO and N_2. This, together with the above questions, is reserved for fuller discussion elsewhere.

Our knowledge of the neutral carbon monoxide molecule is summarised in the diagram, Fig. 1, and in

TABLE II.

Emitter.	Spectrum.	ν_e.	Excited States. (a′)	Excited States. (b′)	Normal State. (a″)	Normal State. (b″)
CO	Cameron's	48,478	1728·2	14·6	2151·1	12·7
	3rd Pos.	35,300	2258·5	48·5 ?		
	4th Pos.	64,721	1499·28	17·24	2147·74	12·703
	Ångström	22,162	2158	76		

Table II. With regard to the possibility of identification of the initial levels of the third positive system and the Ångström bands, which are not very different, it does not seem possible to pronounce finally until more complete measures of the third positive bands are available. With regard to the latter, I have found that apparently the initial states $n' = 0$, 1, and 4 are present, while $n' = 2$ and 3 are absent (incidentally, this curious probability distribution in the various vibrational states is quite a common phenomenon). I intend to discuss this elsewhere. I am afraid the weight of evidence at present is against the identification of the above initial energy levels. The two values 10·34 volts and 10·73 volts may possibly be identified with the ionisation potential 10·1 volts (Foote and Mohler) of CO, but if so, this raises the identification difficulty.

With regard to Table II., I must be content merely to record the facts and discuss them fully elsewhere. As with 1-valence electron emitters, the greater stability of the second excitation level in comparison with the first may be noted.

Excepting the fourth positive bands, which must now be attributed definitely to CO, the surmises of a previous letter (NATURE, October 10, 1925) based on experimental evidence as to the CO origin of Cameron's bands, the Ångström bands, and the third positive bands are now seen to be confirmed.

Contrary to the views some have held, it seems doubtful if we can attribute *any* spectra to a carbon dioxide molecule. This would harmonise with its structure, which is of the 'inert gas type' and may not be expected to radiate (cf. BN). For similar reasons the silicon oxide and titanium oxide band spectra are probably due to SiO and TiO and not to SiO_2 and TiO_2. This may, therefore, have an important bearing from a thermo-chemical point of view on the temperature of the titanium oxide stars.

R. C. JOHNSON.

Physics Department,
Queen's University, Belfast.

The Constancy of Atomic Weights.

THE natural desire we have to attain finality in argument or experiment is usually helpful to progress but sometimes needs restraint. Believing such a need to exist in current thought upon the subject of this letter, we enter a plea for the retention of an open mind as to whether, in fact, elements as they naturally occur have always and everywhere the same atomic weight. The problem is evidently of fundamental importance, and its elucidation is likely to be hindered if chemists generally regard it as solved. We can the more easily ask for judgment to be reserved, as

work done in these laboratories has provided the best evidence yet available for both constancy and variability in atomic weight.

Determinations of the ratio of boron trichloride to silver carried out by the writers in 1924 afforded purely chemical evidence that samples of boron from widely separated sources differed in atomic weight by about 0·02 unit (*Journ. Chem. Soc.*, 1925, **127**, 696). Later determinations of the density of boric oxide from the same and other sources disclosed differences in density which in sign and magnitude confirmed the variations in atomic weight previously found (*ibid.*, 1926, **128**). While we are unable to trace any flaw in this work, we have expressed our view that, in such a matter, it is unsafe to base conclusions on any one set of researches and that independent work is urgently needed.

At about the same time, Jäger and Dijkstra (*Versl. Akad. Amsterdam*, 1924, **33**, 333; *Proc. Acad. Amsterdam*, 1924, **27**, 393; *Zeit. anorg. Chem.*, 1925, **143**, 233) seeking to ascertain, by purely physical means, whether or no the atomic weight of silicon were constant, prepared tetraethyl silicane from six terrestrial sources and six stony meteorites, compared the densities of the samples by a pyknometer method. They record in their paper the observed densities and the corresponding differences in the atomic weight of silicon. This method of stating the results may evidently give an erroneous impression of their precision, because Dr. Aston (Annual Reports on the Progress of Chemistry, 1924, **21**, 243) was led to describe this as a "conclusive paper" affording evidence "that the ratio of the isotopes of silicon is constant within the limits of the highest accuracy attainable at present." We have, therefore, calculated the actual atomic weights of silicon corresponding with the observed densities, making the assumption, obviously reasonable and good enough for comparative purposes, that the mean observed density of tetraethyl silicane = 0·767349 corresponds with the most probable value of the atomic weight of silicon Si = 28·060. From these values it is at once apparent that the maximum and minimum values are 28·051 and 28·060, with a difference of 1 part in 1477. When we remember that many atomic weights have an uncertainty much less than 1 part in 5000, it is difficult to justify the terms "conclusive" evidence and "highest accuracy attainable" quoted above.

We are aware that Jäger and Dijkstra observed that the refractive index of their samples of tetraethyl silicane showed a variation corresponding with the variations in density, and hence concluded that the latter were, at least in a great part, due to varying traces of impurity, but we believe that this argument is fallacious. There is no direct evidence on the point, but it seems not unlikely that an increase in the proportion of a heavier isotope of silicon in a silicon compound would increase the refractive index of that compound, just as, say, substitution of barium for calcium increases the refractive index of glass.

It happens that during the last three years we have been engaged in preparing to make a re-determination by chemical means of the atomic weight of silicon using, as in the case of boron, samples from widely separated known sources. In the course of this work the opportunity has arisen for one of us to make a careful comparison of the densities of samples of silicon tetrachloride prepared from these sources and subjected to the same very rigorous process of purification. From these densities it is possible to deduce values for the atomic weights of silicon which show a maximum difference of 0·005 unit. These density figures will, we hope, be published shortly, and we give here simply the atomic weights deduced from them together with those cited earlier in this letter.

TABLE.

ATOMIC WEIGHTS OF BORON AND SILICON.

Boron.		Silicon.		
Briscoe and Robinson.	Briscoe, Robinson and Stephenson.	Jäger and Dijkstra.		Robinson and Smith.
		Terrestrial	28·051	28·059
10·841	10·847	,,	28·055	28·059
10·825	10·823	,,	28·051	28·058
10·818	10·818*	,,	28·070	28·062
..	..	,,	28·066	28·063
..	10·818	,,	28·062	Mean 28·060
..	10·806	Mean	28·059	..
..	10·788	*Meteoric*	28·060	..
..	..	,,	28·060	..
..	..	,,	28·060	..
..	..	,,	28·066	..
..	..	,,	28·060	..
..	..	,,	28·060	..
..	..	Mean	28·061	..

* Standard.

We do not, of course, believe that the new data for silicon prove that its atomic weight cannot vary, but they do afford evidence that the variation, if it occurs, does not exceed about 1 part in 6000.

H. V. A. BRISCOE.
P. L. ROBINSON.

Armstrong College,
Newcastle-upon-Tyne,
January 26.

Hybridity, Parthenogenesis, and Segregation.

IN a recent paper entitled "On Parthenogenesis originating in Lepidopterous Crosses" (*Trans. Nat. Hist. Soc. of Northumberland, Durham and Newcastle-upon-Tyne*, N.S., 6, Part II.) we discussed certain hybridity experiments between the geometrid moths *Tephrosia crepuscularia*, Bkh., and *Tephrosia bistortata*, Goeze, both of which species had been previously proved to be non-parthenogenetic; in that work conclusions were set out which may be briefly summarised as follows:

(1) These two species cross readily, yielding hybrids which are fertile *inter se* and fertile also when back-crossed on either parent; this fertility continues unimpaired when any of these hybrids are continuously inbred.

(2) Several unmated females, the outcome of crossing *T. crepuscularia* ♀ ♀ and *T. bistortata* ♂ ♂, deposited eggs freely, and in certain cases a small percentage of their eggs developed parthenogenetically.

(3) From these facts we concluded that there was some relation between parthenogenesis and hybridity which, in our opinion, was one of cause and effect.

(4) Specially noteworthy was the fact that the parthenogenetic offspring showed segregation in respect to wing colour, pattern and sex.

These results are of importance inasmuch as the thesis that parthenogenesis could be induced by hybridity had been advanced by Ernst (1918) on theoretical grounds in his "Bastardierung als Ursache der Apogamie im Pflanzenreiche," and accepted by Täckholm, Holmgren and others as a satisfactory explanation of the observed facts in critical genera like Rosa, Erigeron, etc. Whilst we agreed generally

with this position, we felt, and therefore stated, that a rigid proof of its validity was lacking, *i.e.* the experimental production of an apogamous hybrid from parents conclusively shown to be non-apogamous had never been achieved.

Our experiments, curiously enough from the zoological side, provided the desired case and we had thought that they were unique. Recently, however, we received papers from Prof. Nabours, Kansas State Agricultural College, which recount his painstaking genetical experiments with grouse locusts (1919, "Parthenogenesis and Crossing Over in the Grouse Locust Apotettix," *Amer. Nat.*, 53, No. 625; 1925, "Studies in Inheritance and Evolution in Orthoptera, V. The Grouse Locust *Apotettix eurycephalus*, Hancock," *Technical Bulletin* 17, Kansas State Agr. Exp. Stn., Manhattan), and afford welcome support to our work. This aspect, however, does not seem to have occurred to Prof. Nabours.

From his 1925 paper (p. 229) Prof. Nabours' conclusions may briefly be quoted: (1) "The members of the species *Apotettix eurycephalus*, Hancock, are bisexual, the fertilised eggs producing males and females in equal numbers, and parthenogenetic, the unfertilised eggs, with rare exceptions, hatching females . . .," and (2) in respect to colour and pattern and, to a less extent, in sex, he asserts "the segregation of factors occurs in individuals producing parthenogenetically apparently to the same extent as in those reproducing bisexually."

Nabours believes that "segregation and crossing over occur before the inception of the parthenogenetic processes," and as a possible explanation of his results, that "the chemical changes which take place during the wait of the pronucleus, in the absence of fertilising sperm, furnish the stimulus to parthenogenesis." Further, he seeks to explain his homozygotes by various hypotheses demanding the doubling of chromosome number.

In view of the essential similarity of these results of Nabours and ours, we consider that one explanation may cover both sets; in short, the solution suggested lies in hybridity.

This opinion receives weighty support from evidence we adduce from Prof. Nabours' own papers. In the second (1925) paper he writes (p. 7): "Messrs. Rehn and Hebard [1] have examined specimens of these and definitely determined that they belong to the same species (Nabours, '19)." Turning to the 1919 paper, we find in a footnote (p. 131), "Identified by Mr. Rehn as *Apotettix eurycephalus* Hancock, and by Doctor Hancock as follows: 'nearer the Mexican species *Apotettix convexus* Morse, than the nearly allied Texan species, *Apotettix eurycephalus* Hancock. *Inasmuch as you have used material from both Texas and Mexico in your experiments, it is possible you have hybridised the two . . .*'" (italics ours). Investigations into Prof. Nabours' pedigree tables of the females used in parthenogenesis show that the ancestors can be traced to both stocks, the Texan and the Mexican.

Recognising the implication in this footnote, we submit, therefore, that Prof. Nabours, in supplying from a different group of insects this additional example of segregation under parthenogenesis, has also furnished, although he has not appreciated the fact, a case of parthenogenesis consequent upon hybridity.

A. D. PEACOCK.
J. W. HESLOP HARRISON.

Armstrong College (University of Durham),
Newcastle-upon-Tyne.

[1] Hebard is obviously a misprint for Hancock, who is cited as one of the authorities in Nabours' 1919 paper.

Measurement of the Discharge of the Blue Nile through the Sluices of the Sennar Dam.

WHEN the Aswan Dam was completed in 1902, very little was known about the discharge of large sluices of the type constructed at Aswan. By means of a large tank of 22,000 cubic metres capacity, the discharge of one type of sluice 3·5 metres high by 2 metres wide was determined for discharges ranging from 1 to 96 cubic metres per second and for heads up to 13·5 metres above the sill. The discharges of other types of sluice were then compared with those of the standardised type by means of the river level. Thus the discharge of the Nile at the important time of the year is known for monthly periods with a probable error of about 0·6 per cent. (For an account of this see MacDonald and Hurst, *Min. Proc. Inst. C.E.*, Paper No. 4350, 1921.)

The fundamental tank measurements were used as a standard with which to compare the discharges of a series of scale models of the experimental sluice. It was found that the ratio of the discharge of the large sluice to that of its model was closely $n^{\frac{5}{2}}$ where n is the ratio of their linear dimensions. The mean departure of the ratio of the discharges from $n^{\frac{5}{2}}$ using six models and three different scales over a wide range of conditions was 0·4 per cent., and the largest departure for a group of experiments on one model was 4·6 per cent. The condition throughout was that of free discharge into air. (For an account of this work see Hurst and Watt, *Min. Proc. Inst. C.E.*, Paper No. 4450, 1924.) The above experiments show that models can be used to predict the discharge of large works, and this is borne out by many experiments made at the Delta Barrage, Egypt, by Mr. A. D. Butcher with models of weirs and regulators.

Another result of the fundamental measurements of the river at Aswan was to show that discharges measured by current meters of the Price pattern agree closely with the results of tank measurements, for ordinary velocities of flow. The mean value of (sluice − current-meter) for measurements during the low stage of the river for 3 years is 0·2 per cent.

I have recently completed a series of experiments on a model, scale 1/50, of one of the sluices of the new Sennar Dam on the Blue Nile. These sluices are 2 metres wide and 8·4 metres high, and will discharge under varying conditions of upstream and downstream head, having sometimes a small depth of water above the sill downstream and being at others completely submerged downstream. The discharge of the Dam sluices has been deduced from the model experiments for all conditions. Since the filling of the reservoir was started last July, a variety of conditions has occurred. During this time the discharge of the river has been measured downstream of the Dam every few days by means of a current-meter. It is interesting to state that a comparison of the discharges measured by current-meters and those deduced from the sluices shows that there is good agreement between them. Thirty-five discharges are available, and the mean result deduced from the model experiments is about 3 per cent. greater than that deduced from the current-meters. This may be modified slightly when the current-meters are re-rated.

These results show the value of model experiments. Their principal value is that though they cannot be relied upon to give results in which the systematic error is less than 5 per cent., the accidental errors are small. For many purposes an accuracy of 5 per cent. would be good enough. However, when once the systematic error has been found from a few current-meter measurements well distributed over the whole range of practical conditions, the model can be used

to give the discharge of a sluice under any conditions of upstream and downstream level and sluice opening within the range of practical conditions. Information thus becomes available with very little labour which would otherwise take many years and great expenditure of money to collect. In the case of the Sennar Dam, the resident engineer has a table of the discharge of the sluices from the commencement of the working of the Dam, upon which he can base his regulation of the river. Without the model results he would have had to experiment for years after the completion of the Dam before he could have constructed a discharge table for the sluices.

H. E. HURST.

Physical Department, Cairo,
January 25.

The Fundamental Level of the Iron Atom.

THERE is still some difference of opinion about the fundamental level of the iron atom. From Laporte's analysis (*Zeit. für Physik*, **23**, 135, 1924) it appears that the chief lines proceed from five fundamental levels, constituting a quintet *d*-group. But this is at variance with the experiments of Stern and Gerlach on the directional quantisation of atoms. Gerlach states that there is a group of strong lines at about $\lambda = 2100$ Å.U., which are not included in Laporte's classification. But Laporte, in support of his view, states that the ^5D group for iron fits best with the rule given by Catalán on the normal orbits of the elements of the transitional series from potassium to nickel (*Journ. Opt. Soc. America*, November 1925). Laporte further states that his point of view " is favoured by some astrophysical facts, and by the almost complete classification of the lines of iron, which now makes it improbable that any important low terms are unknown." I am not aware of the astrophysical facts which Laporte has in view, but such facts as are available to me seem to favour the other view.

In the absorption experiments of Grotrian and Gieseler (*Zeit. f. Phys.*, **22**, 245, 1924), the strong group of $^5D - {}^5D'$ lines of the iron spectrum was obtained in absorption at 1250° C., so that this experiment may be interpreted as deciding against the existence of a higher *s*-term. But we cannot hold this sort of evidence to be decisive, because at this temperature of the furnace it is quite possible that a large amount of ^5D-orbits are produced. Once they are produced they will remain fairly stable, for the transition $D \longrightarrow S$ being forbidden, the *D*-states will be metastable. This is supported by evidence from the chromospheric spectrum. The strongest lines in the iron spectrum, $\lambda = 3856{\cdot}46$ and $\lambda = 3860{\cdot}01$, reach in the solar chromosphere a height of 6000 km., and Evershed (*Phil. Trans.*, 201, 470) notes that they are intensified from intensity 8 (Rowland's scale) in the Fraunhofer spectrum to 15 in the flash spectrum, and this behaviour is typical of lines arising from metastable orbits.

Miss Payne in her recent monograph on stellar atmospheres (Harvard Observatory Monographs) has traced the behaviour of iron lines in different classes of stellar spectra. Unfortunately, she has not treated the behaviour of $^5D - {}^5D'$ lines of iron, but of $1\,^5D - 1\,^7F$ lines. These are intercombination lines, and should therefore be strengthened at lower temperatures. At any rate, they enable us to trace the behaviour of Laporte's fundamental (^5D) levels in stellar atmospheres. Miss Payne states that these lines reach a maximum in the *K*2 type of stars. According to the theory of Fowler and Milne this is typical of the behaviour of lines arising from subordinate series. So the astrophysical evidence seems to indicate that ^5D's are subordinate levels. But in order to be certain on the point, the behaviour of either the $^5D - {}^5F$ group lying at about $\lambda = 3700$ Å.U. or the $^5D - {}^5D'$ group ought to be traced in stellar atmospheres. The stellar data in this region are not very satisfactory.

Laporte's second point of contention, that the almost complete classification of the iron spectrum makes it improbable that any important low terms are unknown, cannot be regarded as conclusive, and I will illustrate my point by an analogy from the spectrum of neon. All the strong lines of neon obtained within the range $\lambda = 2000$ Å.U. to $\lambda = 8000$ Å.U. have been classified by Paschen into series, and it has been shown that there are four *s*-levels, denoted by him as s_2, s_3, s_4, and s_5. There are apparently no strong lines left outside Paschen's scheme of classification, yet we now know that these four *s*-levels do not constitute the normal level of neon, because it is perfectly transparent to all radiation from $\lambda = 2000$ Å.U. to $\lambda = 8000$ Å.U. in the unexcited state. As a matter of fact, Hertz (*Zeit. f. Physik*, **32**, 933, 1925) has discovered two strong lines at $\lambda = 735{\cdot}7 \pm 0{\cdot}5$ Å.U. and $743{\cdot}5 \pm 0{\cdot}5$ Å.U., and finds that these can be represented by $x - s_2$ and $x - s_4$. Goudsmit (*Zeit. f. Physik*, **32**, 794, 1925), rediscussing the whole data on neon, including Landé's system of grouping the neon series, finds that the term x may be regarded as a singlet *S*-term, having the inner quantum number 0, while Paschen's s_2 is a *P* term of the singlet group, having the inner quantum number 1, and s_3, s_4, s_5 constitute the *p* terms of a triplet group, having the inner quantum numbers 0, 1, 2 respectively.

