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The Place of Biology in School Science.

ATTENTION has recently been directed by Mr. Ormsby-Gore and others to the lack of adequately trained men to supply the urgent needs of the Empire for biologists. The need has existed for a long while, but the position has never been dealt with in a comprehensive way, possibly because there was no practicable method of awakening that general interest in the problem which is an essential prelude to its solution. It may now be confidently said that interest is at last aroused, and the time is ripe for attacking the problem itself. There has been a highly significant change in the attitude of the average citizen to the multitudinous problems of Empire, and he now realises how intimately he is concerned in the ordered development of overseas resources. By its general activities, and perhaps above all by its publicity campaign, the Empire Marketing Board is driving home this new outlook, while for some time past it has formed the guiding principle in official circles: we need only instance the new organisation of the Dominions and Colonial Offices, the reports of Commissions that have examined some of the problems in the non-self-governing Colonies, the Research Grants Committee of the Empire Marketing Board, the first Imperial Agricultural Research Conference, and the personal visits of Mr. Amery and Mr. Ormsby-Gore to the Dominions and Colonies. The most important common factor brought out in all these activities is the opportunity for the trained biologist. Innumerable problems await him in every form of agriculture, in forestry, and in education.

There is little doubt that the grave shortage of qualified men would not have occurred had biology not been neglected in the school science course. It is perfectly true that the small proportion of men destined by natural gifts to become leaders in some branch of science are little affected by gaps in their early training; but the spade work, on which the general orderly advance of a subject and its actual employment in practical problems closely depend, is done by men of less transcendent qualities, who form the bulk of the class of professional scientific workers. These men are undoubtedly moulded to some degree by their early education, in the sense that although they are evidently potential scientific workers, the particular branch that they will follow usually depends on what was put before them in their impressionable years. It is well to stress the vital control that the educational syllabus has in maintaining the supply of competent research workers in any branch of

science. German physics and chemistry and their industrial applications provided the outstanding illustration of the pre-War period. This achievement was once described by, we believe, Sir William Ramsay as "the triumph of the second-rate." The phrase can be construed as cynical in intention, but its true meaning is surely that the success depended on adequate training for the mass of research workers, who were only second-rate in comparison with the few men of genius.

The science curriculum of British public and other secondary schools is almost exclusively occupied by formal physics and chemistry, and it is not surprising that recruits for other branches of science are relatively few. Yet it is not easy to make any change, although the desirability of doing so seems evident. The matter has been under careful examination by committees of the British Association, dealing respectively with "Science in the School Certificate Examination" and "Animal Biology in the School Curriculum." The former is naturally the more comprehensive, and makes a clear distinction between science teaching as part of a general education, and as preparation for professional qualification or a degree. It is generally forgotten—and the recent correspondence in the *Times* is no exception—that only a very small proportion of secondary school pupils proceed to universities. Probably 96-97 per cent finish their formal education at the age of sixteen, and the remainder have already begun to specialise in the subjects they intend to follow at the university or elsewhere.

Both classes suffer through the almost complete neglect of biology in their curriculum. The former class have not a properly balanced outlook on science and its manifold relations to the modern world, while in the latter class there are, as already mentioned, potential biologists who will nevertheless become physicists and chemists. The scope and intention of the biological teaching—or better, of the balanced scientific teaching—must be different in the two cases, but obviously the primary need is that the science course in both the preparatory or elementary school and the secondary or public school shall contain an adequate amount of biology. There would be little difficulty about this if our existing educational structure could be demolished and built afresh, for any attempt to graft additional subjects on to an already overcrowded curriculum is faced by grave difficulties. On one hand there are the enthusiasts who would jettison something to make room; some suggest that non-scientific subjects should be reduced: others that physics, chemistry, and mathematics should be curtailed. On the other hand, there are the (unkindly described) vested interests, who assert that the time available for science is already cut to the bone. Meanwhile the vicious circle remains: even if biological subjects were introduced to-morrow, few qualified teachers could be found.

It almost appears that the advocates of biological teaching have unwittingly delayed, by overemphasis, the reforms they have at heart, for they have created more than a suggestion that the present science teaching is out of touch with realities. It is asserted that physics and chemistry courses have become more and more formal; that, for example, a lad may, and does, acquire a dexterity in dealing with weightless strings passing over frictionless pulleys, while entirely failing to appreciate the part that mechanics plays in his daily environment and in the functioning of his own body. There is some truth in the statement, but the question whether it is a valid criticism needs a little closer examination. If there is one thing essential in the present-day civilisation, it is that those who live in it should be able to think accurately. The more complex the environment the more must our actions be based on quantitative rather than qualitative reasoning. The logical application of this axiom leads to a science syllabus in which physics and chemistry predominate, for these subjects, together with their servant, mathematics, are quantitative in their very essence; biology is not, and possibly may never be so, although a beginning has been made by applying the exact sciences, and biochemistry and biophysics already have great achievements to their credit. Since physics and chemistry were first in the field, and in view of their quantitative nature, it is not surprising that they have been used almost exclusively in teaching the virtue of accurate reasoning.

Another claim, recently expressed, is that education and biology can be defined in almost identical terms: education is concerned with the living individual and the habitat in which he must live and work out his destiny; biology deals with the nature of living things and the relations to their environment. Expressed in this way, the definitions seem at first sight interchangeable, but in reality the latter one is the narrower. In the sense in which they are used above, the word 'habitat' has a much wider significance than 'environment.' The human habitat includes the whole range of uses that man has made of inanimate Nature, and it is precisely these achievements that are of most interest to the educated man to-day. The reason

is not far to seek. They give him a faint glimpse of the illimitable and amazing powers that his descendants may wield, and, on a more mundane plane, they contribute greatly to his material security, his comfort, and his recreation.

There is a tendency for the exponents of biological teaching to assume that these immediate material benefits conferred on our civilisation by the applications of physics and chemistry have been responsible for the concentration on these subjects in the schools. Proceeding from this assumption, the argument states that they continue to be taught partly from inertia, but also because they are a useful accomplishment in seeking a living, and by way of emphasis it concludes with the statement that if men were still bought and sold as in slavery times, human biology would possess equal importance. But both the assumption and the argument are unsound; as to the assumption, the most commercially minded physicist has not lost his sense of wonder that a few pieces of wire, put together in a certain manner, should enable him to hear the voice of a fellow-man thousands of miles away; and as to the argument, cattle have been bought and sold for a long time, but it cannot be said that the breeders make much use of modern animal biology. Wherever we look we find the same dominance of the physical world. As an example we may take the yearly attendance figures for the Natural History and Science Museums, and now that each is in a permanent building the comparison is a fair one. The number of visitors to the Natural History Museum has exceeded the half-million mark each year since 1924, and shows perhaps a slight tendency to increase. The attendances at the Science Museum have risen from 430,000 in 1925 to 709,000 in 1927, while the 1928 figure just exceeds 900,000.

To take a lighter illustration, the twenty-fifth anniversary of the first flight of the brothers Wright was celebrated by a dinner under the wings of the historic biplane, attended by pioneers in the art and science of aeronautics, but no similar tribute was offered to the pterodactyl even at the centenary of Cuvier's elucidation of its true nature.

We have to face the fact that the average citizen is not intensely interested in the biological nature of his own existence, and yet it is highly desirable that he should be. Hence the introduction of biology into primary and secondary education must be achieved in the face of a certain apathy, coupled with protests both from the commercially minded and those educationists who fear a loosening of discipline in science teaching.

Apathy will disappear in proportion as interest is aroused. When the opportunities for biologists in the overseas Empire and at home are fully appreciated by schools and by parents, any objections on the ground of unsuitability as a preparation for a professional career will disappear. In this connexion we hope that the authorities will arrange for the widest possible distribution of two leaflets prepared by direction of the Imperial Agricultural Research Conference. These deal with the opportunities for students of biology; one is addressed to teaching authorities, the other to parents and students, and both set out in moderate terms the bright prospects for some time to come for able young biologists. The final hurdle, however, is the most formidable; it is to persuade a well-entrenched system of science teaching, conscious of its intellectual and utilitarian value, and proud above all of its value as a mental discipline, that it is nevertheless incomplete without biology. How is this to be done? Bateson himself supplied the answer in his article in the Huxley Centenary issue of NATURE: "No one better than Huxley knew that some day the problems of life must be investigated by the methods of physical science if biological speculation is not to degenerate into a barren debate."

There would be few to dispute that primary science education should concentrate on the simplest—we might almost say the picturesque—aspects of Nature, and here the various phases of biological science naturally predominate. But for the next stage, the secondary or public school period, the pupil must be brought into closer touch with realities, and the discipline of exact and critical thinking must be firmly established. For this purpose it appears inevitable that wherever possible the approach to biology must be through the medium of physics and chemistry, although the subject must naturally be presented in proper perspective, and in some of its more complex branches only qualitative methods of exposition will be possible for some time to come.

The consent of educationists to this outlook would be tantamount to accepting a course in general science as the backbone of pre-university teaching. The foundation of the course would still be physics and chemistry, but it would also include studies of living things and of the changeful earth generally. Its value as a mental discipline need not be reduced, and its human interest would be greatly increased. The net would be thrown wider, and it would assuredly produce a greater number of recruits for biology than the present system.

Pure Substances: their Preparation, Properties, and Uses.