Here we have the undoubted evidence of the existence of a normal term s_0, which does not give rise to any one of the familiar strong lines of neon. It is now recognised that the spectra of elements having a large number of electrons in the outer ring have more or less a neon-like structure, and if iron, nickel, or cobalt have a still lower fundamental term *s* or *p*, it would not be responsible for any strong lines in the usual range. To find this term, the spectrum in the Schumann region must be very thoroughly investigated, and then only can the point be settled.

N. K. SUR.

Department of Physics,
University of Allahabad.

The Constitution of the Heaviside Layer.

IN the issue of NATURE of September 5, 1925, p. 357, Messrs. Breit and Tuve give a method for determining the height of the Heaviside Layer at night. It consists essentially in transmitting a series of impulses and recording them on a receiver at about 7 miles distance. Two groups of impulses were obtained, the time interval between two successive impulses giving the difference in time taken to traverse the two paths, one going direct to the station, and the other by the indirect path up to the Heaviside and back. From the results a height of about 80 km. was deduced.

The authors state that other experiments were tried on a 600 metre wave-length over distances of 100 to 150 miles, but these gave no definite results, there being, I presume, no second impulse due to the indirect ray.

The object of this letter is to point out a possible reason for this failure. At these distances the indirect ray strikes the Heaviside layer at practically 45°, assuming the height of 80 km. is correct. Now if the constitution of the layer is one in which there are free ions and electrons, the pressure being so low that the average time between collisions is large compared with the time period of the waves, a constitution which from other experimental evidence we have reason to expect, and if the wave is polarised

with the electric force in the vertical plane, nothing will be reflected at 45° incidence. This angle is in fact the polarising angle of the layer, and is independent of the frequency, and moreover does not depend on how the layer is graded, that is, whether it is a gradual or a sharp transition. Under these conditions only the direct ray will be received, the indirect ray not being reflected.

If this reasoning is correct the results obtained over these distances constitute not only a rough confirmation of the height measurements, but also of the assumed constitution of the layer.

T. L. ECKERSLEY.

Research Department,
Marconi's Wireless Telegraph Co., Ltd.,
Chelmsford.

British Chemical Glass.

PROF. W. E. S. TURNER, of the Department of Glass Technology in the University of Sheffield, in a letter to the *Times* of February 15, stated that "this industry . . . owes its inception to Sir Herbert Jackson and the hearty co-operation of several glass manufacturers in 1914 and 1915." I am sure that Sir Herbert Jackson would regret that the sole credit should be given to him and no mention made of Prof. Meldola, the chairman under whom he worked, and I trust, therefore, that NATURE will be able to find space to correct a statement so deficient as that made in the *Times*.

So early as August 29, 1914, Meldola realised the difficulties ahead, and wrote to a colleague: "I think of preparing a general plan of campaign for recovering British chemical industries lost through German competition." On September 22 he presided at a joint meeting of the Councils of the Institute of Chemistry and the Society of Public Analysts, at which special committees, one of them dealing with glass, porcelain, and filter-paper, were appointed. He was chairman of the latter committee and also of the special Glass Research Committee appointed on October 30 by the Institute of Chemistry. He presided at nearly all the numerous meetings of this committee, attending one only three days before he died, "working to the very last in his great desire to advance the interests of his country and of chemical science." I quote the words of his colleague, Prof. E. G. Coker, in the brief reminiscences of Meldola published by Williams and Norgate in 1916.

The letter which appeared in the *Times* is sufficient proof that these facts are not known as they should be or have passed out of mind. Nevertheless, there must be many who remember the debt that is owing to Raphael Meldola, and they surely will "see to it that his name be not forgotten."

EDWARD B. POULTON.

Oxford, February 25.

Names for Companion Stars.

ALTHOUGH it has not been customary to give specific names to the dark or inconspicuous companions of bright stars, there are one or two such bodies of so much interest and importance, and likely to be so constantly referred to in the science of the future, that perhaps exceptions might be made in their case. I write, therefore, to ask whether an outsider in astronomy may modestly make a suggestion for astronomers to consider, and to reject if they do not approve.

The companion of Sirius is so extraordinary a body, and the detection of its specific properties is the outcome of such brilliant work, that I suggest that the name Eddington might be applied to it. Presumably less is known about the companion of Algol—the first spectroscopic binary—and possibly, as it seems dark, it scarcely deserves a name; but the name of its discoverer, Vogel, might perhaps be attached to that.

These suggestions may be rather presumptuous; but no harm seems likely to be done by their publication.

OLIVER LODGE.

February 6.

The Nature of Active Nitrogen.

I HAVE not been able to follow in detail the recent discussion on the nature of active nitrogen, being closely occupied with other problems. It seems worth while, however, to direct attention to a part of my early work which seems to have dropped out of notice, but is, I believe, worthy of attention (Strutt, *Proc. Roy. Soc.*, A, vol. 86, pp. 264-267, 1911). It is there shown that the luminosity of active nitrogen can, as it were, be squeezed out of it by compression, the luminous emission of the α (1st positive) group of bands, and, perhaps the other series also, but this was not investigated, being immensely enhanced by compression. When the old volume is restored, it is found that the capacity to produce the glow is exhausted, though, apart from the compression, it would have lasted much longer.

The experiment was regarded at the time as proving that the action is bi-molecular, and I think is at least as telling as any other evidence pointing in the same direction.

RAYLEIGH.

Terling Place, Chelmsford,
February 27.

As the result of investigations which have been proceeding for some time, the writer, in collaboration with Dr. E. K. Rideal, has been able to show by three independent methods that the heat of formation of active nitrogen is about $-43{,}000$ cal. per gm. molecule.

This is in agreement with the value suggested by Strutt in 1911, and since it is known that the heat of dissociation of the nitrogen molecule is most probably of the order of $-300{,}000$ cal. per gm. molecule, the hypothesis that active nitrogen is atomic cannot well be substantiated. Rather would it appear that 'active' nitrogen represents a metastable molecule at not a very high energy level.

A full account of the investigations will shortly be published.

E. J. B. WILLEY.

Department of Physical Chemistry,
University of Cambridge.

A Mistaken Attribution in South American Linguistics.

WITH reference to the note under the above title in NATURE of February 20, p. 283, it may be of some interest to point out that the Arda in question no doubt refers to Ardra, Arder, or Allada, formerly one of the greatest towns on the Dahomian coast, which was conquered by King Agaja of Dahomey in 1724. The inhabitants speak a variety of Ewe, very similar to the ordinary Popo.

There was a considerable trade in slaves between Dahomey and the Brazils, and it is conceivable that descendants of Ardra slaves penetrated to the part of Amazonia mentioned in the text.

P. AMAURY TALBOT.

Bishopton,
Stratford-on-Avon,
February 22.

The Species Problem and Evolution.[1]

By O. W. RICHARDS and G. C. ROBSON.

II.

CORRELATION.

THE mutual relation and interaction of the various characters by which species are distinguished from each other is very imperfectly understood at present. On one hand, all the characters distinguishing a species may, or may not, form an integrated system. On the other hand, certain characters may be correlated with one another to some extent. The possibility that the characters of different species may form integrated systems is at present very uncertain. The only evidence in support of this view is derived from certain inter-specific crosses in which the parental characters segregate *en bloc*; and further investigation of this subject is urgently needed.

Whenever two characters always seem to occur together they may be related as cause and effect, or both may be due to the same cause. When this is the case, and when the effect cannot be traced clearly to the cause, such a relation will be called merely correlation. Two characters may be also correlated by genetical means, either being linked or by a varying number of individuals of a population being homozygous for both of them. These types of correlation will rarely be absolute. The former must be of some importance, but cannot be a universal explanation of correlation, since it will not often happen that all the characters that are found to be correlated in a species are due to genes situated in the same chromosome. The latter means of correlation is certainly of wide importance; perhaps two characters which are highly correlated in a species, but segregate out when an interspecific cross is made, are always correlated in this way. A special agency must obviously be invoked to account for the existence of a character in the homozygous condition in most of the individuals of the species when it arose originally in only a few.

ISOLATION.

In this section are to be considered causes of isolation other than topographical barriers. A number of explanations have been put forward to explain failure to interbreed on the part of species which seem to have every opportunity of crossing. Thus it has been supposed that differences in the copulatory organs might produce a mechanical barrier between species so differing. Such mechanical isolation, however, can not often be effective. In the first place, when such differences in the copulatory organs do occur, they are often restricted to the male and, when comparable differences occur in the female as well, no coadaption of the organs of the two sexes has been shown (Boulangé, 1924). Furthermore, species which differ in their genitalia have been crossed without mechanical difficulty.

There are many cases known in which closely allied forms living together with ample opportunities for interbreeding rarely cross in Nature. The cause of this disinclination to interbreed ('selective mating') can rarely be assigned to known differences between them. There are certain factors which may be important in particular cases, for example, differences in scent and mating-behaviour. Selective mating may even occur within a species; for example, Crozier (1918) has shown that in Chromodoris the pairs that interbreed tend to be of the same size and that large specimens rarely mate with small. Where differences in habitat and seasonal occurrence exist, they more obviously produce some degree of isolation; but it is not often that either of these alone would be completely effective. As we have seen, none of these modes are universal causes of isolation when acting alone; but in any case in which several were involved at the same time, isolation might be nearly complete. When interbreeding is not stopped by any of these means, sterility may yet make it ineffective. In motile animals, in which alone selective mating can occur, sterility is not necessarily a primary cause of isolation. It has been already seen that it by no means always precedes or even accompanies the early stages of structural divergence. In these forms probably some kind of selective mating is most often the cause of isolation, and sterility is due to later divergence.

In forms in which the male fertilising element is carried to the ovum by external agencies (for example, in plants and sessile animals, etc.), isolation can only be produced by differences in breeding-season or by sterility. Although in some species isolation is produced by the former means, it is probably not in the majority, and the latter must be more or less sterile when crossed. In the case of plants there are some genera in which the species concept breaks down owing to the absence of marked sterility or any other means of isolation among the members.

EVOLUTION.

The initial stages of evolutionary divergence involve three processes: (1) the occurrence of variations, (2) the spread of new variations in a species, and (3) the break-up of a species into different populations.

1. The origin of heritable variation is still very obscure, and in particular there is as yet no clue to the origin of those changes in habits which must have played so important a part in evolution. There may be said to be three main views on this subject: that heritable variation is the result of automatic change in the germinal material, that it is due to change produced in the germ cells by external causes, and that it is the effect of change produced by such causes in the soma and transferred to the germ cells. In practice it will be difficult to distinguish between the second and third of these.

The experiments which have been conducted to elucidate this problem are by now numerous; but in spite of them the problem is still unsolved. For one reason or another, the results which are claimed to prove that the effects of the environment can be transferred from the soma to the germ cells have had to be rejected or are still *sub judice*. Each of these

[1] Continued from p. 347.

experiments is of course entitled to separate consideration, and some are of greater merit as experiments than others. With justice, however, it must be said that they do not as yet collectively form a convincing body of evidence.[2]

Of the direct modification of the germ cells as a factor in evolution we have likewise no decisive proof, though there is some circumstantial evidence in favour of this possibility. The means by which the germ cells have been experimentally modified rarely seem, however, to bear any relation to the natural environment of living organisms. It is a fair criticism to suggest that very few of the experiments designed to elucidate this problem reproduce those environmental circumstances in which evolutionary change must be assumed to have taken place.

The action of the environment may perhaps be seen in the following examples, in which, however, it is difficult to say whether the effects have been on the germ cells and soma or on the germ cells alone. These examples fall into two classes. On one hand, the species of a genus may be so distributed that they occur at different points in the gradient of some environmental factor (for example, temperature, humidity). Some special variation in the species (for example, hair-length) may be correlated with the change in the environment. This variation may be seen both within a species in different parts of its range and by the comparison of species the ranges of which include different parts of a gradient. When a character shows a correlation with changes in an environmental gradient, it is of course difficult to prove that the changes in the character are neither phenotypic nor adaptive, though in particular cases this may be most unlikely. On the other hand, there are a number of cases in which in allied species identical morphological varieties are of two kinds—heritable and non-heritable. For example, Crow (1924) has given examples in the Algæ of characters which are only developed in special environmental conditions in one species, but appear to be genetically fixed in others. Though these examples prove nothing as yet, they suggest a useful line of inquiry into the causes of variation.

In order to explain certain special types of evolutionary phenomena, some authors have recourse to two theories which are sometimes confused—the principles of Orthogenesis and of Momentum and 'Programme Evolution' (Eimer, W. Lang, Dendy, Osborn). The former principle expresses the idea that in allied forms, for an indefinite time after divergence, there is an innate capacity to produce the same type of variant. If this were true in a wide sense (which is not yet shown) it would be wrong to assume that species could respond to environmental change by variations in all directions. The terms Momentum and Programme Evolution, though not applied to identical phenomena, seem to have very much the same implication. One refers to the development in certain groups of monstrous or over-complicated structures; the other is applied to 'determinate' evolutionary series, which are accomplished without any apparent reference to Natural Selection or any other principle. At present, however, these three terms are labels for types of evolutionary phenomena which are of obscure causation and uncertain frequency.

It is perhaps necessary to point out that possibly new forms may arise by fresh combinations of pre-existing characters. There is a certain body of evidence that has been thought to show that new species may arise as a result of crossing. This evidence and the corresponding cytological data relate almost exclusively to plants. The rôle of this process in evolution is as yet very uncertain, and, if it is operative at all, its effect is probably limited.

2. The process of divergence by which species arise consists either of the consecutive differentiation of one character after another, or perhaps in the change of a large set of characters *en bloc*. For the occurrence of the latter there is only a little evidence which has been mentioned previously. Variations as a rule must arise in a few individuals, except where the environment has some identical effect on all the members of the species; so that as a rule the addition of new characters implies the spread of variations in the population. This is usually supposed to take place mainly by the action of Natural Selection, which ultimately requires that species must differ in adaptive characters.

In the first place, it is practically impossible to show that a character is not of value to an organism without an exhaustive knowledge of the life history and physiology of the latter. On the other hand, the adaptive value of a structure must not be presumed in default of evidence to the contrary. A character can only be called adaptive (*a*) if it is useful, (*b*) if its possession does not entail a counterbalancing disadvantage. In the following discussion it is merely the utility of characters which will be considered.

A character which is not directly useful may be correlated with a useful one, as Darwin suggested. It would be a very difficult thing, however, to give an example of this in which the character is specific. No doubt such cases do occur, and perhaps even frequently; but they cannot be assumed to play an important part in evolution until direct evidence of their frequency is forthcoming.

The direct utility of the characters previously described as specific may now be considered.

(*a*) *Structural.*—There is not very much satisfactory evidence of the utility of the differences between closely allied species. There are some observations (summarised by Pearl (1917)) which suggest that certain small structural characters may be of selective value, though Pearl points out that other investigations of this sort yield no such result. It is also the case that, when allied species differ in their mode of life, their structural differences do not in general seem to be connected with such differences in the habits (but cf. Regan, 1925, p. 5).

(*b*) *Physiological.*—The evidence here is very unsatisfactory; but such physiological differences between allied species as are known are not yet shown to be of survival value.

(*c*) *Reproduction.*—It is difficult to see any sense in which the differences in sterility between crosses can be adaptive. As regards the differences in secondary sexual characters, some seem to be quite unconnected

[2] Since this article was written, an important paper by Messrs. J. W. Heslop Harrison and F. C. Garrett has appeared (*Proc. Roy. Soc.* B, 99, Feb. 1926, p. 241) on the inheritance in Lepidoptera of melanism induced by the presence of lead and manganese in their diet. These results seem in general to be above criticism; but their precise significance cannot be discussed in this brief notice.

with mating, and many of them are very unlikely to be directly useful. Any character which plays a part in mating may, however, have been influenced by some form of sexual selection.

(*d*) *Habitat and Food.*—When allied species differ in habitat and food it has been assumed that they are structurally or physiologically adapted to such divergences; yet it is not only in many cases quite unproved that such adaptations occur, but even if they do occur it is very uncertain which type of difference was primary. The rôle of Natural Selection in producing such differences is very dubious.

(*e*) *Miscellaneous Differences.*—It is difficult to find any case in which survival value may be attributed to the differences in behaviour which come under this heading.

It thus seems that the direct utility of specific characters has rarely been proved and is at any rate unlikely to be common. Furthermore, since the correlation of structure, etc., with other characters shown to be useful does not at present rest on many well-proved examples, it cannot yet be assumed that most specific characters are indirectly useful. Thus the rôle of Natural Selection in the production of closely allied species, so far as it is known at present, seems to be limited. This statement is not to be taken as a wholesale denial of the power of Natural Selection. The latter is not in question when structural differences of a size likely to effect survival are involved. It is only the capacity of selection to use on a large scale the small differences between closely allied species that is unproved.

Recently another process which occurs in Nature has been suggested as a possible cause of the spread of characters whether adaptive or not (Elton 1924). Many animals are subjected to severe fluctuation in numbers through epidemics, bad weather, etc., and this has two possible effects. The usual result would be that the small number of individuals left over after, for example, an epidemic, would not include many of the uncommon variations, and the number of different variants in the population would be continually limited. After a minimum there is of course room for many more individuals than are actually found, so that during the subsequent multiplication there may be little or no competition. If an uncommon variant survived by accident, or if an unusually low minimum did not leave a random sample of survivors, then in the course of multiplication the character of the population would be changed. At present this seems to be the most likely means by which an entirely unadaptive character could spread.

3. If variations arise in only a few individuals at a time, they will not often be spread quickly to all the members of a species, so that if samples of a widely distributed species be taken from different parts of its range they are likely to differ in the collection of characters which distinguish them. Such difference will be further accentuated if the area occupied is broken up by topographical barriers which may cause isolation. This, however, to be permanent must be grounded in some of the other causes referred to above (for example, selective mating). Some animals live in colonies, such as certain land snails (Cepea) and moths (Zygaena). Of these the former have a limited power of dispersal, while the latter, in spite of their power of flight, tend to keep to their own colonies. Adjacent colonies which are not separated by impassable barriers may differ in the same way as do the geographical races of widely distributed species. Thus two forms living at separate points in the range of a species may differ in a number of characters which, acting in conjunction, may cause isolation, while neither of them would differ from its next-door neighbour enough to produce this result. It has been suggested that most widely distributed forms constitute such "syngamic chains" (Poulton). Anything which breaks this chain would isolate two groups which sooner or later might become two distinct species. The origin of variation in habits within a species is at present not yet well enough known to enable us to make further generalisation about the methods by which isolation is produced.

Conclusion.

There are many characters (structural, physiological, etc.) by which species may be distinguished, but differentiation does not take place to the same extent in all of them, and sometimes, as criteria, they are at variance with each other. As no standard can be proposed by which species may be distinguished from varieties, there is no absolute criterion of species. Failure to interbreed is perhaps the nearest approximation to such a criterion, and it is also possible that a special type of sterility may be revealed which might provide a more definite limit than that indicated by structure. The nature of the various grades of sterility, however, requires a more complete analysis. At present the incidence of specificity is very imperfectly understood, especially in physiological characters. Even in structural divergence it is not yet known why in each group of animals certain organs tend to show the effects of divergence sooner than others.

Causes which in theory should spread new characters through a population are known; but much more evidence is required as to their actual operation and as to the extent and nature of the correlation that has been observed between specific characters. It is very unlikely that divergence at its earliest stages is promoted to an important extent by Natural Selection. In Nature, species are more or less broken up by causes leading to permanent isolation. These causes may be numerous; but at present we know very little as to the *primary* cause in any particular case—whether, for example, divergence in habit precedes that of structure or vice versa, and whether sterility precedes or follows structural divergence. Finally, there is very little exact knowledge as to the physiological differences which must occur between forms having different habits.

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The Electrical State of the Upper Atmosphere.

THE meeting of the Royal Society on March 4 was devoted to a general discussion on the subject of "The Electrical State of the Upper Atmosphere," at which a number of prominent physicists interested in this subject had been invited to take part. The large attendance at the meeting showed the importance of the subject in the scientific world at the present time; and it was evident that a very useful purpose was being served in directing the attention of the meteorological and atmospheric physicists to the insistent demands made by modern wireless research for an upper ionised stratum in the atmosphere which is capable of deflecting wireless waves and returning them to the earth's surface.

In opening the discussion, the president of the Royal Society, Sir Ernest Rutherford, outlined the three possible methods of investigating the upper atmosphere. Above the limits of direct observation, the pressure and temperature are to some extent calculable, while observations on meteors provide experimental information. The highly penetrating radiation recently investigated by Millikan was found to increase in intensity upwards from the earth's surface, and the suggestion was made that this radiation might possibly originate in thunderstorms. It was pointed out that in order to obtain a permanently ionised layer it is not necessary to assume a very strong ionising agent; since, owing to the slow rate of recombination at the higher levels, a small rate of production of ions may result in a very large permanent ionisation.

With the aid of a carefully prepared chart, Prof. Sydney Chapman, of the Imperial College of Science and Technology, then summarised our present knowledge of the physical constants of the atmosphere. By means of self-registering instruments carried in sounding balloons, direct observations have been made at heights up to 30 km. The absolute temperature of the atmosphere decreases from 285° at the earth's surface to 220° at a height of 10 km., which is the upper limit of the troposphere. Above this the temperature remains constant up to a height of 60 km., where it begins to increase again to a value approaching 300° for a height of 100 km. At this height the pressure and density of the air have values which are about 10^{-5} of those at the ground level, while the mean free path of the molecules increases from 10^{-5} at the earth's surface to 3 cm. at 100 km. height. The gaseous constituents of the atmosphere are thoroughly mixed as the result of winds in the lower regions, but they become separated at the higher levels with nitrogen as the main constituent. The existence of aurora at heights of from 90 km. upwards appears to require the lifting of gases from the lower regions. Attention was further directed to the comparatively high conductivity which the ionised layer is required to possess in order to explain the phenomena of terrestrial magnetism.

Mr. C. T. R. Wilson referred to recently published data on thunderstorm distribution, from which it has been deduced that about 1800 thunderstorms are in continual progress over the earth's surface, accompanied by lightning flashes at an average rate of one hundred per second. Combining these results with the experimental measurements of the quantity of electricity in each lightning flash, it was shown that these thunderstorms represent an energy supply having the enormous value of 10^{12} watts, which, however, is only 10^{-4} of the energy received by the earth from the sun in the form of heat. It was suggested that electrons moving in electric fields with strengths of the order of 10,000 volts per cm. in the neighbourhood of lightning flashes, may be responsible for a very penetrating form of radiation in the atmosphere. In a later portion of the discussion Mr. Dobson described results obtained in observations on the disappearance of meteors and showed that this leads to increased values for the temperature and pressure of the atmosphere at heights of the order of 100 km.

The radio aspect of the discussion was opened by Sir Henry Jackson, who emphasised the long-felt need of an adequate explanation of long-distance wireless signalling, of the variations in signal intensity, and of the more recently observed variations in apparent directions of arrival of wireless waves at a receiving station. He stated that during the last few years an enormous amount of experimental data on these points has been obtained by a group of investigators associated with the Radio Research Board and that the experimental facts are now well established. All this work indicates the necessity for a layer in the upper regions of the earth's atmosphere which is capable of deflecting waves reaching it in such a manner as to return them to the earth's surface. A brief account was also given of some recent experiments carried out on a wave-length of 12 metres in which a ship transmitter was employed. As the ship proceeded away from the receiving station the signals disappeared for a range of transmission of about 100 miles. This was presumably due to the high attenuation of such waves in travelling over the earth's surface, although accurate knowledge on this point is still lacking. As the ship proceeded on its course no signals were received until the distance was increased to 1100 miles, beyond which the signals again disappeared. At 3000 miles and again at 6000 miles the signals were very clearly heard, although they were inaudible at intermediate ranges. Such results as these demand for their explanation an ionised layer which will permit the passage of wireless waves with a very small attenuation and will arrange for waves to be returned to the earth at certain places only.

Prof. E. V. Appleton indicated the desirability of investigating the wireless phenomena at comparatively short distances, and then described two sets of experiments, carried out with the assistance of Mr. M. A. F. Barnett, which provide proof of the reception of downcoming wireless waves at the earth's surface. The first of these demonstrated the interference between two sets of waves from the same transmitting station, one set having travelled along the earth's surface and the other set via the upper regions of the earth's atmosphere. The second experiment was based on the fact that, for an electromagnetic wave arriving at the surface of a conductor, the resultant horizontal

magnetic force is greater than that of the vertical electric force, and by measuring the ratio of these forces the angle of incidence of the waves can be calculated. Attention was directed to the importance of the earth's magnetic field on the operation of the ionised layer, and also to the fact that, from observations on very short wave-lengths, information is obtainable as to the density of electrons required in this layer.

The next contribution to the discussion was made by Dr. R. L. Smith-Rose and Mr. R. H. Barfield, who gave a brief account of some of their recent experimental measurements on wireless waves received from the upper atmosphere. By means of careful measurements of the directions of both the electric and magnetic forces at the earth's surface due to wireless waves from a distant transmitting station, it was shown that, at times in the neighbourhood of sunset and in the hours of darkness, some of the received waves were travelling in a downward direction, evidently the result of deflexion from the upper atmosphere. Several methods of measuring the angle of incidence and relative intensities of such waves have been developed and give consistent results. In an example given in the paper, the angles of incidence varied from 13° to 34°, and the latter value is shown to correspond to a height of deflecting layer of about 88 km., which is in good agreement with the results of other investigators. The intensity of such downcoming waves is of the same order as the direct wave along the earth's surface which is received simultaneously, and the combination of the two sets of waves is responsible for the variations in signal intensity in the readings of a direction-finder which were observed during the experiments. The need for further investigation and the lines of proposed future experiments were mentioned by these speakers.

In concluding the radio side of the discussion, Prof. W. H. Eccles reminded the audience that the observed effects might vary very much over the enormous range of wave-lengths which is now being used in practical wireless communications. The diffraction of the waves around the curvature of the earth would be appreciably different with wave-lengths of, say, 20 and 20,000 metres, and it is also possible that the shorter of these waves may be returned to earth at a comparatively low height, about 30 km., in the atmosphere. The speaker directed attention to some lacunæ in the Larmor theory of the propagation of waves, and emphasised the need of further experiments directed towards the elucidation of some points which are at present somewhat obscure.

Among the speakers who took part in the later portion of the discussion, Dr. G. C. Simpson stated that Britain now leads the world in the matter of knowledge and research on the science of the upper atmosphere.

Transatlantic Radio Telephony.

ON Sunday, March 7, the General Post Office gave representatives of the Press an opportunity of taking part in the engineering tests, made in the ordinary course, by the technical staffs of the General Post Office and the American Telegraph and Telephone Company. Mr. Shaughnessy, the engineer in charge, gave an interesting résumé of what has already been done. He also described the route that is travelled by the voice signals and detailed some of the many difficulties that will have to be overcome before two-way telephony between London and New York can be established on a commercial basis. So far back as 1914 the engineers of the Bell system in the United States succeeded in establishing one-way communication between Arlington and Panama, San Francisco, Honolulu and Paris successively. Three years ago similar experiments between London and New York proved that it was highly probable that a limited two-way service could be established.

In England, the circuit ends at the London Trunk Exchange of the British Post Office. In the United States it is terminated at the headquarters of the American Telegraph and Telephone Company at 24 Walker Street, New York City. In speaking from London, the signals are carried by underground telephone wires through two repeater stations direct into the microphone of the Post Office Radio sending station at Rugby, where the aerial used is carried by five lattice masts each 820 ft. high and a quarter of a mile apart. The radio signals then go a distance of 2900 miles to the receiving station at Houlton, Maine. From there they traverse a distance of 600 miles through two repeater stations to New York.

In transmitting from New York the speech is carried a distance of 70 miles to the sending station of the Radio Corporation at Rock Point, Long Island. From there it is transmitted by radio a distance of 3300 miles to the Post Office receiving station at Wroughton, near Swindon. From this point it is carried over a telephone circuit to London, a distance of 90 miles.

The wave-length utilised in England is 5770 metres and in the United States 5260 metres. The power used at each end is about 200 kilowatts, but owing to improvements in the method of radio transmission adopted, the ordinary broadcasting telephony station would have to employ about double this power to attain the same efficiency.

Arrangements were made by means of which some twenty press representatives in London had two-way conversations with their American confrères. These conversations could be overheard by all those present. The speech was remarkably clear, being quite equal to that heard in ordinary telephony. It was stated that the atmospheric conditions were favourable. Very little disturbance was produced by Morse or atmospherics. The difference between the voices of the speakers was clearly recognisable. This was the first occasion on which group conversations by the public were held between London and New York.

The Post Office engineers are to be congratulated on the many difficulties they have overcome, particularly in balancing the land telegraph lines in order to get two-way transmission. We are still, however, a long way from commercial telephony across the Atlantic. Doubtless it will come in the future. We wish the engineers every success in their strenuous endeavours.

Obituary.

PROF. A. R. CUSHNY, F.R.S.

THE sudden death of Prof. A. R. Cushny, professor of materia medica and pharmacology, University of Edinburgh, at the early age of sixty years, is a severe loss to medical science and to pharmacology in particular, for he was one of the chief pioneers of this science. The outstanding events in his career are as follows:—He was educated at the University of Aberdeen, and then studied on the Continent, and from 1892–1893 was assistant to Schmiedeberg at Strasbourg. In 1893 he went to the University of Michigan as professor of pharmacology, and in 1905 returned to England to take the chair of pharmacology at University College, London. In 1918 he went to Edinburgh to take up the post he held until his death.

Cushny made many important contributions to our knowledge of pharmacology and physiology, but his name is associated particularly with his investigations upon the mode of action of digitalis on the heart, and upon the secretion of urine. Whilst at Michigan, he carried out a series of researches of fundamental importance which established the mode of action of digitalis on the mammalian heart; and later in London, in association with his friend the late Sir James Mackenzie, he applied the knowledge gained in these researches to the study of the therapeutic action of digitalis. In 1925 he summarised our present knowledge of this subject in a monograph on digitalis and its allies.

Cushny carried out numerous important researches on the mode of secretion of the urine, and in 1917 he published a monograph, in which he advanced the first coherent theory regarding the secretion of urine which accords at all with modern ideas of physical chemistry.

It is as one of the chief pioneers and founders of the science of pharmacology, however, that Cushny will be especially remembered. In 1899 he produced the first edition of his well known "Textbook of Pharmacology and Therapeutics," which was the first systematic textbook on this subject to be published in English. He had a very remarkable power of shrewd and balanced judgment, and this was based not only on an exceptionally wide knowledge of pharmacological literature, but also on a personal knowledge of all the leading pharmacologists in the world. This combination of knowledge and judgment gave his textbook an unrivalled authority. His whole influence was thrown towards making pharmacology an exact science, and he admitted no tradition of therapeutics as a fact unless it was supported by definite evidence. For these reasons, the work has had a profound influence on the development of pharmacology in Great Britain and has greatly assisted the growth of the subject as an exact science.

Cushny's personality made him an exceptionally fine teacher and inspirer of research. His kindness and patience were inexhaustible, but his wide knowledge and shrewd judgment made him the natural enemy of anything like slack or inaccurate work. He founded the school of pharmacology at Michigan and made it an important centre of research, and repeated this performance in London. Finally, when he went to Edinburgh he found research work in Pharmacology at a low ebb and in a few years established a strong school. Cushny was the senior pharmacologist in Britain, and his wide experience and knowledge, his strong but kindly personality, and his great powers of judgment, made him the natural leader of his scientific colleagues, and also one whose advice was greatly valued on matters scientific, academic, and personal.

In addition to his scientific and academic activities, Cushny also served on numerous commissions and other public bodies, notably on the Chemical Warfare Committee, the Central Control Board (Liquor Traffic) and the Council of the Royal Society.

Cushny was a great pioneer and leader, and his untimely death is an irreplaceable loss to the medical sciences. Those who, like the writer, worked under him as assistant, have double cause to mourn the loss of a great teacher and kindly friend. His circle of friends was world-wide, and the sympathy of all will be extended to his widow and daughter in their sudden bereavement.

PROF. D. S. CAPPER.

PROF. DAVID SING CAPPER, who died from heart failure following acute rheumatism on February 12 at his home in Golders Green, was for twenty years professor of engineering in the University of London, King's College. He retired from this position in 1921 to devote himself to the commercial side of engineering. At the time of his death—he was only sixty-one years of age—he held the position of director in the Haulage Improvement and Constructions, Ltd., a company interested in the development of mechanical road transport.

Prof. Capper's early training, like that of most educated Scotsmen of his time, was of a wide and varied nature with a classical bias. After taking his degree at Edinburgh, he adopted the engineering profession and studied for some time at University College, London, under Sir Alexander Kennedy. His practical experience was obtained first as a pupil with Messrs. R. and W. Hawthorns of Leith, and later with Messrs. Humphrys, Tennant and Co., of Deptford, where for two years he acted as assistant to Mr. R. Humphrys. He took an energetic interest in the proceedings of the principal engineering societies, and was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Junior Institution of Engineers.

Prof. Capper was appointed professor of engineering at King's College, Strand, in 1890, and in 1905 he published, in the First Report of the Steam Engine Research Committee, the results of his long and important research on valve leakage carried out under the auspices of the Institution of Mechanical Engineers. The same year he became a member of the Senate of the University, and so many-sided were his manifold educational activities that at different times he had the distinction of being a governor of Sir Roger Cholmeley's School, a member of the governing body of the Imperial College of Science and Technology, and a member of the delegacy of King's College. He gave of his best in such services, where his long experience,

persuasive manner, an almost uncanny quickness in summing up the gist of a resolution, and an unfailing sense of the feelings of a meeting, made his presence a great asset.

Consistent with his leaning towards the practical side of his profession, Prof. Capper carried on a consulting practice for many years in addition to his other duties. Incidentally he was one of the pioneers of the 'Sandwich' system of training for engineers, wherein a student gained works experience with some well-known engineering firm in tandem with his college degree course each year for four years, instead of the usual three at college only.

When in 1908 Lord Haldane introduced his plans for the formation of Officers Training Corps at the various universities, Prof. Capper threw himself into the scheme with whole-hearted enthusiasm, and with characteristic zeal undertook the difficult task of commanding the University of London contingent. Later, with a stimulating sportsmanship, he passed all the examinations, and through every stage in the training curriculum of a territorial officer, from the barrack square at Chelsea to the School of Musketry at Hythe. In August 1914 he took command of a training camp for two hundred young officers at Headley, and eventually commanded various training schools for officers. He transferred to the 2/5th Royal Warwicks in 1916 as temporary major, readily sacrificing his rank of lieut.-colonel in his keenness to serve overseas. Then at the age of fifty-one years this university professor went out into the trenches as second in command of an infantry battalion; an example of patriotism and pluck which is worthy of record. Early in 1917 he was invalided home on account of heart trouble and transferred his energies to the Ministry of Food, where he assisted in a research on food preservation until the end of the War, when he returned to his duties at King's College. O. S. S.

WE much regret to record the death, on February 26, of Mr. Henry Hatfield, I.S.O., barrister-at-law, for more than thirty years Chief Examiner at the Patent Office. Born at Stockport in 1854, and educated at Owens College, Manchester, and the Royal College of Science, Dublin, Mr. Hatfield intended to enter for the Geological Survey. He went to the Patent Office instead, however, in 1878, becoming Chief Examiner in 1888, and later was authorised to act for the Comptroller-General. During his regime many changes in patent procedure were inaugurated, notably the modern methods of 'search' by a scientific staff. To the general scientific public, his work in connexion with the founding of the Patent Office Library, which has now become one of the best scientific libraries in Great Britain, will be better known.

News and Views.

A LARGE company of the Royal College of Science Association and others assembled at the Imperial College Union, South Kensington, on Friday last, March 5, on the occasion of a complimentary dinner to Sir John Farmer, professor of botany in the College, upon whom the honour of knighthood was conferred by the King at the beginning of this year. Sir John Farmer is the senior professor of the Royal College of Science, and when the Imperial College was instituted by Royal Charter in 1907 for the purpose of giving the highest specialised instruction, and providing the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry, doubt was expressed as to whether botany could appropriately be brought within the contemplated scheme. Fortunately, its economic significance was realised, with the result that the department devoted to instruction and research in this branch of science has become of the greatest value in the development of the plant resources of the British Empire. Students trained by Sir John Farmer now hold responsible posts in educational institutions, agricultural stations, and great plantations throughout the Empire, and when he visited Trinidad a year or so ago, as many as five in that single place were at the port to welcome him. Mr. Herbert Wright, who proposed the toast of the guest of the evening, testified as an old student to the wide and stimulating influence of Sir John Farmer's work. To have established a school of pure and applied botany which has contributed so much to scientific progress and practical service is a great achievement, and we cordially associate ourselves with Sir John Farmer's colleagues and students in congratulating him upon it and the recognition of his work represented by the honour recently conferred upon him.

PROF. ARNOLD SOMMERFELD, who on Wednesday, March 3, delivered the first of a course of three lectures on "Atomistic Physics" at the Imperial College of Science and Technology, under the auspices of the University of London, is one of Germany's leading mathematical physicists. He is now professor of physics at the University of Munich, where he is a colleague of Prof. Wien, who visited Great Britain last year. Prof. Sommerfeld was born in 1868, and during the early years of his career published many papers on various branches of theoretical physics and pure mathematics. He is known chiefly, however, on account of his more recent work in developing the application of the quantum theory to the problem of the spectra of the elements, initiated by Bohr. Independently of Wilson he showed that by a generalisation of Bohr's original theory of the hydrogen atom to include the possibility of elliptic orbits, and the introduction of the relativistic change of mass with velocity into the equations of electronic motion, the existence of a 'fine-structure' of the series lines of hydrogen and ionised helium might be expected—a prediction which was brilliantly verified in the case of ionised helium by Paschen. Later he introduced into the discussion of spectral term-relationships the idea of 'inner quantum numbers,' which, since the discovery of multiplets by Catalan, has received a very wide application. His book, "Atombau und

Spektrallinien," first published in 1920, has already passed through four editions, and is recognised as the standard work on the subject. It has been described as 'the twentieth century bible.' An English translation of the third edition, under the title "Atomic Structure and Spectral Lines," appeared in 1924.