La notion d'espèce en chimie. Par Prof. Jean Timmermans. Pp. iii + 134. (Paris: Gauthier-Villars et Cie, 1928.)

PROF. TIMMERMANS has chosen as a basis for his monograph on "Chemical Species" the definitions given by Wald in 1897, and used by Ostwald in 1904 in the Faraday Lecture in which he tried to show that the molecular theory had become a superfluous hypothesis in view of the rapid development of the applications of thermodynamics to chemistry. According to these definitions, a *chemical compound* is merely a 'hylotropic' substance which remains constant in composition over a range of temperatures and pressures, within which it resists all attempts at fractionation. A *solution*, on the other hand, may remain of constant composition when attempts are made to fractionate it by a single method, for example, by distillation under a given pressure, but generally begins to break up when a second process of fractionation is tried, for example, by fractional distillation under a different pressure, or by freezing. If, however, the material remains hylotropic and resists fractionation under all available conditions, it is classed as an *element*.

These definitions appear to be strictly logical, but do not provide an immediate solution of the practical problem of recognising a chemical compound. Thus it is not easy to say under what physical conditions stable oxides such as magnesia or alumina begin to dissociate into their components, although a schoolboy could prove their complexity by a synthetic method. In cases such as these, the attempt to find a physical definition of a chemical species seems to lead to less satisfactory results than the traditional chemical methods.

A converse difficulty arises in the case of substances which undergo isomeric or polymeric change. Their behaviour then depends entirely upon the velocity with which this change takes place. If the change is slow, the two substances will behave as distinct species, and can be fractionated in the ordinary way, provided that the process of fractionation is fast in comparison with the velocity of change. Since, however, this velocity is often increased enormously by the presence of catalysts, it may be necessary to take exceptional precautions to maintain the purity of the sample, for example, by using silica containers in order to avoid contamination by the alkali of a soft glass vessel. If these precautions are not taken, or if the velocity of change is inherently fast, the two species will behave as one; and no process of fractionation will be of the slightest use unless it can outrun the isomeric or polymeric change. Substances of this kind will be hylotropic under all conditions, except those which give rise to a fundamental decomposition. The hylotropic phases, if liquid or gaseous, will be equilibrium mixtures of the different species; but if a solid phase crystallises out, it will generally consist of a single species, since separation of the first crystal from the liquid or gaseous phase is immediately followed by a restoration of equilibrium, which results ultimately in a complete conversion into the solid species of lowest vapour pressure.

It is necessary to lay stress on the complete breakdown of the usual criteria in cases of this type and to assert as clearly as possible that merely negative evidence has no value as a proof of molecular uniformity. Thus the author cites Sidgwick's test for distinguishing between isomers and polymorphs, by observing whether an increased concentration is produced by saturating a solvent with both solid phases. If an increase is observed, the difference between the two solids is evidently maintained in the liquid phase and by definition the two forms cannot then be mere polymorphs; but Prof. Timmermans falls into a common error by quoting a case in which no increase of solubility is observed, and concluding from this evidence that "the two substances are polymorphic forms of the same compound." On the other hand, if one form is colourless and the other coloured, or if the two forms show a marked difference of colour, it can generally be asserted with some confidence that they are probably different species, even if their saturated solutions are identical in concentration, refractive index, optical rotatory power, etc., since it is unlikely that any mere rearrangement of the crystal lattice will suffice to produce a coloured aggregate from molecules which are colourless when packed in a different way. The only logical conclusion in such a case is to treat the coloured and colourless molecules as different species, but to assign a high value to the velocity of transformation.

It is indeed impossible to be quite certain that any given case of polymorphism may not be accompanied by molecular transformation, although this is less likely to occur in the case of an element, such as iron, where the molecules appear to be composed of single atoms which cannot be accused of any tendency to undergo changes of this kind. The fact that the interconversion of white and

grey tin is complete, whilst that of the two dichloroethylenes is reversible, does not depend, however, on the fact that the two forms of the element are polymorphic, whilst those of the organic compound are isomeric (as is suggested in the text), but on the fact that the former are solid, whilst the latter are liquid.

The practical work of determining the physical properties of pure substances is a task to which Prof. Timmermans has devoted himself for some years, and on this subject he can now speak with unrivalled authority. In this respect he is the principal upholder of the British tradition of exact physico-chemical measurement, which he inherited as a student of Prof. Sydney Young, and can also claim the privilege of having worked under Prof. Kamerlingh Onnes at Leyden and under Prof. Ph. Guye at Geneva.

The difficulties of this work are twofold, since its value depends equally on chemical purity and accurate physical measurements, and there are not too many data which are above reproach in both respects. Thus, on one hand, it is necessary to write down as mere approximations the ordinary data as to the properties of organic compounds, such as melting-points determined with uncalibrated thermometers, often without any correction for the exposed stem ; but it is equally clear that precise physical determinations of the physical properties of creosote (the only example of magnetic rotatory dispersion cited by Drude), or of hydrocarbons separated from petroleum by fractional distillation, have no greater claim to accuracy. Whilst, therefore, the first part of Prof. Timmermans' monograph deals, as it should, with the theoretical difficulties which are met with in trying to define a chemical species, the second and third parts deal with the practical problems encountered in preparing pure substances and determining their physical properties.

It is not necessary to repeat here the valuable advice, and the equally necessary warnings, which are now given, since those who are interested in similar work would be well advised to read the words of the author rather than a paraphrase by the reviewer. A more useful purpose may therefore be served by directing attention to the valuable service rendered by the Bureau International des Étalons Physico-chimiques, of which Prof. Timmermans has been the director since 1922. This bureau, although financed largely by Belgian industrial chemists (and notably by the firm of Solvay et Cie.), also forms a permanent part of the activities of the Union Internationale de la Chimie, ranking alongside the commissions which are responsible for preparing the Tables of Atomic Weights and the Annual Tables of Numerical Results. It is indeed one of the functions of the Bureau to fill up the gaps in the existing tables of physical constants ; but this is being done in a systematic rather than in a piecemeal manner by preparing various series of pure organic compounds, such as the hydrocarbons and their halogen derivatives, the alcohols, ethers, oxides, ketones, and aldehydes of the fatty series, and then determining for each compound the boiling-point (to $\pm 0{\cdot}05°$) and its variation with pressure in the neighbourhood of 760 mm., the freezing-point, the critical solution temperature, the density at 0°, 15°, and 30° C., and the coefficient of expansion, the indices of refraction at 15° for eight different rays, with their temperature coefficients, dispersion, and molecular refraction. The data thus obtained are compared critically with all the earlier measurements that are available, and are submitted to correspondents (of whom the reviewer is one) in each of the countries represented in the Union Internationale before being printed, with the result that in the course of the next five years there should become available an unrivalled series of standard measurements on a wide range of pure substances.

These data can then be used, on one hand, as a means of testing the purity of samples prepared and used all over the world, since a sample of benzene, or cyclohexane, or ethylene bromide which melts at a lower temperature than that finally adopted as correct cannot be regarded as adequately purified. On the other hand, the physical constants of the pure compounds can be used in the calibration of instruments of measurement in any laboratory, however remote. This applies not only to thermometry, where the fixed points are almost always determined in this way, but also to calorimetry, where the water capacity of the instrument can be checked by the combustion of pure benzoic acid, and to measurements of viscosity, surface tension and the like, where absolute calibration is difficult or impossible in an apparatus of normal type.

In view of the latter method of using pure substances, the Bureau des Étalons has undertaken to supply standard materials for calorimetry, refractometry, viscosimetry, and thermometry (both at high temperatures and down to $-160°$ C.), and proposes to add to this list suitable substances for the calibration of measuring vessels at low temperatures, of manometers and potentiometers, and, in addition, to extend the scope of its work

by including inorganic as well as organic substances. These materials can be procured from the Director, Bureau des Étalons, Université de Bruxelles (Solbosch), Belgique, and, by a reciprocal arrangement, materials purified by the Bureau of Standards in Washington can be purchased from the same address, whilst the Belgian products are also available in Washington. T. M. LOWRY.

Illumination in Mines.

Mine Lighting. By Dr. J. W. Whitaker. (Monographs on Coal-Mining.) Pp. xvi + 200. (London: Methuen and Co., Ltd., 1928.) 8*s*. 6*d*. net.

DR. WHITAKER'S little book has been published at a very opportune moment, for the attention of all connected with coal mining is becoming increasingly focused upon the question of underground illumination. The fact was clearly brought out at the recent annual meeting of the Institution of Mining Engineers, where one of the most important of the papers presented, and one which gave rise to a particularly keen discussion, was devoted to this subject.

Quite apart from the undoubted fact that in the mine, as everywhere else, no man can possibly do efficient work unless he is supplied with an adequate amount of light to enable him to see clearly the work upon which he is engaged, in coal mining there is the additional consideration that, in the opinion of Dr. J. S. Haldane, Dr. L. T. Llewellyn, and other authorities, that very distressing and troublesome disease, miner's nystagmus, is due essentially to deficient lighting. It is quite true that other medical men have contested this opinion and have brought forward other possible causes, but so far the weight of opinion, strongly supported by the findings of the Nystagmus Committee, inclines to the view that the cause is as above stated, and the author of the book now before us seems to share this view.