A DEPUTATION from the Universities of Cambridge and Edinburgh was recently received by the Colonial Secretary with reference to the inauguration of an Imperial Forest Research Institute at the University of Oxford, combined with a fourth year's course in forestry. This project had been recommended by the Empire Forestry Conference which met in London in 1920. Few members of that Conference had full knowledge of the great progress made in forestry education at Cambridge and Edinburgh as the result of a recommendation of the Commission appointed in 1908 by the India Office after the closure of Cooper's Hill. That Commission invited these universities to inaugurate and equip schools of forestry, pointing out that competition would be to the benefit of forestry. At both universities forestry education up to a fourth year's post-graduate honours course was instituted. Only the Colonial Office and the Forestry Commission took up the recommendations of 1920 and provided the funds with which the Institute and fourth year's work were started at Oxford, provisionally for five years, in October 1924. In selecting candidates for employment, from men with a degree or diploma in forestry, these two departments make an allowance to the chosen probationers and insist on their proceeding to Oxford to take the fourth year's course. The deputation pointed out the hardship thus incurred by men having to change their universities and, in the case of Edinburgh, to incur a far greater expense. In the opinion of the delegation, the innovation would result in a decrease in a good type of man coming forward to take forestry as a career.

A PAPER on the applications of electricity to agriculture by Mr. Borlase Matthews was read and discussed at the Institution of Electrical Engineers on March 4. He succeeded in proving many useful and convenient applications of electricity in connexion with farming. In his opinion, when a quarter of the area near a transmission line is arable land, the supply will prove profitable to the electric company. A specification is given of the author's electric tractor suitable for small farms. It is designed for ploughing, general haulage, and many other field operations. When carrying out field work, the machine takes its supply of current from an overhead wire and a cable laid on the ground. It has a 'half creeper' track so that it can go over rough ground. It also has a storage battery, so that it can proceed from field to field as well as haul loads on the public road. It seems possible that the plough may be replaced by the rotary tiller, which has many points in its favour. This machine is excellently adapted for an electric drive, and the latest type of instrument buries the weeds and leaves, a result desired by most farmers. From the financial point of view, however, a strong case was not made out. Ploughing only takes place over a limited period of the year, and so it does not offer that uniform load desired by electric companies. Mr. Matthews' electric tractor, however, offers possibilities which should be further explored.

SIR HENRY MAYBURY, Director-General of Roads Department, Ministry of Transport, in his discourse on "London Traffic" at the Royal Institution on Friday evening, March 5, stated that the problem of the transport facilities of the great Metropolis cannot be solved unless it be approached on scientific lines. In 1903 a Royal Commission was appointed to inquire into the question, and made recommendations for improvements to which effect was never given. Another Royal Commission was appointed in 1921, and the outcome of its recommendations was the passing of the London Traffic Act in 1924, and the appointment, under the Minister of Transport, of the London and Home Counties Traffic Advisory Committee. This Committee has made a thorough investigation of the various tramways and omnibus routes, and is required to supervise an area within a circle extending about 25 miles from Charing Cross. The engineering staff of the Committee has given much attention to the bridge question in the traffic area, and is making a report thereon. The results of the Committee's recommendation have been so far successful in the adoption of the gyratory or continuous working arrangement as now in operation at the end of Parliament Street, Bridge Street, and near the Victoria Memorial; and schemes of identical character have been approved for Trafalgar Square and Hyde Park Corner. By utilising many of the existing subsidiary roads, which may be made continuous and through routes, and by the use of effective direction signs by day and night, it is believed that with much advantage a large amount of traffic can be deflected. The Committee is proceeding with negotiations with the various local authorities, in order to find a satisfactory solution to the vast problem of London traffic, which is of so much importance to the comfort, health, and general welfare of the citizens of London.

SEVERAL valuable papers on power-plant design and operation were read and discussed at the December meeting of the American Society of Mechanical Engineers held in New York. These papers are of special interest in Great Britain at the present time. In the United States cheap overhead lines are permitted, and this leads to the building of super-power stations. As the cost of labour is high, this also accentuates the economies effected by their use. Mr. C. W. E. Clarke describes the rapid advances made by the Colfax station of the Duquesne Light Company. It began to operate in 1920 with a turbo-alternator generating 60,000 kilowatts. The steam pressure used was 275 lb. per square inch and its temperature was 600° F. In 1923 it was decided to use pulverised fuel and to raise the steam temperature to 650° F., preheated air being supplied to the furnaces. It was found, however, that the bricks

lining the furnaces were apt to be fluxed at this temperature. In the newer boilers the furnaces are water lined and no trouble has been experienced. The boilers cost 16 per cent. of the total cost of the station, and the turbines and electric generators practically cost the same. The steam pressures used are rapidly increasing. American makers are prepared to supply boilers for a working pressure of 1200 lb. per square inch. Turbine makers, however, are unwilling to go beyond a pressure of 600 lb. Their problem, being a dynamical one, is more difficult than the statical problem of the boiler makers. It is stated that the cost of a boiler to work at a pressure of 1000 lb. is about twice as great as that of a boiler for a pressure of 200 lb. per square inch. As yet there is no British station working at a pressure much in excess of 500 lb. per square inch. Sir James Kemnal recently suggested that, with very high pressures, steam drums should be drawn solid and not riveted as they are at present.

MOUNT SINAI has been considered as a site for a third Smithsonian station to study fluctuations of the sun's light and heat, but it has now been abandoned as a possibility. Dr. C. G. Abbot, Assistant Secretary of the Smithsonian Institution of Washington, D.C., and Director of the Smithsonian Astrophysical Observatory, has left the Red Sea and finished his tour of India. He is now on his way to South Africa, continuing his search for a suitable site. It is hoped that data obtained from a third station, and later from a fourth, if more funds should become available, will increase the possibility of making trustworthy weather forecasts all over the world, weeks and even months in advance. Data are already being obtained from the study of the sun at Mt. Montezuma on the western slope of the Andes Mountains in Chile, and on Table Mountain in Southern California; and the National Geographic Society has made a third observation station possible by extending financial aid.

PROF. FRASER HARRIS, formerly lecturer on physiology in the University of Birmingham, delivered the last of the present series of Monday evening lectures at the Midland Institute on March 8. His subject was "Biology in Shakespeare." Prof. Fraser Harris said that he used the word biology as meaning all knowledge concerning life, vegetable and animal, both in health and disease; but for the purposes of the lecture, he would not include any references to botany, zoology, or medicine. He did, however, include one or two allusions to surgery, the most interesting of which were the lines spoken by the Archbishop of York in "Henry IV.":

> "If we do now make our atonement well,
> Our peace will, like a broken limb united,
> Grow stronger for the breaking."

References to the physiology of the following were studied in the plays—sleep, the heart, arteries, veins, and nerves; fainting, the doctrine of the three kinds of spirits, the halitus sanguinis; the action of alcohol; digestion; starvation; the description of Falstaff's death; infection; first aid; the vis medicatrix naturæ; the pia mater and the visceral distribution of the emotions. The physiological psychology of visual hallucination; trophism of nerves; sense before motion; retinal fatigue; the Sauson images; giddiness; psychical blindness and paraphasia were also illustrated by references from the plays.

THE anxiously awaited report of the Broadcasting Committee under the chairmanship of Lord Crawford and Balcarres was issued late last week (H.M.S.O., Cmd. 2599, price 6*d*.). The terms of reference were "To advise as to the proper scope of the broadcasting service and as to the management, control, and finance thereof after the expiry of the existing licence on December 31, 1926. The Committee will indicate what changes in the law, if any, are desirable in the interests of the broadcasting service." The Committee recommends that after the end of this year, the broadcasting service in Great Britain should be in the hands of a public corporation to be known as the British Broadcasting Corporation, consisting of not more than seven or less than five commissioners nominated by the Crown. These commissioners should be persons of judgment and independence and free of commitments; they should receive adequate remuneration. Advisory committees would be appointed by the commissioners in consultation with appropriate societies and organisations, so that all phases of broadcasting may receive consideration. As regards research, the Committee states that expenditure will govern progress: "Outlay on bold experiment should not be meagre. Research should be constant, both official and unofficial." The Committee was much impressed by the evidence received on the importance of broadcasting in education in its widest sense, and advocates the extension of such facilities, if necessary, by the introduction of special wave-lengths for definite subjects.

FEBRUARY temperature was a record in England, and the observations at Greenwich Observatory published in the Daily Weather Reports of the Meteorological Office and in the Weekly Returns of the Registrar-General show some exceptional results. The mean air temperature for the month at Greenwich was 45°·7 F., which is the highest mean for London or Greenwich in February during the last 156 years; it is 6°·9 above the monthly normal for the 150 years from 1770 to 1919, and in practical agreement with the normal for April. In this long series of years the February mean for 1869 was approximately in agreement with that for 1926, and the only other means of 45° or above were 45°·3 in 1779 and 45°·1 in 1872. There were two days, February 21 and 26, with the shade temperature above 60°, and there were eleven days with the temperature above 55°; there were eight days with the temperature for the 24 hours 10° or more in excess of the normal, while the only days with the temperature below the normal were February 9 to 14. The minimum or night temperature was above 40° on seventeen nights, and there were only two nights, February 13 and 14, with frost

in the shade. On two days, February 22 and 26, the black bulb thermometer in the sun's rays exceeded 100°, the respective readings being 106° and 111°, but the duration of bright sunshine for the month was small, registering only 1·3 hours a day on the average, while the normal is 2·0 hours. Separating the mean of 150 years into periods of 50 years, the means at Greenwich for February are 38°·1 for 1770–1819, 39°·0 for 1820–69, 39°·4 for 1870–1919; the mean for the 150 years is 38°·8. The normal for 35 years, 1880–1915, in general use by the Meteorological Office is 39°·8.

ACCORDING to the *Weekly News Bulletin* issued by the U.S.S.R. Society of Cultural Relations with Foreign Countries, preparations are being made for the celebration of the eightieth birthday of Dr. A. P. Karpinsky, who has been a member of the Academy of Sciences for forty years and its president for the past ten years.

BESIDES the earthquake felt at Comrie at 4·24 A.M. on February 21 (NATURE, March 6, p. 355), it is now stated that a second and perhaps slightly stronger tremor occurred at about 7·40 P.M. on the following day. Both were felt at Lawers, two miles east of Comrie, and at St. Fillans, four miles to the west. The epicentres probably lie about a mile to the west or north-west of Comrie, and close to those of the remarkable series of earthquakes in 1839 and the following years, thus showing a slight displacement to the west since the shocks of 1895 and 1898.

THE discovery has been announced, by the New York correspondent of the *Times*, of the element of atomic number 61, by Dr. B. S. Hopkins and others, of the University of Illinois, apparently by the use of X-ray methods. The full account of the work will be awaited with much interest, for element No. 61 belongs to the group of 'rare earths,' the separation of which has always been unusually difficult owing to the close resemblance in properties of the individual elements. On the evidence of high-frequency spectra, it has been shown that the group consists of fourteen elements ranging from lanthanum (At. No. 57) to lutecium (At. No. 71), with a gap represented by element No. 61. Prof. Hopkins' discovery would apparently complete the group.

AT a meeting held at the Institution of Civil Engineers on March 5, the organisation of a body to deal with questions of fuel technology was discussed. The proceedings were opened by Sir William J. Larke, of the National Federation of Iron and Steel Manufacturers, who referred to the widely divergent character of fuel practice in industry, and emphasised the need for a body aiming at co-ordination of existing knowledge on the subject. Sir Philip Dawson stated that the fuel bill is a dominant factor in industry; it forms 35 per cent. of the production costs in the iron and steel industry; 50 per cent. in the generation of electricity; and 30-45 per cent. of locomotive costs on railways. Sir Richard Redmayne also supported the suggestion for the organisation of an institution of fuel technology, and a committee was appointed to discuss preliminaries and to decide the question of collaboration with the Institution of Fuel Economy Engineers.

IN 1922 the staff of the Research Laboratories of the General Electric Co. Ltd., Wembley, decided that in making communications in scientific journals, the most appropriate method of recognising the co-operative conditions under which their research work is conducted was by expressing authorship as in the name of the whole of the staff. Mr. C. C. Paterson, Director of the Laboratories, now informs us that this formula has been misunderstood, and objections have been urged against it even by those who agree with it in principle. A change is therefore to be made, and the formula "by . . . (Communication from the Staff of the Research Laboratories of the General Electric Company, Wembley)" has been selected.

THE Council of the Institution of Mining and Metallurgy has made the following awards: The gold medal of the Institution to Sir Robert N. Kotzé, Government mining engineer for the Union of South Africa, in recognition of his distinguished services to the mining industry, with special reference to his work on the dust problem in the mines of the Rand, and of his public work in promoting the development of the natural resources of the Union of South Africa; "The Consolidated Gold Fields of South Africa, Ltd." gold medal to Prof. L. H. Cooke, in recognition of his services, extending over many years, in the advancement of the science and practice of mine-surveying and the improvement of surveying instruments, and of his valuable contributions to the literature on the subject; "The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to Dr. H. C. Boydell for his paper on "The Rôle of Colloidal Solutions in the Formation of Mineral Deposits."

THE Geological Society of Peru, which was founded at Lima in July 1924, has issued the first volume of its *Boletin*. The report of the second meeting includes a speech by the President of the Republic, who attended to express his sense of the value of a geological society to a country so rich in mines as Peru. The first printed paper, on some fossil shells from the Cretaceous and Eocene of Peru, is by the president of the Society, Dr. C. I. Lissón, professor of geology in the School of Engineers of Lima. He also writes at length on the palæogeography of Peru, and publishes a series of maps of the country at successive geological periods. Among other papers on Peruvian geology may be specially mentioned a valuable summary of the deposits yielding petroleum, by Mr. R. A. Deustua. The publication is well printed and illustrated, and shows that the Society has made a good beginning. To our congratulations we would add our best wishes for its continued success.

THE United States Department of Agriculture Library has recently issued an author and subject index covering the publications of the Department of Agriculture on plant pathology up to January 1, 1925, exclusive of the publications on the diseases caused by insects. In the author arrangement all

anonymous and some ephemeral publications have been omitted. The subject index aims at giving a complete record of the publications of the Department on plant pathology. Some selection has been made for subjects upon which there are many contributions, the brief and less important ones being omitted. For subjects on which there are few publications, all have been included. The index covers 158 pages of close type-script, a preliminary account being given of the various series of reports and bulletins that are dealt with. Some of the more recent papers are now available for free distribution, and many of the others may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C., though most of the early series are entirely exhausted. The Library of the Bureau of Plant Industry is interested in establishing exchange relations with other institutions which issue publications on plant pathology and other subjects pertaining to the work of the Bureau.

A COMPACT and ingenious soil testing outfit has just been put on the market by the British Drug Houses, and should prove of considerable value to farmers and research workers who may need to get a rapid indication of acidity or alkalinity in field soils. The outfit consists of a small double-chambered porcelain boat, a porcelain spatula, and a dropping bottle of B.D.H. soil indicator. The soil and indicator are carefully mixed in the larger end of the boat, allowed to settle and the supernatant liquid decanted into the smaller end, where the colour may be observed readily. The colours range from red with a very acid soil, through orange and yellow, to green in a neutral soil, while alkalinity is shown by blue. The first three colours indicate that lime is needed to improve the fertility of the soil. Tests made with the outfit show that it is practical in type, is easily worked, and that the colour differences are clear and sharp, making it specially useful to observers who are not experienced in the manipulation of scientific apparatus.

MESSRS. Ogilvy and Co. have sent us the third edition of the pamphlet on how to use the microtome, prepared by Prof. S. Becher of Giessen, which is issued by Messrs. Leitz. It is an eminently practical compendium which describes clearly how to imbed tissues in paraffin and celloidin and how to use the various forms of microtomes made by Leitz; and most microtomists will probably find in it some small points which they have not heard of or have forgotten. To beginners it should certainly be useful. The only serious defect is that it does not mention the Cambridge rocking microtome, the practical excellence of which seems scarcely to be realised outside Great Britain. Fixation and staining are dealt with only incidentally, but we note that Prof. Becher thinks highly of some nuclear stains (naphtopurpurin, etc.) which are not well known here. The translation is quite clear if not always idiomatic: for English readers reference should have been made to Lee and Gatenby's "Microtomists' Vade-Mecum" rather than its collateral, P. Mayer's "Zoomikrotechnik."

MESSRS. W. Watson and Sons, Limited, 313 High Holborn, London, W.C.1, have recently issued a catalogue of optical and other scientific instruments, with which is combined a dictionary. The latter contains all the descriptions and illustrations included in the "Dictionary of British Scientific Instruments," issued by the British Optical Instrument Manufacturers' Association, and referred to in our columns (NATURE, May 12, 1921, pp. 324-5) shortly after its publication. The combined catalogue and dictionary forms a work of reference which should be of great value and interest to the users of scientific apparatus. The catalogue contains a typical selection of instruments manufactured or supplied by Messrs. Watson. These cover a very wide range and include magnifiers and microscopes, telescopes and field glasses, optical projection apparatus, nautical and meteorological instruments, drawing and surveying apparatus. Among the newer instruments is the 'Binar' pocket combined telescope and magnifier. This consists of an achromatised object glass and a focussing eyepiece, and gives a magnification of $2\frac{1}{2}$ diameters. The object glass alone can be used as a magnifier of about 6 diameters. The telescope is of such small dimensions that it can easily be carried in the waistcoat pocket. The 'Window' telescope is a lens of 15 in. diameter which can be placed in contact with the glass of a window. By its means, observers within a room may conveniently obtain a magnified image of distant objects visible from the window, and thereby the attractions of a house with a pleasing outlook become enhanced.

READERS interested in books relating to the Near East and Egypt should obtain Catalogue No. 476 of Mr. F. Edwards, 83a High Street, Marylebone, W.1, which gives particulars of nearly 900 works concerning Egypt, Mesopotamia, Arabia, Palestine, Asia Minor, the Balkan States, the Sudan, etc.

THE latest catalogue (No. 265) of Messrs. W. Heffer and Son, Ltd., Cambridge, contains the titles of some 1600 books and journals relating to mathematics, physics, astronomy, chemistry, and chemical technology. It should be useful to those requiring publications in the sciences named; also for reference.

MESSRS. C. BAKER, 244 High Holborn, London, W.C.1, have sent us a new issue of their well-known classified catalogue of second-hand scientific instruments. It contains a noteworthy collection of physical and related apparatus, and in particular there is a large number of student's microscopes and accessories. A special catalogue of this section can be obtained post free on application.

MESSRS. Crosby Lockwood and Son announce "The Science of Flight and Practical application," 2 vols., by Capt. P. H. Sumner. The work will be a study of the principles of flight and practical aircraft. Vol. 1, dealing with airships and kite balloons, will be published shortly. The same publishers will also issue "Hydrology," by J. M. Lacey, treating of rainfall and the influence of its distribution on the earth.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Two junior engineers at the Forest Products Research Laboratory, South Farnborough, Hants—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (March 20). A senior technical assistant for experimental work at Greenock in connexion with high-speed internal combustion engines of a special type—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (March 20). A number of assistant electrical engineers in the Admiralty Service—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (March 20). A head of the Engineering (Production) Department of the Joint Technical College under the Wolverhampton and Staffordshire Education Committees—The Director of Education for Wolverhampton, Wolverhampton (March 20). A senior botany mistress at James Allen's Girls' School, East Dulwich Grove, S.E.22—The Headmistress (March 30). A physiological botanist and a biochemist under the Government of Madras (Development Department), for research work on cotton—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (April 1). A pathologist under the Manchester Committee on Cancer—The Chairman, Manchester Committee on Cancer, 1 Mount Street, Manchester (April 3). A professor of physics in the University College of South Wales and Monmouthshire—The Registrar, Cathays Park, Cardiff (April 17). A warden of the College House of Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (April 30). An assistant in the department of entomology (Division of Tropical Medicine and Hygiene), London School of Hygiene and Tropical Medicine—The Secretary, 23 Endsleigh Gardens, W.C.1 (May 31). A chemical laboratory assistant in the Experimental Department of the Fine Cotton Spinners' and Doublers' Association—F. P. Slater, Rock Bank, Bollington, near Macclesfield. A teacher of engineering subjects at the Wandsworth Technical Institute—The Principal.

Our Astronomical Column.

RECENT MAGNETIC DISTURBANCE.—A magnetic disturbance was recorded at Greenwich on March 5, commencing at 10 hr. and lasting until 6 hr. on the following morning. The most disturbed part of the magnetograph traces was between 16 hr. and 23 hr. on March 5, when the extreme range in declination amounted to 53′. The disturbance is thus somewhat inferior to those commencing on January 26 and February 23, but is of interest on account of its apparent connexion with a large sunspot in solar latitude 27° south, mentioned in NATURE of March 6, p. 356. The magnetic disturbance began when the spot was 21° or 1·6 days west of the sun's central meridian.

ENSOR'S COMET.—The absence of any reports of European observations of this comet is cause for surprise. It was easily seen at Johannesburg in bright twilight towards the end of January, and it should have been equally bright early in March. The morning sky has been generally cloudy in England, but Dr. W. H. Steavenson utilised a clear interval on the morning of March 5 to search for it; he found no cometary object as bright as magnitude 9 within 30′ of the tabular place. Assuming that no error was made in setting, this would indicate a very unexpected decline in light. This would not be unprecedented; Westphal's comet underwent a similar mysterious loss of light in the autumn of 1913. Further observations are desirable before the fact is regarded as established. Mr. G. Merton noted that the comet approached Mercury within a tenth of a unit about February 11. The mass of Mercury is, however, too small to produce any appreciable disturbance at this distance.

THE MEASUREMENT OF STELLAR RADIATION.—An interesting article by Dr. Hale on "Heat from the Stars" is published in *Scribner's Magazine* for January. After an historical introduction, the work of the late Prof. Nichols with the radiometer is described, and an amusing reminder of the great sensitiveness even of his early type of radiometer is afforded by the remark that the observed deflexion due to the heat radiation from a human head 2000 feet distant was as much as 25 millimetres. Work with thermo-couples by Pfund, Coblentz, and Pettit and Nicholson is next described; the sensitiveness of the instrument used by the two latter observers being so great that the radiation from stars even so faint as the thirteenth magnitude has been measured. Finally, after an account of Abbot's work on the energy distribution in stellar spectra, Dr. Hale explains the relation between facts obtained in the manner described and theories of stellar constitution and life-history, as exemplified by the work of Eddington and Jeans. The article is well illustrated and interestingly written for the general reader, forming a useful summary of the work accomplished up to the present time in this department of astronomy.

NOVA PICTORIS.—*Astr. Nach.*, No. 5413, contains an interesting paper on this star by Prof. J. Hartmann of the La Plata Observatory. The position is given as R.A. $6^h\ 34^m\ 56^s{\cdot}58$, S. Decl. 62° 34′ 32″·7 (equinox 1925·0). Magnitudes of the star are tabulated from 1925, May 27 (mag. 2·8) to Nov. 23 (mag. 4·4). The principal maximum (mag. 0·96) was on June 9; there were secondary maxima on July 28 (mag. 1·8) and Aug. 10 (mag. 2·3). The star remained conspicuously visible to the naked eye for more than seven months, which is longer than the duration of most recent novæ.

Prof. Hartmann elaborates a new theory of novæ; a great increase of temperature is supposed to arise in the star's central regions, causing a rapid expansion of the surface. In the present case the radial velocity due to this expansion was found to average 140 km./sec. The star's radius prior to the outburst is estimated as 1,400,000 km.; on May 27 this had increased to 141,000,000 km., and on June 9 to 298,000,000 km. Throughout the expansion the surface temperature is assumed to remain unaltered, but after the maximum, cooling sets in and the spectral type changes. Taking the star's original spectral type as A 2, its parallax is found to be 0·0007″, and distance 4500 light-years.

Prof. Hartmann notes that a change of surface temperature from the coolest to the hottest stellar type would account for only one-tenth of the increase of light, so that increase of diameter is also required.

Research Items.

ORIGIN OF THE ESKIMO.—Writing on the results of the fifth *Thule* Expedition, 1921–24, in the *Geographical Journal* for February, Mr. K. Rasmussen believes that the original Eskimo culture must have been of an exclusively inland type, that of a people dwelling by lake or stream. In course of time, either by following the wandering reindeer or driven by hostile Indian tribes, the aboriginal Eskimo moved to the Arctic shores, adapting their implements to the needs of hunting in the sea and on the ice. Reindeer appear to have led them to the region between Coronation Gulf and Boothia peninsula. From there they moved west to Alaska and east to Greenland. The belt of tundra west of Hudson Bay barred the passage of one large group now known as the Caribou Eskimo, among whom the aboriginal inland culture has been preserved. The Eskimo who moved to the coast evidently flourished, and hence their extensive migration west and east. Finally, in comparatively recent times, a new migration has taken place from the interior down to the coasts. These conclusions are in close accordance with the views first advanced many years ago by Prof. Steensby. The papers contain a summary of the main results of the expedition and has several photographs of the Caribou Eskimo.

SPIRIT WORSHIP IN THE NILGIRIS.—In the *Indian Antiquary* for January, Rai Bahadur B. A. Gupte gives an account of a curious family of 'Pariahs,' who lived in the Nilgiri Hills about twenty years ago, two of the members of which were said to be spirit-possessed, and to have certain powers. Not only did they profess to foretell the future, but they also claimed to be able to ward off calamities, exorcise demons, give children to the barren, and regulate the sex of unborn children. Their influence was so great that although 'untouchables,' Brahmans and their womankind mixed with them freely. The possessed members were the younger son and younger daughter, the former by Mariamma, the goddess of cholera, and the latter by Kani-amma, the virgin goddess. Mari-amma, ferocious and wild, was represented as a widow who guided Kani-amma, who was fair, young, and attractive. A small hut was set out as a shrine of Mariamma, who was represented by a small stone figure about 9 inches high. The author witnessed several performances by the family in one of which the goddess, speaking through the girl, answered questions propounded by him; in another the son as 'god' went through a dancing performance in the course of which he stood on the edge of a scythe. No mention is made of the more violent symptoms usual in 'possessions.'

GEOGRAPHY OF WISCONSIN.—Wisconsin has an active Geological and Natural History Survey which has been responsible for several memoirs on the State. The latest of these is a well-illustrated volume, published by the State at Madison, on the geography of south-western Wisconsin (Bulletin No. 65), by Mr. W. O. Blanchard. The various geographical factors of topography, soil, climate, mineral resources, and position are treated in turn by an author with a wide personal knowledge of the country. The result is a lucid explanation of the past and present economic conditions and distribution of population. Another publication by the same society (Bulletin No. 67) is a brief outline of the geography of the whole State by Mr. W. O. Hotchkiss and Mr. E. F. Beau. This is written in a more popular style, but forms a useful summary.

PRENATAL DEATH AND SEX RATIO IN THE PIG.—Dr. F. A. E. Crew (*Proc. R. Soc. Edin.*, vol. 46, pt. 1) finds that the primary sex ratio in pigs is at least 60 per cent., 150 males to every 100 females being produced as a result of fertilisation, due either to a differential production of the two sorts of spermatozoa or a differential functional activity on the part of these. There is a serious prenatal mortality affecting chiefly the males and operating in such a way as to make the secondary sex ratio practically equality. The reason for this higher male death-rate the author believes to be fundamentally genetic in its nature, and suggests that the male type of physiology is less able to withstand the stress of functioning both prenatally and postnatally than is the female. His results confirm those arrived at by Parkes in a similar inquiry.

ASYMMETRY IN MAMMALIAN SKULLS.—Mr. A. B. Howell (*Proc. U.S. Nat. Mus.*, vol. 67, art. 27) has investigated very thoroughly four mammal skulls which exhibit definite asymmetry, two primates and two pinnipedes. From his examination of this material the author concludes that the primary cause inducing asymmetry in the skulls of mammals is probably accident or disease to the bones or muscles of one side of the head at an early age, of such a character as to result in a stunted or infantile condition of a crucial part of the bony framework and a reduction in the rate of growth, or strength, through lesions, of the corresponding muscles. The normal development of the bones of the skull is directly dependent upon the growth of the attached muscles. If the latter for some reason or another remain infantile or fail to grow, the bones to which they are attached will remain proportionally undersized. In the four skulls examined, the original seat of the injury was in the neighbourhood of one of the glenoid fossæ, and the author discusses the relations of the temporal and masseter muscles in their size and strength with the extent of the asymmetry observed in the skulls.

THE VASCULAR SYSTEM OF THE MYXINOIDS.—Prof. F. J. Cole has continued his systematic study on the myxinoid fishes, and in pt. vi. (*Trans. Roy. Soc. Edin.*, vol. 59, pt. ii., 1925) of his monograph presents a detailed and excellent account of the vascular system of Myxine. Many important new features are brought out. Asymmetry of the veins is of constant occurrence, with the result that vessels which are not homologous perform the same functions on the two sides of the body. A third pair of local hearts is described in relation to the cardinal veins, in addition to the previously known unpaired portal and paired caudal hearts. The cardinal hearts are sacs formed by swellings of the veins in question, guarded by valves, and possessing extrinsic structurally modified muscles. In the possession of an extensive lacunar system, myxinoids are specialised, and a complete account of this system is now available for the first time. These lacunæ are lined by endothelium and are divisible into red and white lymphatics. The former always contain red blood which enters them from the arteries, and they also communicate with the veins by valved apertures. They form, therefore, part of the blood vascular system interposed between the arteries and veins and take the place of a closed capillary system, which is absent in those regions where these lymphatics occur. The dominating feature of this system is an extensive subcutaneous sinus, so that the animal lies in its skin as in a loose sac. The white lymphatics represent a true lymphatic

system corresponding to that of higher vertebrates. It forms a complete system in itself, beginning as a blind plexus in the walls of certain organs and discharging finally into the veins, indirectly through the red lymphatics, and also directly via the caudal hearts.

SNOW IN EASTERN SIBERIA.—To the *Recueil de Géophysique* (vol. 4, pt. 3) of the Geophysical Observatory of Leningrad, M. W. B. Shostakovitch contributes a statistical paper on the snow covering of eastern Siberia since 1881, when regular observations were first made, until 1913. The data, while showing a distinct correlation between the thickness of the snow covering and the quantity of winter precipitation, prove that various factors have importance. Topographical features have great influence; on windward slopes the snow cover is greater and on leeward slopes less than the precipitation would suggest. Most interesting, however, is the conclusion that the annual variation in thickness of the snow cover is especially great in regions where snow is comparatively scarce. February is the month of maximum thickness, the depth of snow in that month averaging 10 cm. to 20 cm. in the Amur valley, except at the mouth, where it rises to 70 cm., and increasing generally towards the north-west and north-east but keeping comparatively shallow in the Okhotsk district and Lena valley. Practically the whole of eastern Siberia, except the east coast, has a snow covering for at least 150 days a year, the duration increasing with latitude to 250 days.

ISOSTASY IN WESTERN SIBERIA.—In 1912 the Russian Astronomical Society sent an expedition to Western Siberia to determine the force of gravity at various stations. From the results obtained, isostatic reductions have now been made by Wm. Bowie and his co-workers (*Am. Journ. Sci.*, Feb. 1926, p. 113). The remaining anomalies are very small, and provide further support for the view that isostasy obtains for all portions of the earth's crust. The data for Siberia and for other regions are conveniently summarised in a table, part of which is here reproduced. The figures refer to the number of gravity stations and to the mean anomaly in dynes with regard to sign.

United States . . .	296	−0·006
Southern Canada . .	42	−0·009
Northern Canada . .	9	+0·001
India	73	−0·004
Holland	51	−0·001
Alps and vicinity . .	31	+0·019
Western Siberia . .	9	−0·005

To these may be added,

Southern Pacific Islands .	5	+0·030

This last result should probably be reduced by one-half to take into consideration the much higher density of Pacific as compared with continental rocks (*Journ. Wash. Acad. Sci.*, Dec. 4, 1925).

ECHO SOUNDINGS IN THE INDIAN OCEAN.—In the waters to the south of Java and Bali and around Christmas Island, where soundings hitherto have not been numerous, several hundred echo soundings were taken last autumn from four Dutch submarines and the depôt ship *Pelikaan*. An account of the work with a chart of the waters is published in *Verhandelingen* No. 17 of the Royal Observatory of Batavia. The instruments used were those generally employed for submarine communication between vessels. Several observations being made for each determination, the time error was reduced to about 0·1 second. The few previous soundings on the whole agree with the echo soundings; occasional discrepancies may be due to inaccuracies in the geographical positions of the earlier work. The regularity of the submarine contours in a region with great differences in depth suggests the reliability of the echo work. A remarkable result is the discovery of a row of submarine elevations in about lat. 11° S., or more or less in a line with Christmas Island, and immediately to the north of them a long steep-sided trough of more than 3800 fathoms and reaching in one place to 4107 fathoms.

THE DETERMINATION OF THE WAVE-LENGTHS OF X-RAYS BY MEANS OF A REFLECTION GRATING.—Doan and Compton have recently observed the diffraction of X-rays falling on a metallic grating at a very small angle with the surface, and, in the *Comptes Rendus Acad. Sci.*, Paris, January 4, M. J. Thibaud describes measurements made on the $K\alpha$ and $K\beta$ copper rays, using a plane glass grating with 200 lines per mm. with a width of less than 4 mm. The angle between the rays and the surface of the grating was less than the limiting angle for total reflection, and the photographic plates showed two broad stripes corresponding to the direct and the totally reflected rays, and a diffraction spectrum with remarkably fine lines. The wave-length for the line $K\alpha$ Cu was determined as $\lambda = 1{\cdot}540$ Å.U., correct to about 1 per cent., while measurements on diffraction in crystals, using the accepted values for their lattice constants, give 1·538 Å. The Compton effect did not appear to influence the result, and theory shows that any such influence would be extremely minute for the angles employed.

A NEW X-RAY SPECTROGRAPH.—At the meeting of German physicists in Danzig in September 1925, Dr. H. Seeman of Freiburg described a new X-ray spectrograph without a circular scale, which allowed its zero point to be accurately determined, did not depend on focussing, and could be used with crystal surfaces far from perfect. His paper appears in the issue of the *Physikalische Zeitschrift* for January 21. The camera holding the plate on which the diffraction photograph is taken is bounded on one side by a plane surface at right angles to the plate. On this plane surface a bridge-piece, in the centre of which the crystal is fastened, can slide. The surface of the crystal is adjusted to be nearly parallel to the plane surface. In front of the surface of the crystal is a knife edge, the distance of which from the crystal can be adjusted. The X-rays fall on the crystal at an angle of 10°-20° to the surface, and the knife edge prevents their direct access to the plate. Two photographs are taken, the crystal being rotated through 180° about an axis perpendicular to the plane side of the camera by moving the bridge on the plane. A wider beam is used in determining the zero. The author describes two other methods of using the camera: one, which he calls the 'pin-hole camera,' suitable for all X-rays, and the other a transmission method suitable for thin crystals and X-rays they do not absorb.

FIBROUS CRYSTALS OF SODIUM CHLORIDE.—We have received a communication from Mr. L. McCulloch, of the Research Department of the Westinghouse Electric and Manufacturing Co., Pittsburgh, in which he refers to the statement by Ruskin, quoted by Prof. Desch in his British Association address on the chemistry of solids (see NATURE, Oct. 24, 1925, p. 610), to the effect that whilst red cuprous oxide may sometimes form fine hair-like threads, sodium chloride and other cubic minerals never assume such a form, the statement being used to illustrate the imperfection

of our knowledge of the cause of variations of habit among minerals. Mr. McCulloch sends photographs of columnar or fibrous crystals of sodium chloride, obtained by growth in an acid gel prepared by mixing a solution of sodium silicate with hydrochloric acid. These crystals are slender rods, several millimetres long, with cubic terminations. Such crystals have been prepared on several occasions, one of the earliest records being that of A. Knop, who records hair-like crystals of potassium chloride in his "Molekular-constitution und Wachstum der Krystalle" (1867), whilst others are recorded by O. Lehmann in his "Molekularphysik" (1889). The presence of gelatinous material favours elongated growths, and many observations of the kind are found scattered through the literature. One of the photographs shows curving and distortion of the rods, which is also characteristic of growths in gels.

SAMUEL HAHNEMANN AS A CHEMIST.—At the request of some of his medical friends, Prof. E. O. von Lippmann has investigated (*Chemiker-Zeitung*, 1926, Nos. 1 and 4) the chemical knowledge of Samuel Hahnemann, the founder of homœopathy. In books on the subject, Hahnemann is often described as an accomplished chemist, and the investigations of von Lippmann show that the title is well deserved. So far as chemistry is concerned, Hahnemann was entirely self-taught, but he nevertheless made rapid progress, and was one of the first to realise that a training in chemistry is of the greatest importance to the medical student. In 1784 he undertook the production of a German edition of a work by Demachy (1728–1803), entitled "L'art du Destillateur des eaux fortes" (Paris, 1773), and called it "Der Laborant im grossen, oder die Kunst, die chemischen Produkte fabrikmässig zu verfertigen." This book, which is a kind of technological text-book of the most important chemical preparations, and is by no means concerned merely with acids, was enriched by Hahnemann with a large number of original contributions. Among these may be mentioned the detection of hydrochloric acid by means of silver sulphate, and of sulphuric acid with lead chloride; the estimation of sulphuric acid and other chemicals by means of specific gravity determinations; and a clear realisation of the importance of the newly-discovered 'fire-air' in the process of combustion. Hahnemann devised also a method of estimating arsenic by precipitating it in the form of its sulphide from a solution made weakly acid with hydrochloric acid, and gave the alternative method of precipitation with an ammoniacal solution of copper. About 1788 he invented the sulphuretted hydrogen test for the presence of lead in wine. Although Fourcroy had suggested the same test, he was not able to overcome the difficulty that iron might interfere with it, whereas Hahnemann showed that by making the wine weakly acid with spirit of salt, the iron would not be precipitated. Hahnemann carried out many more pieces of chemical research, notably an investigation of silver nitrate, and von Lippmann concludes that he possessed an uncommonly good knowledge of the science. It is noteworthy that, so early as 1792, he is described in Crell's "Annalen" as a celebrated analytical chemist.