It is well known that in the vast majority of collieries in Great Britain it is necessary to employ only safety lamps. It is also well known that when safety lamps were first devised, it was the importance of safety that was mainly stressed in the first instance, and it was only later, when the conditions of safe light were thoroughly understood, that the amount of illumination received attention. How greatly this question has been overlooked until quite recently may be gathered from the Government memorandum on "The Test of Safety Lamps," published in 1912, in which the only photometric test exacted from flame safety lamps is that the lamp is required to give a minimum candle-power of 0·30 during a period of ten hours. It is now generally admitted that the miner requires at least ten times as much light as is imposed by the above Government legislation.

There is still a great deal of ignorance on the subject of mine lighting, even amongst the most progressive colliery managers, and Dr. Whitaker's little book should go far to dispel this ignorance, because it places in the hands of the colliery manager a small, clearly written, and very complete work on the subject. The author commences by explaining the properties of light, and then proceeds to the units of photometry and a description of various photometers; it is to be regretted that amongst these he has not included the very simple but quite efficient photometer recently devised by Drs. Haldane and Wheeler. A chapter is devoted to a description of the eye and a discussion of vision, whilst the nature of miner's nystagmus is also discussed. Considerable attention is devoted to the history and development of the flame safety lamp; then come chapters describing various types of electric lamps, whilst another chapter is devoted to acetylene mine lamps, and another useful chapter deals with the arrangement and operation of colliery lamp rooms.

In the chapter on acetylene mine lamps no mention is made of the fact that acetylene safety lamps have been made and put on the market, although it is quite true that they have not met with any general acceptance. Under the heading electric lamps, cap lamps are certainly discussed, but it may well be said that they have received less attention than their importance appears to warrant.

Perhaps the most serious omission in the book is that the flame lamp is considered only as an illuminating appliance and its other very important function, namely, that of a detector of fire-damp, is not considered. No doubt the author could be justified in claiming that this consideration lies outside the scheme of his work, but in fact it is very difficult to divorce the two uses of the flame safety lamp from each other. There is little doubt that if the electric safety lamp were as capable of being used for gas detection as is the flame safety lamp, it would long ago have displaced the latter, and the flame safety lamp only holds its own on account of its value as a gas detector. Great efforts have recently been made to improve the illuminating power of the flame safety lamp, so as to enable it to compete on this score with the electric lamp, but it is still too early to say whether

these efforts will or will not be attended with success. If such an improved safety lamp can be produced without at the same time impairing its value as a gas detector, there is little doubt that it would be preferred to the electric lamp, and everyone interested in coal mining sincerely hopes that such an improvement may be the outcome of the experiments that are now being carried out.

If such advances are actually made, Dr. Whitaker will no doubt take care to chronicle and describe them in a future edition. Meanwhile it can only be said that this work offers a safe guide to all interested in this important subject, and is worthy of careful study by all engaged in colliery work.

Archæological Discovery in China.

Archives de l'Institut de Paléontologie humaine. Mémoire 4: *Le paléolithique de la Chine.* Par M. Boule, H. Breuil, E. Licent et P. Teilhard. Pp. viii + 138 + 30 planches. (Paris: Masson et Cie, 1928.) 160 francs.

THE archæological discoveries in China of Fathers Teilhard de Chardin and Licent, of which a preliminary account appeared in *L'Anthropologie*, T. 35, p. 201, 1925, are the subject of a magnificently illustrated memoir written in collaboration with MM. Marcelin Boule and H. Breuil, which is now published by the Institut de Paléontologie humaine. The reverend fathers are responsible for the narrative account of the investigations at the palæolithic sites of Choei-tong-keou and Sjara-osso-gol, and the description of the worked quartzite implements from the base of the loess, while M. Boule deals with the palæontology in collaboration with P. Teilhard and also contributes an introduction, and H. Breuil examines the implements from each site in detail. The investigations which have produced the important results here described were undertaken at the instance of the Institut, which sent P. Teilhard to China in search of evidence bearing upon the antiquity of man in Asia. The prescience which directed and sent out the mission has been fully justified. The results, now that they have been placed in their proper perspective by careful scrutiny in the laboratory of the Institut, are of first-rate importance.

On geological and palæontological grounds, the pleistocene of China is equated with that of Europe. It would appear that the range backward in time of the loess has been much over-estimated and that preceding conditions in China and Europe may be regarded as very much the same. The fauna are strictly comparable both in time and character, the differences, notably in the predominance of the gazelle type, being due to climatic and geographical conditions. There would thus appear to be adequate ground for the inference that in pleistocene times there was a continuity of conditions in Europe and Asia extending from China to Central Europe and even to France.

For prehistory this is a conclusion of first-rate importance, not merely in the equation of palæolithic man in Europe and in China, but also in certain consequential inferences. The Chinese industries were advanced Mousterian—Early Aurignacian. Not only are early Palæolithic types entirely absent, but notwithstanding the Mousterian types, the characterisation of the industry as a whole is Upper Palæolithic. Again, the two sites are not identical, the most noticeable difference being the higher number of microlithic implements at Sjara-osso-gol, where they were about a third of the implements found. In the absence of comparable stratigraphic evidence it is impossible to say if this indicates a later phase. Probably it does not, but is due entirely to local conditions. The Abbé Breuil thinks it may represent an ethnic or tribal distinction. However that may be, in the main feature the two sites agree—the conjuction of various Palæolithic types which in western Europe would belong to different periods. M. Boule compares the Siberian sites, and, having these in view, it is suggested that Asiatic conditions must not be judged by a test which may apply only to the special circumstances of western Europe. M. Boule puts forward the view, and in this he is followed by his collaborators, that Asia was a vast workshop in which the stone industry was elaborated. It was in advance of Europe at corresponding epochs of time, while the precise differentiation of the various industries in Europe demonstrated by the stratification was due to successive migrations from the common source.

It cannot be denied that this theory is attractive and that there is much to be said for it. Nor must too much store be laid upon the absence of early types of implement when so much remains unexplored. Yet if the East Anglian evidence be accepted, it does seem singular that the earliest handiwork of man or his predecessor should appear in western Europe. Now that parity of conditions has been established in China, we may perhaps expect to hear of evidence which previously has been overlooked through failure to appreciate the circumstances.

Our Bookshelf.

Introduction à la théorie des quanta : les équations de la mécanique et de l'électronique. Par Dr. Marcel Boll et Charles Salomon. (Collection de Physique et Chimie.) Pp. xx + 457. (Paris : Gaston Doin et Cie., 1928.) 85 francs.

ANYONE who opens this admirable book expecting to find in it a discussion of the quantum theory will be completely disappointed. After some fifteen introductory pages the quantum theory is practically never mentioned. But such a reader's disappointment will be his own fault. There is still no proper introduction to the quantum theory other than a thoroughgoing study of classical mechanics and electrodynamics. This book contains a really excellent account of these subjects, aimed, as the authors say, at subsequent study of the quantum theory.

The subjects are studied, as they should be, on their own merits, but the emphasis and choice of material has been influenced by the needs of the student of the quantum theory. We have met no better introductory work on general dynamics and electrodynamics to put into the hands of a student who desires to approach the quantum theory with a substantial knowledge, not a mere smattering, of these important subjects. During a first reading the treatment of almost every section seemed good and complete, with the exception of that on the difficult theory of the adiabatic invariance of the action variables of a multiply periodic system. The difficulty introduced by accidental degeneracies during the change of parameter seemed not to be fully faced, though there is a summary of the important work of von Laue.

The book can be heartily recommended as *the* book for physicists on general dynamics.

R. H. F.

Elementary Organic Chemistry. By Homer Adkins and S. M. McElvain. (International Chemical Series). Pp. xi + 183. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1928.) 11*s.* 3*d.* net.

THIS book was written to supplement a short course in organic chemistry given at the University of Wisconsin, and in consequence does not appear to be complete in itself or to agree with the inclusion of ' Elementary ' in its title. The beginner would be bewildered by the number of compounds dealt with in rapid succession in the first chapter of some 32 pages, and in the subsequent chapters the usual procedure is to consider a homologous series in a very general manner with only the briefest reference to the most important members of the series, or in some cases to omit them completely. Thus in the chapter on aldehydes and ketones, acetone is not even mentioned.

The authors have laid great stress on structural formulæ, which are printed in large type (in fact, the reaction showing the formation of fluorescein occupies nearly a page), and spend considerable time on nomenclature, which is so often neglected in elementary text-books ; but unfortunately these are almost the only points in favour of the book, as it could not be used by a beginner unless to supplement some course of lectures, and then only if these followed the general arrangement of the book.

J. R. H. W.

Bells Thro' the Ages : the Founders' Craft and Ringers' Art. By J. R. Nichols. Pp. xi + 320 + 53 plates. (London : Chapman and Hall, Ltd., 1928.) 21*s.* net.

To meet the revived interest in bells, and because most of the books on the subject are out-of-print or inaccessible, Mr. Nichols, himself a member of the Ancient Society of College Youths and the Lincoln Diocesan Guild, has written this study of bells and bell-ringing. In his view, the period in the seventeenth and eighteenth centuries which has been called the ' Golden Age of Bell-founding ' is in danger of losing its claim to that title owing to the activities of modern founders. Be that as it may, his volume will be welcome to the practitioners of the art and those whose interest in the subject calls for a convenient book of reference.