THE ALGEBRAIC NUMBERS AND DIVISION.—In his presidential address to Section A of the American Association for the Advancement of Science at the recent Kansas City meeting, Dr. J. C. Fields, of the University of Toronto, lectured on "The Algebraic Numbers and Division." The modern theory of algebraic numbers had its origin about a hundred years ago in attempts to prove Fermat's last theorem, where a crucial difficulty arose through the discovery that an integer in an algebraic field is not, in general, uniquely expressible as a product of 'prime' integers in the field. Many attempts to extend the conception of an 'integer' in such a way as to restore uniqueness of factorisation were made by various writers, the matter being finally settled by Kronecker and Dedekind, whose definitions of an 'ideal,' the new entity required for the purpose in view, differed mainly in the matter of notation. More recently Hensel, in his "Theorie der Algebraischen Zahlen," has developed yet another method which has enabled him to obtain the most important known properties of algebraic numbers with remarkable ease. Hensel's method is based on the representation of a number r in the form

$$r \equiv a_i p^i + a_{i+1} p^{i+1} + \ldots + a_k p^k \pmod{p^{k+1}}, \quad i \gtreqless 0,$$

where each coefficient a_s is chosen from the integers 0, 1, 2, . . . $p-1$. This p-adic representation holds not only for rational integers but also for rational fractions, and can be extended to apply to algebraic numbers too. In the application to algebraic numbers the general member of a field is taken to be $A_1\omega_1 + A_2\omega_2 + \ldots + A_n\omega_n$, where $A_1, A_2, \ldots A_n$ are p-adic numbers and $(\omega_1, \omega_2, \ldots \omega_n)$ a basis of the field. By this means Hensel has obtained a complete solution of the problem of resolving a prime number into its prime ideal factors. Most of Dr. Fields' address was devoted to the detailed technicalities involved in the p-adic representation of algebraic numbers. The case of a quadratic field was discussed more fully towards the end of the lecture.

ELECTRIC INDUCTION FURNACES.—The evolution of the electric furnace in which the refractory materials are heated by high-frequency induced currents, and some of the useful applications of this type of furnace, are well described by Dr. Northrup in a paper printed in the February issue of the *Journal of the Franklin Institute*. The earliest form of electric furnace used resistance heating. Then Moissan enclosed an electric arc in a box made of lime and succeeded in obtaining temperatures much higher than those obtained by other methods. He melted and reduced most of the refractory oxides, but unfortunately the resulting substances contained carbon and other impurities which were introduced by the vapours of the arc. In inductive heating, the radiated electromagnetic energy passing through the jacket of heat-insulating material falls on the conducting substance causing eddy currents which heat it. The heat-insulating refractory material used in the crucible is transparent to long-wave radiations but is nearly opaque to the short wave-length heat radiation. The heat thus rapidly accumulates and the temperature elevation becomes very high. With a frequency of 50, the ordinary frequency of supply in Great Britain, the magnetic field used must be very strong, and so iron has to be employed. But with frequencies of 500 or more, we get the 'ironless' inductive heater. At these high frequencies the condensers that have to be used in order that the ratio of the true power supplied to the apparent power may be large are very much smaller, and so their manufacture becomes commercially feasible. The method is specially applicable to very large installations. The Westinghouse Company make ingots of nickel-iron which are practically free from carbon and weigh 225 lb. There are a few gas holes in the ingots, but they are free from oxide and, as they weld together under forging operations, no metal is lost in trimming. Tantalum, which fuses at 2900° C., can be readily melted by the inductive method and produced practically free from carbon.

Standards in Illumination and Photometry.

AT the meeting of the Illuminating Engineering Society held on February 25, a series of communications were presented reviewing recent British Engineering Standards Association's specifications dealing with illumination and photometry. Mr. P. Good, in an introductory paper, explained the aims and objects of the Association. In arranging for the preparation of standards, the Association does not act on its own initiative, but only on demands from outside; for example, from a representative trade organisation, a technical society, or a Government Department. When the British National Committee of the International Illumination Commission invited the Association to carry out standardisation in the field of illuminating engineering, a conference of all interested parties was called. The formation of a Sectional Illumination Committee was the immediate result of this conference, held in January 1924. This Committee is thoroughly representative, and the fact of many of its members being also members of other bodies or committees interested in illumination is favourable to co-operation and avoidance of overlapping of work. Specifications for portable photometers [1] and for industrial lighting fittings for electric lighting,[2] and a glossary of terms [3] used in illuminating engineering and photometry, have already been issued. Three other committees, concerned with illuminating glassware, street lighting, and photometric integrators, are actively at work but have not yet reported.

Papers summarising the three reports so far issued were then presented by the chairmen of the respective committees. Lieut.-Col. Edgcumbe, in dealing with the specification for portable photometers, pointed out that it opened new ground. Two broad classes of photometers are recognised: (*a*) for exterior work (for example, street lighting) where a range of 0·01 to 2 (or preferably 5) foot-candles is necessary, and (*b*) for interior use, where the range should be 0·2 to 20 foot-candles, or preferably higher. Provision for measurements of brightness as well as illumination is also desirable; the former should preferably be expressed in candles per square inch. The author discussed in some detail the nature of the test-screen, and the problem of obtaining a surface which would approach 'perfect diffusion,' and therefore have the same brightness when viewed at all angles. In practice it is found necessary to limit the angle of view, and the test-surface should be capable of being placed at least 4 ft. from the photometer and still fill the whole of the field of view. Other clauses prescribe the use of an ammeter to enable the current through the lamp in the instrument to be maintained constant, and the light from the lamp should have a colour similar to that of a metal filament lamp run at 9 lumens per watt. In conclusion, the various sources of errors in portable photometers were discussed, and it was shown that their additive effect may amount to so much as ±20 per cent. In practice, however, it is unlikely that all errors will be in the same direction, and therefore an all-round accuracy of ±15 per cent. seems a reasonable requirement.

Lieut.-Commdr. Haydn T. Harrison, dealing with the specification for industrial reflector fittings for electric lighting, explained that the main object is to standardise a form of reflector to assist the excellent work of the Home Office Departmental Committee in promoting improved lighting in factories and workshops. The most suitable type of reflector for this purpose appears to be the 'R.L.M.' form, having the following main features: (1) The source of light can be made invisible above a definite angle of cut-off; (2) at the angle where the filament is visible it is viewed against a highly illuminated white reflecting surface; and (3) the reflecting surface, being of vitreous enamel, is easily cleaned. If properly constructed and used, such reflectors should enable sufficient illumination to be provided without undue glare. But it is to be noted that the screening of filaments depends on the latter being in the correct position within the lamp bulb; hence the tolerances allowed in the B.E.S.A. specification for electric lamps are of importance. It was also pointed out that the adoption of forms of reflectors ensuring adequate screening naturally involves some increase in the absorption of light, and consequently a somewhat lower efficiency. Thus if the angle of cut-off be 20° instead of 17½°, as is customary in America, the efficiency may be only sixty per cent. as compared with seventy per cent. for the smaller angle. In comparing different forms of reflectors in terms of efficiency, due consideration must therefore be paid to the completeness with which the filament is screened from the eyes of operators.

The contribution dealing with the glossary of terms used in illuminating engineering and photometry was presented by Mr. P. Good, in the absence of the chairman of this committee (Mr. J. W. T. Walsh). The author directed attention to the stumbling-block of language in dealing with international affairs. Unfortunately the 'scientist-engineers' are apt to set up new towers of babel with every advance in knowledge. In illuminating engineering, the importance of common agreement on terms and definitions is very great. In reviewing the list, Mr. Good explained that it inevitably involves some degree of compromise, and it was shown that, whilst adhering to British methods, efforts have been made to bring the list into line with international and foreign practice. The first term (luminous flux) is fundamental. The term 'flux' to convey the notion of time has been so widely adopted that it appears to the committee preferable to substitute 'radiation.' Nevertheless, as 'luminous flux' has become such a familiar phrase in illuminating engineering, it was ultimately decided to retain it.

The three papers led to a keen discussion, in which Mr. C. C. Paterson (chairman), Lieut.-Col. Kenelm Edgcumbe, Mr. H. Buckley, Mr. G. Campbell, Mr. R. A. Ives, Lieut.-Col. Silvester Evans, Mr. H. C. Allpress, Mr. T. E. Ritchie, Mr. A. Cunnington, M. H. H. Long, Capt. W. J. Liberty, Dr. D. H. Ogley, Mr. L. Gaster, and others took part. The views expressed were generally favourable to the main conclusions of the specifications, though the exact application of the 'cut-off' angle in the case of industrial reflectors was the subject of some discussion. At the conclusion of the meeting a variety of reflectors designed to comply with the requirements of the specification were shown, and a number of portable photometers were exhibited. The latter included the most recent form of 'Holophane Lumeter,' in which various modifications to enable the instrument to comply completely with the specification have been embodied. A novel accessory shown for the first time was the test-plate fitted with a device to enable the angle of incidence of light-rays from the source to be determined. A very simple form of portable photometer recently developed in France (the 'Niam' photometer) was also shown.

[1] British Standard Specification for Portable Photometers (No. 230. 1925).
[2] British Standard Specification for Industrial Reflector Fittings for Electric Lighting (No. 232. 1926).
[3] British Standard Glossary of Terms used in Illumination and Photometry (No. 233. 1925).

Work of the Glass Research Association.

WE have recently received No. 14 of the Bulletin of the Glass Research Association, actually dated July 1925. The distribution of these copies to the press marks a departure from the practice of the Association, but there appear good reasons for so doing. The Association, when it found in 1924 that further Government financial assistance could not in the future be relied on, decided to wind up its activities, and it was clearly desirable that a résumé should be prepared, both for its members and for the scientific public, of the work which it had been able to accomplish. The copy of the Bulletin before us supplies this résumé, and we may add that it appears to have been done in a very efficient manner, the system of classification of the results adopted enabling the reader to grasp the facts readily.

The work of the Association was carried on in the laboratories of the Association itself and also in co-operation with the National Physical Laboratory, with the Department of Glass Technology, Sheffield, with two other research associations, namely, the British Refractories Research Association and the British Cast Iron Research Association, and, finally, in a single investigation on the subject of the efficiency of manual workers, with the Industrial Fatigue Research Board. The National Physical Laboratory was responsible for several papers on the physical properties of glasses, covering the subjects of viscosity, thermal endurance, and elastic and viscous movements in glass. Special mention may be made of the researches on the viscosity of glass, since they covered a wide range of temperature and led to very interesting results.

Investigation of a whole series of problems of a fundamental character involving the processes of glass-melting were carried out at Sheffield, and results, important alike for practice and for theory, were the outcome. Of the work carried out in the laboratories of the Association, the one criticism that occurs to the present writer as he peruses the summary is that it covered so wide a range and appears to have involved so many ambitious programmes, that a number of investigations seemed to halt at intermediate post houses. Nevertheless, a great deal of useful information appears to have been passed on to the glass industry by the Association's workers.

We understand that most of the completed papers presented to the Association will eventually receive full and open publication, and there is no need, therefore, to examine the results of research in detail. The results so far obtained suggested to Research Committee A the direction in which future researches on glass might be planned, and a report signed by the chairman is appended to the Bulletin, suggesting to scientific workers that future investigations might be pursued on the subject of the constitution of glasses, using such methods as the determination of the viscosity, electrical properties or surface tension, the behaviour of glass under electrolysis over a wide range of temperature, a study of X-ray diffraction patterns and of heating and cooling curves obtained under various conditions. Other subjects needing investigation as having more or less direct practical application included the mechanical properties of glass in relation both to composition and to treatment, the thermal properties of glass at all temperatures up to the melting temperature, and the solubility of gases in glass at various temperatures and pressures, their mode of evolution and absorption and their effect on the physical properties of the glass.

A number of suggestions of a practical character are also appended in a note by the chairman of the Refractory Materials Research Committee.

Physical Factors in Mosquito Ecology.

IN the *Bulletin of Entomological Research*, vol. 16, pt. 3, pp. 187-248 (January 1926), Mr. R. Senior-White contributes an important paper on this subject which should receive attention from all concerned with mosquito control. The author finds that, in Ceylon, natural waters exhibit a range of hydrogen ion concentration the *p*H values of which range from 5·4 to 9·2, but, as a general rule, mosquito larvæ only occurred when the *p*H was between 5·8 and 8·6. The *p*H was determined colorimetrically by means of Clark and Lubs' indicators. Species living in moving water have wider tolerances than those of standing water, and the former tolerate higher acidity, and the latter tolerate higher alkalinity, respectively. It also appears that anophelines have wider ranges of tolerance than culicines.

It is, however, less easy to generalise about mosquitoes breeding in artificial waters. Such waters are very diverse: there may be a coconut shell in deep shade, containing acetic acid as the result of fermentation, with water at *p*H 4·4; or there may be a water-butt in full sunlight, its contents green with algæ and giving a *p*H of 9·6+. Under such conditions mosquito larvæ, which are not to be found in natural waters, do occur. The commonest of the artificial-water breeders, *Stegomyia albopicta*, is found to tolerate water right through the entire range of *p*H values tested. The measurement of the "residual" *p*H, *e.g.* the value after bringing the water into gas-equilibrium with the air, is shown to be significant.

Natural-water breeding mosquitoes were thus found to be intolerant of any acidity other than that due to carbon dioxide. The solute-concentration limits were also inquired into and are summarised in terms of conductivity $\times 10^6$ in an accompanying table. Natural-water breeders are all found in water where this figure is below 1000, while artificial-water breeders extend their range into much higher concentrations. There appears to be no sharply limiting factor with respect to dissolved oxygen. In two species, with which a considerable number of observations were made, the data showed that there is a complete tolerance ranging from water with only 0·40 mgm. per litre in the case of *Anopheles maculatus*, and from 0·87 mgm. in the case of *A. listoni* up to super-saturation values of 14·84 mgm. and 12·32 mgm. per litre, respectively. It may be said, however, that waters in which the figure is low are not favoured by anophelines.

In rice fields the presence of *Anopheles listoni*, the only malaria carrier commonly breeding therein, is shown to be dependent on the presence of a considerable amount of dissolved oxygen, and methods for avoiding this are discussed. The toleration-limits of various species with respect to the above-mentioned factors are discussed at length, and taking *Anopheles listoni* as an example the optimum conditions for this species are—*p*H of 6·8-7·0: a conductivity of 300-700 and an oxygen content of 5-7 mgm. per litre. There is shown to be a "feeding-association" of anophelines with certain algæ, on the presence of which that of the mosquitoes probably depends, but these and other points require more space than is available for adequate discussion.

University and Educational Intelligence.

BIRMINGHAM.—Mr. Hugh Donovan, surgical registrar to the Queen's Hospital, has been appointed part-time assistant in the Department of Pathology and Bacteriology.

Gifts recently reported include sums of 50*l.* each from Sir James Kemnal, the Partington Steel and Iron Co. Ltd., Messrs. Balfour, Beatty and Co., and 50 guineas from Messrs. D. Colville and Sons, Ltd., towards the expenses of the new Fuel Treatment Laboratory in the Coal Mining Department; a model illustrating modern methods of shaft sinking in coal-mines by the François Cementation Co.; and two scholarships of the value of 60*l.* each, for three years, from Messrs. British Ropes, Ltd., for students in the Oil Engineering and Refining Department.

CAMBRIDGE.—Mr. F. L. Engledow has been appointed a member of the council of the National Institute of Agricultural Botany. Mr. Engledow is a fellow of St. John's College; he has since the war been working in the Plant Breeding Institute under Sir R. H. Biffen: his special studies have been in relation to yield in the cereals, effective yield testing and detailed field behaviour of various commercial varieties.

Dr. R. A. Nicholson of Trinity College has been elected to the Sir Thomas Adams's professorship of Arabic, in succession to Prof. E. G. Browne, who died on January 5. Dr. Nicholson was formerly University lecturer in Persian.

LONDON.—The following are among the fellows of University College recently appointed: Mr. J. T. Carter, honorary research assistant in histology; Prof. H. B. Fantham, since 1917 professor of zoology and comparative anatomy, University of Witwatersrand; Dr. Morris Ginsberg, lecturer in the department of philosophy and psychology, and since 1925 University reader in sociology, London School of Economics; Prof. Y. Heyrovský, professor of physical chemistry in the Charles' University of Prague; Mr. L. A. Legros, consulting engineer; Dr. A. G. Levy, physician, City of London Hospital for Diseases of the Chest; Mr. G. Udny Yule, president of the Royal Statistical Society.

The following are among the fellows of King's College recently appointed: Sir James Kingston Fowler, physician to the Middlesex and Brompton Hospitals; Mr. L. B. Atkinson, president in 1920–21 of the Institution of Electrical Engineers and chairman and president-elect of the Electrical Research Association; Prof. W. Wilson, professor of physics at Bedford College.

The following doctorates have been conferred: *D.Sc.* (*Botany*): Mr. M. M. Mehta (Imperial College; Royal College of Science), for a thesis entitled "Studies on Lignification." *D.Sc.* (*Chemistry*): Mr. F. L. Usher, for a thesis entitled "The Nature of the Interfacial Layer between an Aqueous and a Non-Aqueous Phase," and other papers.

MANCHESTER.—Applications are invited for the Lewis Atkinson entrance scholarship in electrical engineering, the annual value of which is 50*l.* The scholarship is tenable for three years. Forms of nomination and application are obtainable from the Internal Registrar of the University. They must be returned by April 1.

THE Cambridge local lectures available for 1926–27 are listed in a 36-page pamphlet issued by the Board of Extra-mural Studies of the University. The lectures are grouped under the heads: A—natural science, and B—history, geography, political economy, mental science, literature, and art. Four pages are devoted to Group A and twenty-four to Group B. The natural science lecturers are G. P. Bailey (James Stuart lecturer), F. Balfour Browne, H. Yule Oldham, E. A. Parkyn, and Bernard Smith. The inclusive fee, covering the lecturer's travelling expenses and, as a rule, everything except strictly local expenses, are 48*l.*-66*l.* for a full course of twelve lectures and 33*l.*-45*l.* for a short course of six. A preliminary programme of the summer meeting, 1926, announces that the main subject of study will be India in ancient, medieval, and modern times, and there will also be lectures and classes in theology, architecture, and geology, and, for foreign students, in English language (including phonetics) and literature. The inaugural address will be given on July 29 by the Earl of Ronaldshay.

A PRELIMINARY programme has been issued of the third Congress of the Universities of the Empire, to be held on July 12-16 at Cambridge. The chairman for the morning session of July 13 will be the Earl of Balfour, and the subject of discussion "The State and the University." The afternoon session will be devoted to considering the desirability of establishing in London a school of advanced legal studies (chairman, Viscount Cave). Co-operation in research throughout the Empire, will form the subject of the morning session of July 14, under the chairmanship of the Marquess of Londonderry. The morning session of July 15, under the chairmanship of Sir Matthew Nathan, will be given to a consideration of the mutual recognition of examinations and related topics, while the afternoon session, under the chairmanship of the Duke of Devonshire, will be devoted to the subject of the physical welfare and training of students and the organisation of athletics. At the morning session of July 16, under the chairmanship of the Viscount Cecil of Chelwood, the actual working of the Ph.D. scheme will be discussed, while the afternoon session (chairman, the Viscount Haldane of Cloan) will be occupied with a consideration of the desirability of articulating other pension schemes with the Federated Superannuation System of Great Britain and Ireland.