Mr. Nichols' treatment of the subject on the historical side is comprehensive. Not only are famous bells described in detail, but also he deals with the history of the methods of ringing, the peal, the chime, the changes, and so forth, famous founders, inscriptions and decorations on bells, and of course with the carillon. A chapter is devoted to lore and legends—a subject which requires a whole book to itself, and certainly a broader treatment than Mr. Nichols has given it. To dismiss the belief that bells drive away evil spirits as a mere superstition, misses the significance of the importance attached to the bell in the early Christian Church as shown especially in the lives of the Irish saints.

Sir Joseph Banks and Iceland. By Halldór Hermannsson. (Islandica : an Annual relating to Iceland and the Fiske Icelandic Collection in Cornell University Library, Vol. 18.) Pp. x + 99 + 27 plates. (Ithaca, N.Y. : Cornell University Library ; London : Oxford University Press ; Copenhagen : Andr. Fred. Höst and Sön ; Reykjavík : Bókaverzlun Sigfúsar Eymondssonar, 1928.) 15*s.* net.

SIR JOSEPH BANKS'S visit to Iceland was in the summer and autumn of 1772, a time when comparatively little about that country was known in Europe. He published nothing on his journey, but it is clear a good deal of scientific work was done. Banks kept a diary, which can be traced as having been in the keeping of his wife's family until it was sold among his other papers in 1886. The present owner is unknown. Mr. Hermannsson has put this work together from various sources, and illustrated it by pictures from Iceland which were made at the time and are now in the British Museum. Banks's visit was brief, but it awakened in him a lifelong interest in Iceland. Much of the book traces through Banks's letters this interest, and his efforts on behalf of the Icelanders at a period when their fortunes were low.

Letters to the Editor.

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The Mass-Spectrum of Uranium Lead and the Atomic Weight of Protactinium.

IT will be recalled (NATURE, Aug. 13, 1927) that the identification of the isotopes of ordinary lead was made by means of a sample of its tetramethide kindly supplied to me by Mr. C. S. Piggot, of the Geophysical Laboratory, Washington. He has since succeeded in the much more troublesome task of preparing the similar compound of a rare uranium lead from Norwegian bröggerite. His reasons for this work have already been published (C. S. Piggot, "Lead Isotopes and the Problem of Geologic Time," *Jour. Wash. Acad. Sci.*, May 19, 1928). The first tube of uranium lead methide despatched to me a year ago was unfortunately broken in transit, but the second reached Cambridge safely last summer. At that time I was endeavouring to work out a photometric method of measuring the relative abundance of isotopes. This work is by no means complete, but has recently reached a stage which justified an attempt on the mass-spectrum of this very precious material. The procedure was the same as with ordinary lead methide, but the general conditions of the discharge tube, etc., were not so favourable, so that the spectra obtained are weaker.

The mass-spectrum consists of a strong line at 206, a faint one at 207, and a still fainter one at 208. The last is barely visible to the eye, but easily distinguishable on the photometer curves. The impossibility of eliminating mercury limits the search for lighter isotopes, but there is not the least indication of 203 or 205. Unfortunately, the experimental conditions all conspire to make the determination of the true relative intensities of the lines from the curve of photometer wedge readings too complex to be really trustworthy. Calling the intensity of the strong line 100, the mean of the best plates gives $10{\cdot}7 \pm 3$ and $4{\cdot}5 \pm 2$ for 207 and 208 respectively. As the only curve available for transforming wedge readings into intensities is one derived from krypton, these figures are probably both too high. They correspond to percentages 86·8 : 9·3 : 3·9, and as the packing fraction is indistinguishable from that of mercury ($0{\cdot}8 \times 10^{-4}$), the mean atomic weight deduced is 206·19, rather higher than that determined chemically for other uranium leads. These figures have been communicated to Mr. Piggot, and when combined with the analyses of the mineral should enable its age to be fixed with considerable certainty.

There is, however, another point of view from which these results are of fundamental interest in connexion with the radioactive elements. The line 207 is of peculiar significance. It cannot be due to the presence of lead as an impurity, for in ordinary lead 208 is about twice as strong as 207, neither can it be the product of radium or thorium. It is difficult to resist the natural conclusion that it is the end product of the only other known disintegration, namely, that of actinium. If this is so it settles the mass numbers of all the members of this series, that of protactinium being 231. Extrapolation of the packing fraction curve suggests an atomic weight on the oxygen scale of 231·08.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, Feb. 16.

Origin of Actinium and Age of the Earth.

BY the kindness of Dr. Aston, I have had the opportunity of inspecting his photographs showing the isotopes of lead obtained from the radioactive mineral bröggerite. As he concludes, it seems highly probable that the isotope of mass 207 is mainly due to actinium lead, and that the actinium series has its origin in an isotope of uranium—a suggestion independently put forward by several investigators on other evidence. Since six α particles are emitted in the successive changes from protactinium to the end product actinium lead, the atomic weight of protactinium should be 231. The direct determination of the atomic weight of this element number 91 now in progress in the laboratory of Prof. Hahn in Berlin should afford a crucial test of the accuracy of this deduction.

In the light of this new knowledge and of the measurements made by Dr. Aston of the relative intensities of the lead isotopes in the mineral, it may be of interest to consider its bearing on the origin of actinium and other problems. We shall first discuss the probable mass of this new isotope, which for convenience will be called actino-uranium. It seems simplest to suppose that its mass is 235, and that it undergoes first an α and then a β ray transformation into protactinium. The β ray body is probably to be identified with uranium Y, discovered by Antonoff, which has generally been regarded as the immediate parent of protactinium. On this view, the successive transformations follow the order $\alpha\beta\alpha\beta$, where the α and β changes alternate, and differ in this respect from the main uranium series which follow the order $\alpha\beta\beta\alpha$. It is of course possible to assume that actino-uranium has a mass 239 and number 92, and is converted into a mass 235 of number 92 in consequence of an α ray change followed by two β ray transformations, but no evidence has been obtained of the existence of such β ray bodies, although a careful search has been made for them by Hahn and others.

An estimate of the period of transformation of the new isotope of uranium can be deduced on certain probable assumptions. The ratio K' of the number of atoms of actinium lead to those of uranium lead can be deduced approximately from Aston's measurements, and we also know the ratio K—about 3/100—of the number of atoms delivered in a mineral into the actinium series compared with the number passing into the radium series. If λ_1, λ_2 are the constants of transformation of actino-uranium and the main uranium isotope respectively, it can easily be deduced that $K'/K = \frac{\lambda_2}{\lambda_1} \cdot \frac{e^{\lambda_1 t} - 1}{e^{\lambda_2 t} - 1}$, where t is the age of the mineral from which the lead is derived. We shall suppose for the purpose of calculation that t is 10^9 years—an average estimate of the age of old primary uranium minerals. Taking as a low estimate that $K' = 7/100$, it can be deduced from the equation that $\lambda_1/\lambda_2 = 10{\cdot}6$. Since the half-value period of transformation of uranium is $4{\cdot}5 \times 10^9$ years, it follows that the period of actino-uranium is $4{\cdot}2 \times 10^8$ years. A larger value of K' lowers the period, while a higher value for the age of the mineral raises it.

Taking the period as $4{\cdot}2 \times 10^8$ years, it is seen that the amount of actino-uranium is only about 0·28 per cent of the main uranium isotope—an amount too small to influence appreciably the atomic weight of uranium as ordinarily measured. The amount of actino-uranium at the time of its formation taken as 10^9 years age comes out to be 1·44 per cent.

There is another interesting deduction that can be made from these estimates. It is natural to suppose that the uranium in our earth has its origin in the sun,

and has been decaying since the separation of the earth from the sun. From the work of Aston, it is known that with two exceptions the most abundant isotope in an even numbered element is of even atomic weight. If it be supposed that uranium, like other heavy elements, is formed from stellar matter, it is likely that actino-uranium of odd atomic weight would be formed in smaller quantity than the main isotope of even atomic weight. Even, however, if we suppose they were formed in equal quantity, it can be shown that it would require only $3{\cdot}4 \times 10^9$ years to bring down the amount to the 0·28 per cent observed to-day.

If we suppose that the production of uranium in the earth ceased as soon as the earth separated from the sun, it follows that the earth cannot be older than $3{\cdot}4 \times 10^9$ years—about twice the age of the oldest known radioactive minerals. In addition, if the age of the sun is of the order of magnitude estimated by Jeans, namely, 7×10^{12} years, it is clear that the uranium isotopes which we observe in the earth must have been forming in the sun at a late period of its history, namely, about 4×10^9 years ago. If the uranium could only be formed under special conditions in the early history of our sun, the actino-uranium on account of its shorter average life would have practically disappeared long ago. We may thus conclude, I think with some confidence, that the processes of production of elements like uranium were certainly taking place in the sun 4×10^9 years ago and probably still continue to-day. E. RUTHERFORD.

The Theory of Electrical Rectification.

IT is an experimental fact that certain electrical conductors, when connected in series so as to form a circuit, present a different resistance to currents flowing through them in opposite directions. Examples are the electrolytic rectifiers, the crystal rectifiers, and the dry-plate rectifiers recently developed. In some cases the rectification undoubtedly is due to the circuit itself being modified by the flow of the current. Thus, for example, in an electrolytic rectifier a layer of oxide may be formed on one of the electrodes when the current is passing in a given direction, obstructing its further flow, while no such layer appears at the other electrode, made of a different material, when the current is reversed. Thermo-electric effects may occasionally play a rôle too. In crystal rectifiers, however, the rectification must in general be caused directly by the interaction of the crystal lattices with the conduction electrons (W. Schottky, *Zeit. f. Phys.*, **14**, 63; 1923). For it appears that they rectify alternating currents of frequency 10^7, and of the order of a microampere only (R. Ettenreich, *Phys. Zeit.*, **21**, 208; 1920), and the amount of substance chemically changed in an electrolytic action during a half period of such an alternating current is altogether too small to be made responsible for the phenomenon, quite apart from the fact that chemical changes would scarcely be capable of taking place with a frequency of 10^7. As Ettenreich (*l.c.*) remarks himself, the thermoelectric explanation too is invalidated by his experiments. The question arises then as to what is the elementary mechanism underlying this kind of rectification.

The resistance of a metallic conductor is caused by the transfer of momentum which the conduction electrons have gained under the influence of the applied electric field to the ions of the crystal lattice through collisions or, in the language of wave mechanics, by the scattering of the waves representing the conduction electrons under the action of these ions. Rectification signifies here, therefore, a difference in the scattering power of the circuit for electron waves travelling in opposite directions.

If in first approximation we regard the ions in the lattices as fixed in space, we are led to study the influence on a plane monochromatic electron wave of a field of force the potential V of which vanishes for $x = \pm\infty$, while in planes parallel to the y-z-plane it is doubly periodic. According to wave mechanics such a wave, representing a stream of electrons of definite velocity parallel to the wave normal, on encountering the potential V is partially reflected and partially transmitted. We inquire then if the coefficient of reflection for a given V is the same for incident waves travelling in opposite directions. It can easily be proved that even if the potential V is not symmetrical along the x-axis, as in the case of a number of conductors in series, there is no difference in the coefficient of reflection. It is hence not possible to explain the rectification here considered on the basis of the assumption that the ionic lattices act on the conduction electrons like a field with a given potential V.

If now we regard the ions of the lattice no longer as fixed centres of force, we come to investigate if there will be a difference in the scattering action on electron waves travelling in opposite directions, of particles bound to positions of equilibrium by restoring forces not symmetrical for equal and opposite displacements. It can be shown by a perturbation method that in general the scattering is indeed different. Assymmetrical binding of the ions, which, for some of the substances used in rectifiers actually has been ascertained even for the interior of the crystal by X-ray analysis, will come mostly into play near the boundary, and to a still greater degree at the edges and corners of a crystal lattice. This may be the explanation why some crystal rectifiers consisting of a metal point in loose contact with the crystal have their rectifying properties diminished or entirely spoiled if the point is pressed tightly against its base, for in this process the sharp corners are flattened out. From the viewpoint of the theory here set forth, there seems to exist the possibility of volume rectification in contradistinction to surface rectification for crystals in which, even in the interior of the lattice, the ions are subject to restoring forces not symmetrical for equal and opposite displacements. No experimental data appear at present available to show clearly the existence of this effect.

The proof of the reciprocity theorem for electron waves mentioned above, as well as a mathematical discussion of the difference in scattering caused by asymmetrically bound particles, will be given elsewhere. R. DE L. KRONIG.

Physisch Laboratorium
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Utrecht, Jan. 28.

The Extermination of Whales.

SIR SIDNEY HARMER, in an important paper (Linnean Society, May 24, 1928), directs attention to the wasteful way whales have been killed in the past and to the danger of exterminating them. As regards the Greenland whale, the facts seem to be worse than Sir Sidney states.

Scoresby, speaking of its capture in the Greenland Sea, says towards the end of the eighteenth century: "A striking epoch in the history of the fishing arose" . . . "two or three of the captains of the whale-fishing ships" . . . "instead of being contented with two or three large fish and (instead of) considering five or six a great cargo, set the example of doubling or trebling the latter quantity."

The increased activity thus initiated (which doubt-

less meant entering the ice to an increased extent) certainly led to the capture of a very large *number* of whales, but the statistics of the fishing prove that they yielded only a low average of oil and that many of them were of small size.

In the Greenland Sea between 1792 and 1822 Scoresby, senior, captured 533 whales and brought home (including some seal oil) 4664 *tuns* of oil, an average (without deducting anything for seal oil) of only 8·7 *tuns* (of 252 gallons, weighing about 17 cwt. 1 qr.) per whale against the 20 tons or more of the fully grown animals. Again, in the *Henrietta*, in the three seasons 1792, 1795, and 1798, he captured 79, which only boiled 457 *tuns*, or an average of only 5·6 *tuns* per whale.

The statistics of the Peterhead fleet tell the same tale; in the twelve seasons 1805–1816, the ships of this fleet captured 868 whales, which (possibly including some seal oil) yielded only 7195 *tuns*, or an average of only 8·3 *tuns* per whale.

The young whales are less wary and more easily approached than the old, and as they are often found at the edges of large unbroken fields with only confined spaces to rise and breathe in, their capture is usually easy; it was doubtless in favourable circumstances of this sort that in 1814 the *Resolution* caught 44, which averaged only about 5 tons, and that the same year the crew of the *John* captured 13 at a 'fall,' or without stopping to take a rest.

This wasteful method of carrying on the fishing soon made itself felt; up to about 1820 it remained productive enough and gave profitable employment to a large number of ships, but after that date it began to fall off, and but for the fact that the whalers had the seals to fall back on and were able to supplement their catches of whales, and for a rise in the price of whalebone, the fishing in this region would have ceased nearly a hundred years ago.

The following figures are taken from the record of the Peterhead fleet: 1800–9, average number of whales per ship per voyage, 16·8; 1810–19, 11·3; 1820–29, 7·2; 1830–39, 3·5; 1840–49, 2·1; 1850–59, 1·7.

In the Greenland Sea the Greenland whale was undoubtedly brought to a very low ebb before its pursuit was abandoned; in the 'eighties we seldom saw more than one or two at a time and seldom more than a dozen or two in a voyage. In 1890 only six were seen by all the ships, and in 1898 not a single one.

The following figures show how this branch of the trade, notwithstanding the high price to which whalebone rose, continued to decline: 1860–69 (disregarding a few killed by the Germans before they gave up the trade), 88; 1870–79, 75; 1880–89, 85; 1890–99, 38; 1900–9 (four seasons no ships in pursuit of them), 28.

At Davis Strait the sequence of events was similar to that which took place in the Greenland Sea. In this inlet the fishing commenced in 1719, and so long as it was confined to the east or Greenland 'side' the whales killed yielded a fairly high amount of oil (14 tons for the four years ending 1817) and must have been mostly of large size, but after the extension of the fishing to the 'west side' in 1820, consequent on Ross's voyage, the whales killed yielded a much smaller amount and must have been mostly of small size; for example, in the three seasons 1832, 1833, and 1834, the Peterhead ships captured 415, which on an average yielded only 7 *tuns* (equal to about 6 imperial tons) apiece, and in 1845 the *Joseph Green* killed 40, which yielded only 185 tons and a negligible amount of 'bone.'

This wasteful method of carrying on the fishing again quickly made itself felt, as the following figures taken from the records of the Peterhead fleet show: 1820–29, average number of whales per ship per annum, 9·5; 1830–39, 7·4; 1840–49, 6·6; 1850–59, 2·3.

The figures for the period 1820–50 would doubtless be higher if the ships (sailing ones) could always have got through Melville Bay and reached the west side and Ponds Bay in time; and after the introduction of 'steam' the figures again show an increase, but it was not long before they again began to decline.

In Davis Straits, as at Greenland, the whales were brought to a very low ebb, and it is very doubtful if they will ever recover the ground they have lost; the following figures speak for themselves: 1870–74, total number killed, 724; 1875–79, 343; 1880–84, 350; 1885–89, 76; 1890–94, 77; 1895–99, 58; 1900–1904, 68; 1905–1909, 31.

In the Greenland Sea the smallest whales were captured north of latitude 79°, at any rate north of 78° (in May and June) and in Davis Straits mostly at the mouths of Lancaster Sound and Ponds Bay (in June and July), and if the whalers had refrained from capturing in these situations, these branches of the whale-fishery would undoubtedly have continued productive, and an interesting and valuable animal saved from almost total extinction. Cannot the fin-whales be protected in some such way?

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Retardation of the Ripening of Pears by the Exclusion of Oxygen.

IN view of the interest taken by growers and merchants in England and in South Africa in the possibilities of a new process for the handling of quickly ripening pears in sealed tins or in sealed and punctured tins, the following observations on the behaviour of pears in an atmosphere of nitrogen may be of scientific interest and practical importance.

As a rule, pears are gathered whilst unripe and hard. The yellowing, sweetening, softening, and

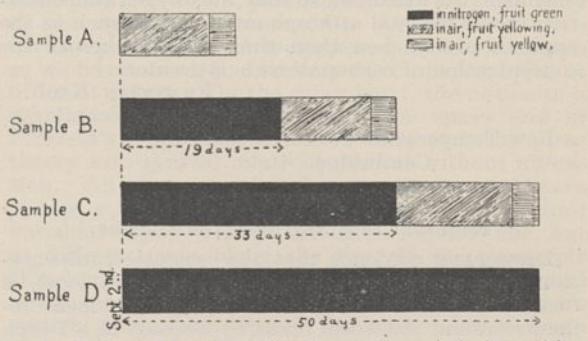

FIG. 1.—Prolonging the storage life of pears (Souvenir de Congres) by holding them in nitrogen. Although normal in appearance when removed from nitrogen after 50 days, sample *D* failed to ripen normally when removed to air.

development of juiciness and final mealiness take place in storage. In some varieties, such as the well-known Williams' Bon Chrétien or Bartlett, these changes are very rapid; in others, such as the Winter Nelis, they are slow.