OFFICIAL statistics of Prussian universities and technical colleges for the summer semester of 1925 show a total of 39,134 matriculated students, including 3234 students from other countries. To these figures may be added the numbers of students in commercial, agricultural, and veterinary colleges, which bring the total up to 42,744, including 3607 from other countries. Of these students from abroad, 1232 were German as regards their mother-tongue, and more than half of them (2110) were enrolled in the University of Berlin (1042) and the Berlin Technische Hochschule (795), Handels-Hochschule (169), Landwirtschaftliche Hochschule (82), and Tierärztliche Hochschule (22). Bulgarian (246), Russian (191), Norwegian (108), and Chinese (101) students were specially numerous in the universities; Bulgarian (158), Russian (140), and Roumanian (134) in the technical colleges. English students in the University of Berlin numbered 10. None of these figures include 'Hörer' or unmatriculated students. The University of Berlin provides through its Deutsche Institut für Ausländer a continuous series of courses in German language, literature, and institutions, each lasting two months. The thirty-eighth of the series (December 1925-January 1926) was attended by 130 students belonging to thirty-two nationalities and including 40 Russians, 17 Japanese and Koreans, 12 Chinese, and 6 Jugo-slavs.

Contemporary Birthdays.

March 13, 1873. Dr. Charles S. Myers, C.B.E., F.R.S.
March 14, 1879. Prof. A. Einstein, For. Mem. R.S.
March 15, 1855. Mr. Charles Vernon Boys, F.R.S.
March 16, 1846. Prof. Gösta Mittag-Leffler, For. Mem. R.S.
March 17, 1863. Sir Herbert Jackson, K.B.E., F.R.S.
March 17, 1847. Sir Alexander B. W. Kennedy, F.R.S.
March 19, 1871. Prof. William Arthur Bone, F.R.S.

Prof. EINSTEIN was born at Ulm (Donau). Nobel laureate in 1921, he was Copley medallist of the Royal Society last year, and recently was awarded the Royal Astronomical Society's gold medal. He is best known, indeed almost popularly known, as the originator of the theory of relativity. In 1905 he showed that the time and space we measure are local in meaning and that we have no means of determining absolute space and time. Then came the identification of mass with energy. In 1915 the earlier theory was extended by a noteworthy generalisation bringing gravity into the scheme. The three crucial astronomical tests of Einstein's general theory of relativity have now all been verified and the theory has even been used to confirm the suspected high density of the white dwarf stars. Einstein has also been concerned in the development of the quantum theory. In 1905 he put forward his law of the photo-electric effect and further contributions on the theory of ionisation and the specific heats of solids culminated in 1917 in another fundamental result—a general equation connecting absorption and emission coefficients.

Mr. C. V. BOYS was born at Wing, Rutland. He was educated at Marlborough and the Royal School of Mines. In 1896 the Royal Society allotted him a Royal medal for the introduction into physical research of refined measurement methods by the use of drawn quartz fibres. Recognition was again accorded by the Society in 1924, when Mr. Boys was awarded the Rumford medal for his invention of the gas calorimeter.

Sir HERBERT JACKSON, Director of Research, British Scientific Instrument Research Association, was formerly Daniell professor of chemistry, University of London, King's College. President of the Röntgen Society, 1901–3, he was president of the Institute of Chemistry, 1918–21. In 1919 he delivered the Trueman Wood lecture at the Royal Society of Arts on "Glass and some of its Problems." Sir Herbert made recently the statement that it is not possible at the present day to obtain anywhere optical glass and optical instruments better than, or in many cases, as good as, those manufactured in Great Britain.

Sir ALEXANDER KENNEDY, consulting engineer, was born at Stepney and educated at the City of London School and the Royal School of Mines. Professor of engineering in University College, London, 1874–89, he there originated the first of the engineering laboratories which now form an essential part of the scientific training in engineering at universities and colleges.

Prof. BONE, chemical and fuel technology engineer, was born at Stockton-on-Tees. Educated at the Friends' School, Ackworth, Stockton Grammar School, and the Leys School, Cambridge he graduated at the Victoria University, Manchester, proceeding afterwards to Heidelberg University, studying there under the late Prof. Victor Meyer. In 1910 the leaders of the coal-gas industry endowed a special chair at the University of Leeds in memory of the late Sir George Livesey, and Prof. Bone was its first occupant. He is the inventor of the 'Bonecourt' system of incandescent surface combustion.

Societies and Academies.

LONDON.

Royal Anthropological Institute (Indian Section), February 23.—R. E. **Enthoven**: Ethnographic research in India. Dealing with the systematic survey of the larger provinces inaugurated by Risley after the census of 1901, the various theories of caste origin were noted, and its present characteristics explained. Stress was laid on the importance of a more thorough record of exogamous caste and tribe divisions, particularly in connexion with the primitive type having many of the aspects of totemism. Further and more extensive work of the nature of recent anthropometrical observations in India is necessary. For the immediate future, the compilation of an all-India record of tribes and castes, and the limitation of the scope of inquiry in regard to both social structure and primitive custom to the already existing questionnaires drawn up by experts are desirable.

Optical Society, February 25.—O. **Aves**: Notes on the significance and detection of low errors of refraction. Examination of a great number of records of tests on the eye for the purpose of prescribing spectacles reveals a large proportion of low errors of refraction. Certain modifications of the usual technique should be incorporated when testing such cases. The usual objective methods of sight examination prior to a subjective test are practically useless in the estimation of errors less than one dioptre; they produce distinct after-images on and around the macular area, which perceptibly interfere with vision. In the subjective test the lenses should be added binocularly, before testing the eyes separately. The blocking of one eye tends to induce strain. Change of lenses during a test should be made smoothly without allowing the eyes to be uncovered by a lens or to be covered by two lenses. Other points in the testing of small errors are the strength of the spherical and cylindrical lens elements, the direction of the axis of the cylinder, refinement of the test for muscular correction, and the possibility of the presence of irregular astigmatism.—W. H. A. **Fincham**: Vertex power and its measurement. The demand for increased accuracy in the determination of refractive errors has emphasised the need for accurate specification and measurement of the powers of correcting lenses. The effect of an ophthalmic lens may be expressed in a number of different ways. The following quantities are used: (1) Equivalent or true power; (2) vertex power or vertex refraction, *i.e.* the power at the vertex nearer the eye; (3) neutralising power, usually the front vertex power; (4) thin lens power, *i.e.* the sum of the powers of the two surfaces, thickness being neglected. In the case of ophthalmic lenses, vertex power is the important quantity, as it gives the effective value of the lens at some definite and easily determined point on the lens, and consequently lenses of any form having the same vertex power are interchangeable if the vertex of each lens occupies the same position with respect to the eye.

CAMBRIDGE.

Philosophical Society, February 1.—F. G. **Mann** and Sir W. J. **Pope**: Metallic complexes with aliphatic poly-amines. The preparation and configuration of complex compounds of platinum, palladium, rhodium, cobalt and nickel with $\alpha\beta\gamma$ triaminopropane, $\beta\beta'\beta''$ triaminotriethylamine, and $\gamma\gamma'\gamma''$ triaminotripropylamine is described.—R. T. M. **Haines** and Sir W. J. **Pope**: Isoquinoline and the isoquinoline reds. By fractional precipitation of coal-tar quinoline, the

amount of isoquinoline present was shown to be nearly 5·5 per cent., or six times as much as was supposed. The reaction leading to the production of isoquinoline red and its homologues is a delicate test for the presence of a reactive methyl-group such as exists in quinaldine. Anhydrous ferric chloride and stannic chloride are as efficient condensing agents as aluminium chloride.—F. H. **Constable**: The behaviour of the centres of activity of saturated surfaces during the initial stages of unimolecular reaction. While decrease in pressure of the reactant has little effect on the velocity of reaction at saturated surfaces, chemically inert diluents cause a marked decrease. These results confirm that the molecules do not react at the instant they bombard the surface, but during the period they remain absorbed. An extension of the Langmuir-Frenkel theory to the dynamics of adsorption on the centres of activity accounts quantitatively for the facts.—A. J. **Berry**: Direct titration of thallous salts by potassium iodate. Thallous salts are capable of quantitative oxidation to the thallic condition by potassium iodate in the presence of a high concentration of hydrochloric acid. Iodine liberated during the reaction is oxidised to iodine monochloride, hydrolysis of the latter being suppressed by the high concentration of hydrochloric acid present.—R. G. W. **Norrish**: influence of surfaces on the combination of ethylene with the halogens. The suspension of reactivity resulting from the drastic drying of potentially reactant systems is rather to be ascribed to a drying of the apparatus, than to any ultra-dryness of the reactants. For example, if the bimolecular velocity coefficient or the surface reaction between ethylene and chlorine in glass vessels be represented by unity, then in similar paraffin wax vessels it falls to 0·0008, even if the gases are moist. When the glass vessels are baked out under a high vacuum, the velocity coefficient falls to 0·12 in spite of the fact that a small portion of the vessel remains of necessity undried. Since the whole of the reaction occurs via the adsorbed surface film, these results indicate that only sufficient water is necessary for full reaction as will saturate the surface with (probably) a unimolecular layer; thus though present only in very small quantities, water may still enter stochiometrically into the reaction equation. —W. A. **Waters**: The chlorination and bromination of 4-aminodiphenyl.—Miss M. **Wright**: Oxidation at charcoal surfaces. Sugar charcoal brings about the oxidation of oxalic acid in dilute solutions, and is itself slowly oxidised. Fractional poisoning experiments show that the two processes are independent, and occur on different parts of the charcoal surface. On blood charcoal there are two catalytically active areas, one small, highly active area containing iron, which is preferentially poisoned by potassium cyanide; and another larger, less active area, similar to that on sugar charcoal. Iron-containing charcoals have been prepared free from nitrogen; when these are reduced in hydrogen, they contain two catalytic surfaces, similar to those of blood charcoal. Nitrogenous charcoals are very active, owing to their large specific surface.

MANCHESTER.

Literary and Philosophical Society, February 9.—R. A. **Wardle**: Rain cotton in the Sudan. The southern Sudan is not an ideal area for cotton grown under rainfall conditions owing to the shortness of the rainy season and to the uncertain distribution of the annual rainfall. Indigenous short staple cottons have been grown, however, for at least eighty years, and experiments have shown that American long staple varieties can be grown successfully and will produce cotton sufficient in quality and quantity to warrant the establishment of cotton cultivation in the Central and Southern Provinces, thus enabling these areas to obtain a surplus of income over expenditure available for developmental schemes. The Government policy is to encourage the cultivation of American long staple varieties by issuing free seed and by providing marketing and ginning facilities. The ultimate limit of acreage under rain cotton will depend largely upon the extent to which road and rail communication between districts and ginneries can be developed.—W. E. **Alkins**: The influence of the metallic contact between the component wires upon the electrical resistance of a stranded conductor. The resistance of a stranded conductor composed of bare wires is usually calculated upon the assumption that the component wires behave in respect of the transport of electrons as though they were insulated from each other. This assumption has been tested experimentally in the case of a conductor consisting of seven copper wires. It was found that the resistance of the stranded conductor was equal, within the limits of experimental error, to that calculated by means of the Reciprocal Law from the resistances of the component wires, and that the metallic contact between the individual wires was therefore without appreciable influence.

PARIS.

Academy of Sciences, February 8.—Emile **Haug**: Fossils of the middle Lias collected by the Charcot expedition at Cape Stewart (Jameson's Land, East Greenland). The fossils found are characteristic of the middle Lias. This view is not in agreement with the results of B. Lundgren (Danish expedition 1891–92). — Georges **Claude**: The explosion at Boulogne-sur-Seine. An account of a fatal explosion of a liquid air plant, and a discussion of the possible causes of the accident.—Ch. **Depéret**: Excavations for prehistoric remains in the layer in which the fossil men of Denise (near Puy-en-Velay) were found.— C. **Sauvageau**: A new type of alternation of generations in the brown algæ. — André **Bloch**: Some theorems on the integral and meromorph functions of a variable.—Kyrille **Popoff**: The gaps which may be presented by a Taylor's series representing a regular analytical function at infinity, and only admitting one singular point which is an essential singular point.—Eugène **Barré**: The theory of [military] mine explosions.—Léon **Brillouin**: Rotation spectra, in the new quantum mechanics, with calculation of the matrices.—André **Pignot**: The adiabatic ignition of hydrocarbon mixtures. The method adopted was the determination of the initial temperature necessary to obtain ignition with a fixed volume compression. The hydrocarbons chosen were those present in ordinary petrol. Experiments were also made with alcohol.—René **Lucas**: The rotatory power of camphor. The hypothesis that camphor can exist in two molecular forms possessing different rotatory powers and dispersions, and that the proportion of these two forms varies from one solvent to another, is in agreement with the experimental results given in this and in an earlier communication.—Mlles. Ellen **Gleditsch** and C. **Chamié**: Contribution to the study of 2-mesothorium and of actinium: These experiments confirm and complete the work of Yovanovitch: the chemical reactions of mesothorium-2 resemble those of the cerium earths, more especially lanthanum.—Albert **Portevin** and François **Le Chatelier**: Some physical properties of the ultra light magnesium alloys. Determinations of specific volume, electrical resistance and coefficient of expansion of magnesium alloys. The most interesting types from the point of view of practical utility are

the binary alloys with nickel or copper, and the ternary alloys magnesium-aluminium-nickel and magnesium-aluminium-copper.—A. **Lassieur**: The magnesia carried down by aluminium hydroxide. If to a solution containing aluminium and magnesium only just sufficient ammonia is added to precipitate the alumina (pH = 7) no magnesia is precipitated. With increasing quantities of ammonia, there is increased precipitation of the magnesia.—L. **Blanc** and G. **Chaudron**: Study of the transformation and oxidation of chromium sesquioxide.—André **Kling** and Daniel **Florentin**: The hydrogenation of organic substances realised at a high temperature and under high pressure. The temperatures at which hydrogenation commences were determined for various organic compounds, and these coincided with the temperatures at which decomposition commenced. It is concluded that in hydrogenation at high temperatures and pressures it is molecular hydrogen which acts on nascent organic molecules.—**Tiffeneau** and Mlle. J. **Levy**: The isomerisation of the ethylene oxides and comparison of the affinity capacities of some cyclic and acyclic radicals.—Marcel **Godchot** and Pierre **Bedos**: The stereoisomeric *o*-methyl-cyclopentanols.—Louis **Barrabé**: The mode of formation and the age of the eruptive rocks of the middle region of the Sakalave country (west of Madagascar).—P. **Fallot** and R. **Bataller**: The direction and age of the folds in the mountains of Bas-Aragon and Maestrazgo (Spain).—L. **Lavauden** and M. **Solignac**: Some geological results of the Trans-saharan expedition of Colonel Courtot (1925).—A. **Demay**: The Hercynian tectonic of Maures.—Ch. **Lormand**: Chemical analysis of the Capvern (Hautes-Pyrénées) mineral water.—J. **Thoulet**: Submarine volcanism at great depths: A. **Renier**: The general morphology of Ulodendron.—Ch. **Brioux** and J. **Pien**: The comparative fertilising action of the different forms of nitrogen existing in the new ureic nitrogenous manures derived from cyanamide. Results with experimental cultures containing ammonium sulphate, guanylurea sulphate, or dicyandiamide, with special reference to the effect on nitrification.—**Doyon** and I. **Vial**: The isolation of an extremely active anti-coagulating substance free from phosphorus by the prolonged autolysis of organs and acid alcohol.—Emile F. **Terroine** and Mlle. Anne Marie **Mendler**: The influence of the nature of the ternary foods on the amount of nitrogen retention in the course of growth.—J. **Cristol**, L. **Hedon**, and A. **Puech**: The passage of the digestive polypeptides into the portal circulation and their arrest in the liver. Details of experiments proving that polypeptides pass into the portal vein in the course of digestion, and are arrested by the liver, since they are not found in the arterial blood.—A. **Policard** and M. **Boucharlat**: The mechanism of the characters of the plasma of sarcomatous animals making it suitable for a medium for the culture of tissues.

CALCUTTA.

Asiatic Society of Bengal, January 4.—P. C. **Mahalanobis**: Analysis of race-mixture in Bengal. Measurements of 200 individuals of Anglo-Indians (new style) in Calcutta are compared with 30 typical castes of North India, representing about 6 geographical divisions and 4 or 5 cultural strata. Intermingling has not been chaotic; it presents a gradual and well-ordered character in which cultural affinity and cultural selection have played a very important part.—MM. Haraprasad **Shastri**: Bhadra Yāna. There has been a gradual increase of number of yānas known. Yāna = a school of thought, modern Indian "panth." The yāna was founded by Bhadrapāda. The central teaching is the negation of the citta.—Johan van **Manen**: The Pali Text Society's Pali-English Dictionary.

ROME.

Royal Academy of the Lincei, December 20.—Francesco **Severi**: Constant level curves of Picard's integrals.—O. M. **Corbino**: Thermo-electric power and Hall's effect.—Michele **Cantone**: New method of studying experimental results. It is often useful, in addition to the curve showing the variation of any phenomenon with a particular property, to trace the curve showing the relation between the corresponding increments.—Achille **Russo**: The first accessory conjugation between impure gametes in *Cryptochilum echini* Maupas.—Beniamino **Segre**: A property of symmetrical determinants of the sixth order.—Carlo **Severini**: Convergence of the series of orthogonal functions.—Giovanni **Sansone**: Indeterminate equations of unity of negative type in real quadratic bodies. The case $D = 2p$, with p prime.—G. **Wataghin**: Dependence of the velocity of light on the movement of the source.—E. **Billows**: Crystals of sulphur accompanying the anglesite and galena of Monteponi.—Helios **Scaetta**: Partial hermaphroditism and parthenocarpia in *Phœnix dactylifera* L.

VIENNA.

Academy of Sciences, January 14.—O. **Wettstein**: A new lizard of the genus Enyalius from Ecuador. Specimens are in the Vienna Natural History Museum.—A. **Duschek**: The relative theory of surfaces.—F. **Hölzl**: Organic acids and bases in non-aqueous solutions.—E. **Heinricher**: Is the formation of haustoria in Santalaceæ produced by chemical stimulation or by contact?—Fr. **Hlucka**: Comparison between the dispersion formulæ of the atomic theory and of the continuity theory.—A. **Köhler**: Report on the progress of the petrographic-geological researches in the south-western Waldviertel (Lower Austria).—H. **Handel-Mazzetti**: Plantæ novæ Sinenses (xxxix.).

WASHINGTON, D.C.