If oxygen be withheld by sealing up pears in a gas-tight container over alkaline pyrogallol (an absorbent of carbon dioxide and oxygen) almost complete inhibition of the various macroscopic changes which are termed 'ripening' is brought about.

We have in this way kept in a hard green condition for several months varieties of pears which in air at ordinary room or shed temperatures softened and decayed within a week or two. The appearance of the fruit on removal after several months' storage in nitrogen was remarkable, being identical with that

shown by the fruit when placed in the sealed container. The pears, moreover, were edible and free from objectionable flavour, nevertheless they proved disappointing because they failed to yellow, ripen, and develop juiciness and the typical pear flavour.

The above is the result obtained in the extreme case of prolonged exposure to conditions of oxygen starvation. Practical and theoretical interest, however, lies in the fact that the retardation of subsequent ripening in air is a function of the time of exposure, so that by adjusting the time of exposure we can change a quickly ripening fruit into a more slowly ripening one which may attain a quality equal to that of untreated fruit.

The original observation of this phenomenon was made by us several years ago. Samples of fruit from some of the original experiments, together with the chart herewith presented, were exhibited in the Ministry of Agriculture's Demonstration Tent at the annual fruit show of the Eastern Counties Commercial Fruit Show Association held at Wisbech in the autumn of 1920.

An investigation of the effect of the variables—oxygen, carbon dioxide, and temperature—on the changes that occur in fruit during storage has since been carried out, and some of the results obtained have been described in Reports Nos. 12 and 30 of the Food Investigation Board. The rate of ripening is a function of the concentration of oxygen and of the concentration of carbon dioxide over a considerable range. Suitable concentrations of sub-normal oxygen and super-normal carbon dioxide can be obtained simply by restricting and regulating the ventilation of the stored fruit, and a crude method of doing this is to use a tin container with a small puncture in it.

Such a method is merely an extension to fruit in bulk of a mechanism with which each fruit is provided by Nature. Ventilation of the interior of individual fruits is restricted by the presence of a relatively impermeable skin with numerous small openings (the lenticels), so that the oxygen concentration in the internal atmosphere of a fruit such as the apple is always less than that in air, whereas the concentration of carbon dioxide is greater.

FRANKLIN KIDD.
CYRIL WEST.
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Regional Isostasy over the Oceans.

IMPORTANT evidence that the isostatic compensation over ocean areas is regional, and not local, is furnished by the remarkable series of gravity measurements around the world made by Meinesz in a Dutch submarine, the results of which have just been published by the Geodetic Commission of Holland ("Détermination de la Pesanteur en Mer," Delft, 1928).

The provisional anomalies for 128 stations on the sea are given, reduced by several different methods. One of these, the Hayford, is based on the hypothesis of complete local isostatic compensation. These results add to the proof I have given that this hypothesis leads to appreciable error, as it is in conflict with known properties of crustal material.

Meinesz made gravity determinations over the greatest ocean depths, including the Guam and Philippines Deeps of 8740 metres (5½ miles). The station over each of these Deeps may be combined with a neighbouring shoal water or port station to form a pair, with greatly different ground elevations. There are seven such pairs of stations, which have depth differences of from 3600 to 8740 metres, with horizontal distances of from 23 to 83 miles only.

These ocean pairs show the same effect that I first pointed out in 1912 from similar land pairs of stations; when the Hayford anomaly for the valley station is subtracted from that for the high station the predominating difference is distinctly positive; the differences are +0·119, +0·103, +0·043, +0·102, +0·045, −0·031, and +0·064 dyne. The positive difference is the effect of over-compensation of the high station and under-compensation of the low station, resulting from the Hayford hypothesis. The average effect for these seven pairs is +0·0016 dyne for each 100 metres difference in elevation, after reducing the water depth to its equivalent in crustal material. This fact, and a rough test, show that the results for these stations will be more consistent when a regional reduction is used. This confirmation of regional isostasy by ocean observations is important, as these stations near the surface of the sea are more free from various suggested causes of local disturbance than are the corresponding land stations.

This work of Meinesz and others shows that there is still a wide field for gravimetric research as to the earth's crust. To facilitate such research the reduction methods should be put in order. They should have less confusing designations. The most used reduction is variously called 'Faye,' 'free air,' or 'elevation only,' but more often is not named at all. 'Isostatic,' unqualified, is improperly applied to a method based on an extreme and untenable hypothesis; isostasy is a general theory, there are already a number of isostatic reductions, and there is no reason to restrict this designation to a particular brand of isostasy. Some degree of regional isostasy must be taken into account. Agreement on a convenient unit designation for 'g' is needed; 'dyne' is objected to, but 'cm./sec.^{2}' is an awkward expression for so important a unit. In investigations involving so many possible variants, as do these affecting the earth's crust, the value of differential methods should be recognised; one example is the above method of using pairs of neighbouring stations, and another would be the study of ocean and land conditions by comparison of groups of level area stations nearly in one latitude, thus eliminating uncertainties in the basic formulæ.

GEORGE R. PUTNAM.
U.S. Department of Commerce,
Washington, D.C.
Dec. 20,

Pre-Palæolithic Implements.

IN NATURE of Feb. 16, p. 257, after some comments upon my recent paper in *Proceedings of the Prehistoric Society of East Anglia* (vol. 5, pt. 3) on the further discoveries of Chellean implements derived from the base of the Cromer Forest Bed, it is stated that "it may not be out of place to direct attention in this connexion to some remarks on the subject of tertiary man in *Man* for January."

I may, however, perhaps be permitted to express my disagreement with this conclusion. To begin with, though the comments in NATURE appear under the title "Pre-Palæolithic implements," the specimens described in my paper mentioned above are definitely of palæolithic age.

Secondly, as I have endeavoured to make clear on several occasions, I regard the Cromerian industries as of Early Pleistocene antiquity, and that therefore they can have no relation to any supposed problems as to the former existence of tertiary man.

Thirdly, rostro-carinate implements had been superseded by the hand-axe in Chellean times, and are, in consequence, almost unknown upon the foreshore sites under discussion, from which it follows that to attempt to involve the fundamentably different speci-

mens from these sites in the still smouldering but much enfeebled controversy as to the human origin of the rostro-carinates is futile.

A perusal, on the part of the writer in NATURE, of my papers on the flint implements from the Cromer Forest Bed should have made these various points abundantly clear. J. REID MOIR.

One House, Ipswich.

Dr. H. J. H. Fenton.

MY friends C. T. H. and W. H. M. have given in NATURE of Feb. 16 a most sympathetic account of their late colleague, Dr. Fenton. Beyond the University of Cambridge, however, there are not a few who would wish to pay tribute to his memory—especially to his greatness as a teacher. It was my good fortune to know Fenton almost intimately from an early date. We were fellow examiners in natural science at Cambridge and together gave the present master of Pembroke the degree which he has since so well shown to be a proper apprizement: it is always interesting to have early judgments verified.

Fenton was never a mere teacher of science. A man of truly scientific mind, he sought to train his pupils to be scientific, something very different. Never a believer in gods, a hater of dogmatism, he was careful to present each problem in its varied aspects, asking his hearers to balance the evidence for and against any particular conclusion—leaving them, having paid their money, to make their own choice, then with reserve. He did this with an air of aloofness, in an apparently affected, lackadaisical but actually very deliberate way, which was most arresting; time was given for what he said to soak in, a challenge to consider his argument. Fluent lecturers are rarely good teachers. I remember my son, as a medical student, being deeply impressed by his teaching—picking him out as the one lecturer worth hearing. If there were only a few teachers such as he was, the position of our science would be far higher; it would be a judicious and logical discipline.

Fenton's discovery of dihydroxymaleic acid—a true discovery—was one of the most masterly pieces of experimental work ever done, the importance of which has yet to be fully appreciated. Having in some way, in early days, fallen foul of authority, outside the Chemical Department he was never held in favour. This he bitterly resented. His queerness was not a little due to the failure of the powers that were to accord him the sympathetic recognition which he knew was owing to his services and achievements. Let us hope that someone will come forward as his biographer and display his method in all necessary detail.

HENRY E. ARMSTRONG.

An Iodine Liberator from Laminariæ.

THE evidence which Prof. Dillon brings forward in his letter (NATURE, Feb. 2, p. 161) does not entirely warrant his conclusion that the agent present in an acidulated extract of *Laminaria* fronds which liberates iodine from potassium iodine is an *organic* substance.