National Academy of Science (Proc. Vol. 12, No. 1, January).—Ernest W. **Brown**: The effect of varying mass on a binary system: a correction [to a paper in the May issue of the *Proceedings*].—Charles E. **Allen**: The direct results of Mendelian segregation. If it is possible to recognise the four spores formed by division of a single mother cell, some indication of the effects of chromosome segregation can be expected in the haploid plants developing from the spores. Generally each tetrad of spores contains two types of spore only as regards the two characters examined in *Sphærocarpos Donnellii*; tetrads with the possible four different spores formed a small minority.—John **Belling** and A. F. **Blakeslee**: On the attachment of non-homologous chromosomes at the reduction division in certain 25-chromosome daturas.—M. **Demerec**: Reddish—a frequently 'mutating' character in *Drosophila virilis*. 'Reddish' is a body colour characteristic which seems to be an allelomorph of yellow and mutating frequently to wild type.—W. E. **Castle**: The explanation of hybrid vigour. Recent evidence supports the heterosis (or heterozygosis) theory that the vigour of hybrids arises from the fact that they are heterozygous for all genetic factors in which the parents differed. This leads to an acceleration of all metabolic processes in hybrids.—Gregory Paul **Baxter** and Howard Warner **Starkweather**: The density and atomic weight of helium (ii.). 2-litre globes were used instead of 1-litre (NATURE, July 11, 1925, p. 68). Original values obtained when corrected

give the density as 0·17846. The average density at a pressure of half an atmosphere is exactly one-half that at a pressure of one atmosphere. The density of oxygen being 1·42898, the atomic weight is very close to 4·000.—Gilbert N. **Lewis**: The nature of light (see NATURE, February 13, p. 236).—Ernest Orlando **Lawrence**: The rôle of the Faraday cylinder in the measurement of electron currents. For electrons under accelerating voltages up to about 24 volts there is a regular increase of electron current to the Faraday cylinder, with increase of length of the latter. With accelerating voltages of 20 to 100 volts, secondary electrons generated by impact in the cylinder lead to large variations in the electron current measured.—Linus **Pauling**: The quantum theory of the dielectric constant of hydrogen chloride and similar gases. The electric moment of the molecule in hydrogen chloride is that of a dipole with proton and electron 0·0694 Å.U. apart; for hydrogen bromide the distance is 0·0528 Å.U.—L. B. **Loeb**: (1) The mobility of gaseous ions in HCl gas and HCl air mixtures. In pure dry hydrogen chloride gas, the average mobilities of the positive and negative ions at 20° C. and 760 mm. mercury pressure are 0·65 cm./sec. per volt/cm. and 0·56 cm./sec. per volt/cm. In mixtures with air there is evidence of the formation of labile clusters formed by increased concentration of molecules of one type in the neighbourhood of the ion. (2) The mobility of gas ions in HCl mixtures and the nature of the ion. Assuming an inverse fifth power law, it is calculated that the molecules of higher dielectric constant in a mixture are present in far greater numbers in the immediate neighbourhood of the ion than in the rest of the gas. This would account for the labile clusters evidence for which was found above. The nucleus plays an exceedingly minor rôle in determining values of ionic mobility.—R. A. **Millikan**: High-frequency rays of cosmic origin (see NATURE, December 5, 1925, p. 823).—J. R. **Roebuck**: The Joule-Thomson effect in air. The porous plug used consisted of a porcelain tube with a rounded end, and great precautions were taken to ensure that the inlet pressure was maintained constant. Inlet pressure of 30 to 220 atmospheres and temperatures of 25° to 300° C. were used. The Joule-Thomson effect falls steadily with rising temperature and pressure, passes through zero, and becomes negative. The coefficient of expansion at constant pressure increases with both temperature and pressure but at a decreasing rate. The temperature of the ice-point works out as 273°·15 K.—Joseph Miller **Thomas**: On normal co-ordinates in the geometry of paths.—E. B. **Stouffer**: A simple derivation of Kronecker's relation among the minors of a symmetric determinant.

Official Publications Received.

The Vredefort Mountain Land in the Southern Transvaal and the Northern Orange Free State. Shaler Memorial Series. By Dr. A. L. Hall and Prof. Dr. G. A. F. Molengraaff. (Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam (Tweede Sectie), Deel 24, No. 3.) Pp. xiv+133+39 plates. (Amsterdam: Koninklijke Akademie van Wetenschappen.)

Aeronautical Research Committee. Reports and Memoranda, No. 981 (Ae. 194): The Design of the Pitot-Static Tubes. By E. Ower and F. C. Johnson. (C.I. Accessories Instruments, 88 and a.—T. 2108 and a.) Pp. 12+11 plates. (London: H.M. Stationery Office.) 9*d*. net.

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1924. By Kaimakam G. Jenkins Bey. Pp. vii+59+4 charts. (Cairo: Government Publications Office.) 5 P.T.

Scottish Marine Biological Station. Annual Report 1924–25. Pp. 23. (Glasgow.)

United States Department of Agriculture. Department Bulletin No. 1357: The Strawberry Rootworm, a new Pest on Greenhouse Roses. By C. A. Weigel. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

Publications of the Kapteyn Astronomical Laboratory at Gröningen. No. 38: On the Frequency of the Absolute Magnitudes of the Stars. By Prof. Dr. P. J. Van Rhijn. Pp. vi+77+2 plates. (Gröningen: Hoitsema Bros.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 6: A Contribution to the Life-History of Bowenia. By Prof. A. Anstruther Lawson. Pp. 357-394+8 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 7*s*. 6*d*.

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 8, No. 7: Deterioration of Sugarcane during its Storage by Windrowing. By Phani Bhusan Sanyal. Pp. 101-126. (Calcutta: Government of India Central Publication Branch.) 6 annas; 8*d*.

Board of Education. Educational Pamphlets, No. 46: Rural Education. Adaptation of Instruction to the Needs of Rural Areas; a Survey of the Present Position. Pp. 59. (London: H.M. Stationery Office.) 6*d*. net.

Conseil Permanent International pour l'Exploration de la Mer. Publications de Circonstance, No. 90: Quelques observations sur l'emploi de l'eau normale en océanographie. Par Prof. J. Giral. Pp. 22. (Copenhague: Andr. Fred. Høst et fils.)

United States Department of Agriculture Library. Bibliographical Contributions, No. 11: List of Manuscript Bibliographies and Indexes in the U.S. Department of Agriculture, including Serial Mimeographed Lists of Current Literature. Compiled by E. Lucy Ogden and Emma B. Hawks. Pp. 38. (Washington, D.C.)

Memoirs of the Geological Survey of India. Vol. 52, Part 1: On the Geological Structure of the Karanpura Coalfields, Bihar and Orissa. By Dr. Albert Jowett. Pp. v+144+14 plates. (Calcutta: Government of India Central Publication Branch.) 7.8 rupees; 12*s*.

Smithsonian Miscellaneous Collections. Vol. 77, No. 10: An Archeological Collection from Young's Canyon, near Flagstaff, Arizona. By J. Walter Fewkes. (Publication 2833.) Pp. 15+9 plates. (Washington, D.C.: Smithsonian Institution.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 67: Seasonal Variation in Pink Boll-Worm Attack on Cotton in Egypt in the Years 1916–1924. By C. B. Williams. Pp. 12+3 plates. (Cairo: Government Publications Office.) 5 P.T.

British Museum (Natural History). Picture Postcards. Set D7: Ornamental Stones, Series No. 1. 5 cards in colour. 1*s*. Set D8: Ornamental Stones, Series No. 2. 5 cards in colour. 1*s*. Set E39: Exotic Butterflies, Series No. 6. 5 cards in colour. 1*s*. Set E40: Exotic Moths, Series No. 9. 5 cards in colour. 1*s*. Set E41: Exotic Beetles, Series No. 4. 5 cards in colour. 1*s*. Set E42: Hymenoptera, Series No. 1. 5 cards in colour. 1*s*. (London: British Museum (Natural History).)

The Physical Society of London. Proceedings, Vol. 38, Part 2, February 15. Pp. 93-168. (London: Fleetway Press, Ltd.) 6*s*. net.

Academia Română. Memoriile Secțiunii Științifice, Seria 3, Tomul 3, Mem. 7: Über Chinas Pyraliden, Tortriciden, Tineiden nebst kurze Betrachtungen, zu denen das Studium dieser Fauna Veranlassung gibt (eine Biogeographische Skizze). Von Aristide Caradja. Pp. 130+2 Tafeln. (Bucarești: Cultura Națională.)

Department of Zoology, University College of Wales, Aberystwyth. New Series, Vol. 1: Report on Marine and Fresh Water Investigations. Edited by R. Douglas Laurie. Pp. iv+48. (Aberystwyth.) 5*s*.

Proceedings of the Royal Society of Victoria. Vol. 37 (New Series), Part 2. Pp. 131-276+plates 17-28. (Melbourne.)

U.S. Department of the Interior. Annual Report of the Commissioner of Education to the Secretary of the Interior for the Fiscal Year ended June 30, 1925. Pp. iii+36. (Washington, D.C.: Government Printing Office.) 10 cents.

Memoirs of the University of California. Vol. 7: The Motion and the Distribution of the Stars; Lectures delivered at the University of California, 1924. By Prof. Carl Wilhelm Charlier. Pp. vii+127. (Berkeley, Calif.)

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 29: Land-Grant College Education, 1910–1920. Edited by Walton C. John. Part 5: Home Economics. Pp. iv+91+8 plates. 15 cents. Bulletin, 1925, No. 39: The Progress of Dental Education. By Prof. Frederick C. White. Pp. 27. 5 cents. (Washington, D.C.: Government Printing Office.)

Diary of Societies.

SATURDAY, MARCH 13.

ROYAL SANITARY INSTITUTE (at Town Hall, Hastings), at 10.30 A.M.—Dr. G. R. Bruce, Miss Hester Viney, Dr. J. Fenton, and others: Discussion on Mothercraft and Fathercraft.—J. Parkin, H. T. Taylor, and others: Discussion on The Effect of the Public Health Act of 1925 on the Work of Municipal Engineers and Sanitary Inspectors.

BIOCHEMICAL SOCIETY (at University College), at 2.15.—C. R. Harington: Chemistry of Thyroxin—(*a*) Method of Isolation from the Thyroid Gland; (*b*) Constitution and Synthesis of Iodine-free Thyroxin.—H. J. Channon: Some Experiments on the Biological Significance of Squalene (Spinacene).—H. J. Channon and G. F. Marrian: An Unidentified, Unsaturated Hydrocarbon occurring in Mammalian Liver.—Prof. I. M. Heilbron: The Chemical Nature of Squalene (Spinacene).—F. H. Carr and E. A. Price: Colour Reactions attributed to Vitamin A.—H. Jephcott and A. L. Bacharach: Studies in the Vitamins of Cod Liver Oil. Part I.—Prof. H. S. Raper: The Production of 3.4 Dihydroxy-phenylalanine from Tyrosine by the Action of Tyrosinase.—R. K. Cannan, Dr. P. Haas, and T. G. Hill: Oxidation-Reduction Potential of Hermidin (Chromogen of *Mercurialis perennis*).—Dr. C. Dorée and E. C. Barton-Wright: A Note on the Stone-Cells of the Pear.—Margaret H. O'Dwyer: On the Nature of the Hemicelluloses.—H. D. Carey: The Relation between Hydrogen Sulphide, Hyposulphites, and Thiosulphates; by a New Method of Structural Formulæ.—E. Ponder: The Shape of the Erythrocyte and its Respiratory Function.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (2).

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—Dr. Eliza A. Collie: The Upper Limits of the Growth of Intelligence.—S. J. F. Philpott: Some Further Notes on Work Curves.

INSTITUTE OF TRANSPORT (North-Eastern Local Section) (at Town Hall, Newcastle-upon-Tyne), at 3.—Prof. J. H. Jones: State Ownership of Waterways.

SCOTTISH JUNIOR GAS ASSOCIATION (at Royal Technical College, Glasgow), at 7.—S. H. Hunter: Scientific Service.

MONDAY, MARCH 15.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Royal Technical College, Glasgow), at 2.30.—Capt. Hill: The Engineering Aspect of Telephone Exchange Accommodation.

CAMBRIDGE PHILOSOPHICAL SOCIETY (Special Meeting) (in Cavendish Laboratory), at 4.30.—Prof. A. Sommerfeld: Some Controversial Points in the Theory of Spectra (Lecture, in English).

VICTORIA INSTITUTE (at Central Buildings), at 4.30.—Rev. Canon V. F. Storr: Revelation.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Specimens of Some Bone Tumours.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. E. Allan, A. G. Barnard, and others: Discussion on Electricity on Board Ships.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Sopwith's Lounge, Newcastle-on-Tyne), at 7.—Informal Discussion on Power Station Economics.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—R. B. Matthews: Electro-Farming; or the Application of Electricity to Agriculture.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—Dr. W. R. Ormandy: The Production of Oil.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.

ROYAL SOCIETY OF ARTS, at 8.—W. F. Higgins: Thermometry (Cantor Lectures) (1).

MEDICAL SOCIETY OF LONDON, at 9.—Dr. E. F. Buzzard: The Principles of Treatment in relation to Diseases of the Nervous System (Lettsomian Lectures) (3).

CHEMICAL INDUSTRY CLUB.

TUESDAY, MARCH 16.

ROYAL IRISH ACADEMY (at Dublin), at 4.15.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. B. Hart: The Development of Psycho-pathology and its Place in Medicine (Goulstonian Lectures) (2).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. C. H. Desch: The Growth of Crystals (1).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Major P. Granville Edge: The Growth of Mortality due to Motor Vehicles in England and Wales, 1904–23.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—A. H. Hallimond: Molecular Volume Relations in the Mica Group.—E. D. Mountain: (*a*) Smithsonite from the Rhodesia Broken Hill Mines; (*b*) The Identity of the Cobija and Lampa Meteoric Stones.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, 17 Albert Square, Manchester), at 7.—L. C. Grant: Developments in High Power Fuses.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group) (Annual Meeting), at 7.—W. B. Ferguson: Standardisation of the Measurements of Photographic Density.—T. Thorne Baker and W. A. Balmain: The Effect of Colour-Sensitiveness on the Gradation of a Photographic Plate.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (Annual Meeting) (at Birmingham University), at 7.15.—Prof. A. R. Ling: Communications from the Department of the Bio-chemistry of Fermentation.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—G. B. Brook: Aluminium: Where and How it is made.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—A. E. Mitchell: Heavy Timber Construction in Harbour and Dock Works.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. G. Landtman: Some Agricultural Rites of the Kiwai Papuans.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—Prof. S. Alexander: Artistic and Cosmic Creation (Lecture).

ROYAL SOCIETY OF MEDICINE (Pathology Section) (Annual Meeting), at 8.30.

WEDNESDAY, MARCH 17.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—J. G. Kimber: The Production of Gaseous Fuel.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Sheffield University), at 7.30.—S. Evershed: Permanent Magnets in Theory and Practice (Second Paper).

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Prof. S. Chapman: Some Recent Advances in Atmospheric Physics (G. J. Symons Memorial Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Lieut.-Col. J. H. Borastan: Co-Partnership.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—E. J. Lidbetter: Social Inadequacy and the Size of the Family (Lecture).

INSTITUTION OF STRUCTURAL ENGINEERS (jointly with the British Section of the Society of Civil Engineers of France), at 8.—A. Knappen: Notes on the Restoration of the Palace of Versailles and the Trianon.

INSTITUTE OF CHEMISTRY (London Section).

SOCIETY OF GLASS TECHNOLOGY (at Stourbridge).

THURSDAY, MARCH 18.

ROYAL SOCIETY, at 4.30.—Prof. S. Chapman, J. Topping, and J. Morrall: On the Electrostatic Potential Energy, and the Rhombohedral Angle, of Carbonate and Nitrate Crystals of the Calcite Type.—Prof. A. O. Rankine: The Effect of Temperature on the Viscosity of Air.—G. I. Finch and L. G. Cowen: Gaseous Combustion in Electric Discharges. Part I.—C. N. Hinshelwood and W. K. Hutchison: A Homogeneous Unimolecular Reaction—the Thermal Decomposition of Acetone in the Gaseous State.—*To be read in title only*:—Prof. H. Lamb: On Wave Resistance.—C. E. Eddy and A. H. Turner: The L Emission Series of Mercury.—G. R. Goldsbrough: The Properties of Torsional Vibrations.—E. T. Hanson: The Theory of Ship Waves.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. B. Hart: The Development of Psycho-pathology and its Place in Medicine (Goulstonian Lectures) (3).

LINNEAN SOCIETY, at 5.—J. L. Sager: Phyllody of the Corolla in *Primula vulgaris* Huds.—Dr. R. T. Gunther: An Early MS. of Apuleius Barbarus *c.* 1100 A.D. in Facsimile.—G. P. Farran: The Copepoda Collected by H.M.S. *Research* in 1900.—Dr. Helena Bandulska: The Cuticles of Some Fossil and Recent Lauraceæ.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Holland Rose: The Indecisiveness of Modern Warfare (1).

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

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss C. von Wyss: Spiders as a Nature Study Topic.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. C. Grant: Developments in High-Power Fusible Cut-Outs.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Chamber of Commerce, Birmingham), at 7.15.—Prof. W. A. Bone: Some Recent Advances in our Knowledge of Gaseous Combustion.

INSTITUTE OF METALS (London Local Section) (at Institute of Marine Engineers), at 7.30.—Dr. C. J. Smithells: The Preparation and Structure of Wires of Pure Tungsten.

CHEMICAL SOCIETY, at 8.—R. J. W. Le Fèvre and E. E. Turner: Orientation Effects in the Diphenyl Series. Part II. The Constitution of Bandrowski's Dinitrobenzidine.—H. R. Ing and R. Robinson: The Orientating Effect of Free and Bound Ionic Charges on Attached Simple and Conjugated Unsaturated Systems. Part I. The Nitration of some Benzylamine Derivatives.—R. S. Cahn and R. Robinson: The Morphine Group. Part IV. A New Oxidation Product of Codeine.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at Royal Army Medical College, Grosvenor Road, S.W.), at 8.15.—Demonstrations by: Prof. Warrington Yorke (on behalf of Prof. Blacklock), Dr. P. A. Buxton, Col. Clayton Lane, Col. W. P. MacArthur, Dr. A. C. Stevenson, Dr. J. G. Thomson and Dr. A. Robertson, Dr. C. M. Wenyon and Dr. H. H. Scott.

FRIDAY, MARCH 19.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Western District Meeting) (at Victoria Hotel, Deansgate, Manchester), at 2.30.—Sir Lewis Beard: New Legislation affecting Local Authorities, including the Public Health Act, 1925, and the Roads Improvement Act, 1925.

INSTITUTE OF HYGIENE, at 3.30.—Dr. R. S. Stevenson: Affections of the Ear, Nose, and Throat and their Prevention.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Lady Chatterjee: Women and Children in Indian Industries.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens of Hydrocephaly and Encephalocele.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section, jointly with Manchester Section) (at Liverpool University), at 6.—Prof. T. P. Hilditch: Structural Chemistry of the Higher Fatty Acids.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—A. E. L. Chorlton: The High Efficiency Oil-Engine.

INSTITUTION OF STRUCTURAL ENGINEERS (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—C. A. Harding: Some Preliminary Factors affecting the Design of Industrial Buildings.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—H. Bairstow: Photography as a Medium of Art Expression.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—Members Evening.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (Annual General Meeting) (at Swansea Technical College), at 7.30.—C. A. Seyler: Chairman's Address.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. H. Willett: Pipe Work: Its Manufacture and Layout.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—J. Tweed: Chips from a Sculptor's Note-Book.

SATURDAY, MARCH 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Rare Gases of the Atmosphere and their Importance in Atomic Theory (3).

PHYSIOLOGICAL SOCIETY (at University College).

BRITISH MYCOLOGICAL SOCIETY (at Lister Institute).

PUBLIC LECTURES.

SATURDAY, MARCH 13.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. G. Cannon: How Animals Feed and what they Eat.

MONDAY, MARCH 15.

ST. THOMAS'S HOSPITAL, at 5.—Prof. R. H. A. Plimmer: The Importance of Vitamins. (Succeeding Lecture on March 16.)

SATURDAY, MARCH 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. Daryll Forde: Agriculture and the Origin of Civilisation.