Inorganic oxidising agents exist, dialysable but relatively heat-labile in presence of organic matter, which might occur in his extract, and would account for his experimental findings. One of these, sodium (or potassium) *iodate*, which in pure aqueous solution in quantities containing only 0·1γ iodine, or even less ($\gamma = 10^{-6}$ gm.), will liberate, in presence of slight excess of potassium iodide and dilute sulphuric acid, free iodine in sufficient amount to be detected by shaking the reaction mixture with a drop of chloroform, or by the addition of starch solution. In view of the large quantity of iodine in various states of combination in these algæ, and the relative ease with which iodate may be formed, the presence of small quantities of this salt is not altogether unlikely. Iodate and iodide could co-exist in the neutral or faintly acid environment of the algal tissues, but would react when the tissue or tissue-extract was rendered distinctly acid.

If results obtained using mammalian tissue-extracts are any guide to the behaviour of plant extracts, there is little doubt that a very minute addition of an iodate to the *Laminaria* extract would reveal itself as a potent 'iodine liberator,' would be dialysable, and would have the same order of heat-lability as was found for this agent by Prof. Dillon. The original extract would probably be found to be rather less active than the outer liquid after dialysis, since the former contains organic substances of high molecular weight which would be expected to combine readily with traces of free iodine, and thus inhibit to a greater or lesser degree the phenomenon of iodine liberation. It would appear that iodate, at least, should be shown to be absent before the organic nature of the iodine-liberating agent can be satisfactorily maintained.

H. D. KAY.

Medical Unit,
London Hospital,
Whitechapel, E.1, Feb. 8.

Unified Field Theory of Electricity and Gravitation.

MAY we be permitted to direct attention to a certain aspect of Einstein's three recent papers (*Berliner Berichte*, pp. 217, 224, 1928; Feb. 1929) on distant parallelism which came to light in a discussion with Prof. D. J. Struik? The avowed aim of these papers is to develop an improved unified field theory of electricity and gravitation. A much more pressing need of general relativity theory is a harmonisation with quantum theory, particularly with Dirac's theory of the spinning electron. On the basis of Levi-Cività's parallelism the task seems hopeless, inasmuch as we have no adequate means of comparing spins at different points. On the other hand, the notion of a parallelism valid for the whole of space and of Einstein's n-uples enables us to carry over the Dirac theory into general relativity almost without alteration. All that we need do is to interpret Dirac's p_0,p_1,p_2,p_3 not as differentiation with respect to four variables x,y,z,t defined throughout space-time, but as differentiation along the lines of the quadruple (Einstein's '4-Bein'). That is, the quadruples need not be integrable so as to furnish us with a co-ordinate system throughout space, for such a co-ordinate system is absolutely inessential in the proof of the invariance of Dirac's equations under a Lorentz transformation.

In other words, the quantities ${}^s h_\lambda$ of Einstein seem to have one foot in the macro-mechanical world formally described by Einstein's gravitational potentials and characterised by the index λ, and the other foot in a Minkowskian world of micro-mechanics characterised by the index s. That the micro-mechanical world of the electron is Minkowskian is shown by the theory of Dirac, in which the electron spin appears as a consequence of the fact that the world of the electron is not Euclidean, but Minkowskian. This seems to us the most important aspect of Einstein's recent work, and by far the most hopeful portent for a unification of the divergent theories of quanta and gravitational relativity.

NORBERT WIENER.
M. S. VALLARTA.

Massachusetts Institute of Technology,
Cambridge, Massachusetts, U.S.A.,
Feb. 7.

The Electronic Charge *e*.

PROF. A. S. EDDINGTON has recently (*Proc. Roy. Soc.*, A, **122**, 358; Jan. 1929) deduced a theoretical value of 136 for the well-known ratio $hc/2\pi e^2$. The reciprocal of this ratio is usually denoted 'the fine-structure constant a.' Without presuming in any way to judge the theory on which this value is derived, I should like to make a few remarks as to the numerical result. The value of the velocity of light c is known with great accuracy ($c = 2{\cdot}99796 \pm 0{\cdot}00004$). On the other hand, the value of the Planck constant h depends primarily upon the value of the electronic charge e, and the probable error in h is almost entirely due to the probable error in e. Every method for evaluating h involves e to a positive power varying from unity to two. The average power depends upon the adopted relative weighting of the different methods. These facts regarding the connexion of e and h I discussed some years ago (*Phys. Rev.*, **14**, 361; 1919).

I am at the present moment just finishing a critical investigation of the probable values of the general constants of physical science, and a detailed account of this work will be published shortly. At the present time my adopted value of h depends, in the mean, on the 1·236 power of e. Hence the *ratio* h/e^2 varies as $1/e^{0{\cdot}764}$. The change in this ratio demanded by Eddington's theory is approximately 1 per cent downward (0·94 per cent, using my own adopted values of e, h, and c). Accordingly, such a change requires an increase in e of approximately one and one-quarter per cent, and a resulting increase in h of about one and one-half per cent, in contrast to a one-half per cent increase in e (and *no change* in h) assumed by Eddington as required. In my opinion the commonly accepted value of e has a probable error of roughly 0·1 per cent, and it is accordingly extremely improbable that the true error is more than twelve times as great.

RAYMOND T. BIRGE.

University of California, Feb. 2.

The Boundary of the Solar Chromosphere.

THE question of the sudden ending of the chromosphere or its gradual fading away in accordance with Prof. Milne's theoretical views may not yet be settled finally by observation. Mr. R. W. Gurney is, however, under a misapprehension (NATURE, Feb. 16, p. 240) in thinking that the bright K line studied by Mr. P. A. Taylor and Mr. McCrea up to a height of nearly 100,000 km. above the sun's limb was thought to be an ordinary chromospheric line. The tangential slit happened to fall across a high prominence and the measures refer to the portions of the slit lying on the prominence, which gave a regular fading away with height; one or two obvious brightenings had to be ignored, where structure in the prominence complicated the issue. These points were easily recognised in the picture of the prominence shown in the second flash spectrum which was obtained with an objective prism.

The difficulty of the scattering of light in our atmosphere is not easy to meet, but evidence from our other plates, for example, the objective prism spectra, does not point to any serious trouble in our case. We had the good fortune to observe the sun in a perfectly clear hole in a somewhat cloudy sky. Messrs. Miller and Marriott, half a mile away, observed through thin haze. The heights of the chromospheric lines proper, which we published, were taken from the arcs given by the objective prism spectrograms of the flash, and these would not be seriously affected by light scattering. Incidentally, it may be added, they are not inconsistent with Mr. Gurney's views.

F. J. M. STRATTON.
C. R. DAVIDSON.

Feb. 18.

An Isotope of Oxygen, Mass 18.

THE weak doublets of the atmospheric absorption bands of oxygen have been found to originate from a molecule consisting of an oxygen atom of mass 18 combined with one of mass 16. The interpretation recently published by Mulliken (*Phys. Rev.*, **32**, 880; 1928) for the strong bands holds in every detail for the weak band. The isotopic rotation–zero point vibration doublets have been calculated by means of the equations of Loomis (*Bull. Nat. Res. Council*, 2, chap. v.; 1926) and the atmospheric absorption data of Dieke and Babcock (*Proc. N.A.S.*, **13**, 670; 1927). The vibrational frequency used for the lower state is that calculated by Birge (*Bull. Nat. Res. Council*, 2, 232; 1927) from the available data. From the above, the formulæ for the separation of the isotopic doublets in the four P and four R branches is as follows:

$$\Delta\nu_P = 2{\cdot}12 + 0{\cdot}0556[B''m^2 - \beta''m^4 - B'(m-1)^2 + \beta'(m-1)^4]$$

$$\Delta\nu_R = 2{\cdot}12 + 0{\cdot}0556[B''m^2 - \beta''m^4 - B'(m+1)^2 + \beta'(m+1)^4]$$

$$m = \tfrac{3}{2}, \tfrac{7}{2}, \tfrac{11}{2}, \text{ etc.}$$

The constants as given by Dieke and Babcock are

$$B'' = 1{\cdot}438 \qquad \beta'' = 6{\cdot}31 \times 10^{-6}$$
$$B' = 1{\cdot}390 \qquad \beta' = 5{\cdot}75 \times 10^{-6}$$

The average deviation of observed minus calculated separations is $-0{\cdot}05$ cm.$^{-1}$. The maximum deviation is $-0{\cdot}13$ cm.$^{-1}$. This is well within the limit of accuracy of the data. No other isotope of oxygen combined with an atom of mass 16 will satisfy the data. The data show that the normal state of the oxygen molecule has one-half unit of vibration in agreement with the wave mechanics theory.

W. F. GIAUQUE.
H. L. JOHNSTON.

Department of Chemistry,
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Intercombinations in the Arc Spectrum of Carbon.

PROF. A. FOWLER and E. W. H. Selwyn have recently classified the lines of the arc spectrum of carbon, and identified triplet as well as singlet terms, but no intercombinations have apparently been obtained. Recently I took a heavy arc spectrum of Acheson graphite in the region λ2000, and obtained a number of lines, some new, and others recorded by previous observers like McLennan, Hutchinson, and others. I was able to identify the following intercombination lines:

	Classification.	Transition.
51313	$^1\overline{D}_2 - {}^3\overline{P}_1$	$(2L_2 \leftarrow L_2M_1)$
51356	$^1\overline{D}_2 - {}^3\overline{P}_2$	(,,)
39862	$^1\overline{S}_0 - {}^3\overline{P}_1$	(,,)

This enables us to calculate the exact differences between the fundamental levels $^3P_{012}$ and $^1D_2$, $^1S_0$ of $2L_2$. We get $^3P_1 - {}^1\overline{S}_0 = 20474$, while according to Fowler and Selwyn it is 21142. Taking Fowler's $^1D_2$ value as the more correct, the values of fundamental ^3P terms have to be decreased by 667 cm.$^{-1}$. We have also lines conforming to the inner-transitions $(L_2L_2 \leftarrow L_13L_2)$; from the new lines I have also obtained identification of some of the $(2L_1L_2M_1 \leftarrow L_12L_2M_1)$ transition lines.

The frequency difference $^3P_1 - {}^1S_0 = 20474$ corresponds to the wave-length λ4884·2, and I could get no such line in the coronal spectrum.

DATTATRAYA SHRIDHAR JOG.

Physics Department,
Allahabad University.

Aspects of Fossil Botany.[1]

By Dr. D. H. SCOTT, F.R.S.

I. FERNS AND SEED FERNS.

THE fact that many of the well-known fern-like fossils of the Carboniferous formation were not ferns at all, but true seed-bearing plants, has long been familiar to students of palæobotany. It is a quarter of a century since the recognition of the seeds of *Lyginopteris oldhamia* by Prof. F. W. Oliver first led to the institution of the class Pteridospermeæ, or, in popular language, seed ferns. Yet, after this lapse of time, and in spite of all the attention given to the subject, much still remains obscure. We are still ignorant of the relation between true ferns and seed ferns, either as regards their respective importance in Carboniferous times, or the degree of affinity between them.

The early discoveries, in *Lyginopteris*, *Neuropteris*, *Aneimites*, and *Dicksonites*, cast doubt on such extensive groups of supposed ferns, that the impression was soon created that a majority of the Carboniferous 'ferns' were, in reality, seed-plants. At the present time even the great tree-ferns, the so-called Marattiaceæ of the Coal-measures, are called in question: Were they ferns or Pteridosperms?

Since the original discoveries of 1903–5, a number of additions have been made to our knowledge of seed-bearing plants of fern-like habit. Cases of direct continuity of seed with frond have been demonstrated in a further species of *Neuropteris*, in a *Sphenopteridium* and in a *Sphenopteris*, the two latter of Lower Carboniferous age. Prof. Halle, in his important investigation of the fossil flora of China, has already discovered five new cases of the kind, in the Permo-Carboniferous beds of the Province of Shansi, in northern China. One of his discoveries must be specially considered, for it has a direct bearing on the position of the supposed Marattiaceæ of the period.

The plant is *Pecopteris Wongii* (named after a Chinese colleague). There seems to be no doubt that one seed at least is attached to the rachis of the frond, while others are so grouped as to suggest a connexion. The seed is an ovoid body about 7 mm. in length. The case is a critical one, for the new species is almost identical with the well-known *P. Miltoni*, which has the fructification of *Asterotheca* and is therefore referred to Marattiaceous ferns. If it were positively known that *P. Wongii* bore the sporangia of *Asterotheca* as its male organs, the new species would afford the strongest evidence in favour of the transference of the Carboniferous 'Marattiaceæ' to the Pteridosperms.

In *Nystroemia*, a new genus, both sporangia and seeds were found, on distinct specimens, almost certainly belonging to the same plant. This plant thus appears to be one of the rare and fortunate instances in which both sexes are known in the same Pteridosperm.

The most important, however, of the new Pteridosperms is undoubtedly the American genus *Eospermatopteris*, described by Miss Goldring. It is of Upper Devonian age, and is thus the oldest known seed-bearing plant. To avoid repetition, *Eospermatopteris* will be considered in the following article, devoted to early floras.

The male or pollen-bearing organs of the Pteridosperms are of special importance in the present survey, for it is chiefly on them that the comparison with the contemporary tree-ferns, the so-called Marattiaceæ, depends.

The original discovery, by Kidston, of the *Crossotheca* fructification of *Lyginopteris* is well known. The fertile pinnules are oval leaflets bearing pendulous sporangia or pollen-sacs on their lower surface. The peculiar feature is the bilocular structure of each pollen-sac, a point difficult to demonstrate in the imperfectly preserved material. Indirect confirmation is, however, afforded by clearly bilocular sporangia observed by Prof. Oliver in petrified specimens of other fructifications. Some doubt has been cast on the identification of the frond; Zeiller, however, accepted it as the foliage of *Lyginopteris*. The genus *Telangium*, founded by Dr. Margaret Benson, differs from *Crossotheca* in the sporangia standing erect on the end of the stalk, instead of being pendulous. Dr. Benson thought that her species, *T. Scotti*, was the male fructification of *Lyginopteris oldhamia*. It may have belonged to some allied plant, but the sporangia are not bilocular. Various other fructifications, preserved in the form of impressions, have been referred to *Telangium* and regarded as the male organs of Pteridosperms.

Our knowledge of the supposed male fructifications of seed-ferns is often unsatisfactory, owing to the obscurity of fossils preserved as structureless impressions. Kidston's case of *Neuropteris Carpentieri* is one of the best, for here the fertile pinnules are on the same frond with the sterile leaflets, differing somewhat from them in shape. The densely packed sporangia contain a quantity of spores—no doubt the pollen-grains. In *Potoniea* the large orbicular discs have been shown to bear sporangia. This genus probably represents the male fructifications of species of *Neuropteris*.

It may be said that the polliniferous organs of the Pteridosperms, where known, are almost constantly borne on specially modified pinnules or on a naked rachis. The only case in which they have been found, as it appears, on the unaltered frond, is that of *Dicksonites Pluckeneti*, to which we shall return.

It has hitherto been generally assumed that there existed, in Carboniferous and Permian times, a considerable body of true ferns, side by side with the Pteridosperms, or seed-plants of fern-like habit. The true ferns were regarded as including three groups, the Primofilices, the great tree-ferns of the

[1] Based upon a short course of lectures delivered at University College, London, last autumn.

Upper Carboniferous, and a few others, such as the Permian Osmundaceæ.

The Primofilices are undisputed, and so are the Osmundaceæ of the late Palæozoic. The great problem is that of the tree-ferns commonly referred to the Marattiaceæ. These plants had tall stems, reaching at least 60 feet in height, clothed with a felt of descending roots. The highly compound fronds were of the *Pecopteris* type, resembling species of *Cyathea* among living ferns. The stems, known as *Caulopteris* or *Megaphyton* by their external features, as *Psaronius* when the structure is preserved, bore the large and conspicuous leaf-bases, and had a completely fern-like anatomy, usually with many concentric steles. There is a general, though not an exact, anatomical resemblance to the recent Marattiaceæ, and this is also shown in the polyarch roots.

The fructifications, in most cases borne on the underside of the fronds, are also Marattiaceous in type, the sporangia of each group being united together in various degrees, to form synangia. In most of the genera the sporangia are grouped about a centre, the synangium thus being more or less circular, as in the recent *Kaulfussia*. In *Ptychocarpus* they are completely united, and so also in a genus *Cyathotrachus*, discovered by Prof. Watson. In *Asterotheca*, of which many species are known, the sporangia are only slightly connected at the base, and the synangia are seated directly on the frond. In *Scolecopteris* the arrangement differs in the fact that the synangium (of four or five sporangia) is borne on a definite pedicel. In *Acitheca*, often included under *Scolecopteris*, a pedicel is present, but the sporangia are not seated on it but merely fixed around it.

I have recently observed a new species of *Scolecopteris*, and propose to name it *S. Oliveri*, after Prof. Oliver, who brought the material in which the specimens occurred from Autun. The sporangia are elongated, regularly four in each synangium; the most characteristic feature of the new species is that each fertile pinnule is immediately subtended by an apparent sterile pinnule, exactly fitting on to its lower side. It is probable that the two bodies are parts of one and the same pinnule, strongly incurved on itself.

So far, everything in these plants seems fern-like and much suggests the Marattiaceæ. Yet the highest authority, Dr. Kidston, in his latest work, expressed grave doubts as to the nature of this group. His opinion is stated in his great series of memoirs on the "Fossil Plants of the Carboniferous Rocks of Great Britain," which were in course of publication at the time of his death. In his first memoir, Dr. Kidston was still inclined to accept the current view, for he then thought it tolerably certain that the typical Pecopterids, with exannulate sporangia united into synangia, were ferns (Part 1, p. 17; 1923). In a later memoir, issued the same year, his tone is more doubtful, but he still allowed that *Asterotheca* and probably a few other Carboniferous plants that bear exannulate sporangia "may be Marattiaceous" (Part 4, p. 277). In the next memoir Dr. Kidston left the systematic position of *Asterotheca* an open question, but added: "The generic differences which separate *Scolecopteris* from *Asterotheca* are those of degree rather than of structure. The former genus I believe to be more probably a Pteridosperm than a fern" (Part 5, p. 483; 1924). Thus one important genus was already given up, and it was becoming clear that its companion must follow. Lastly, in the final memoir so far issued, Dr. Kidston stated that the affinities of *Acitheca* seemed to him to be Pteridospermous, and if so, that he could not see on what grounds *Asterotheca* and *Scolecopteris* could be excluded from the Pteridosperms. "It would therefore appear that the evidence in support of the occurrence of Marattiaceous Ferns in Carboniferous times rests on supposition, rather than on satisfactory proof" (Part 6, p. 538).[2]

We thus have to face the question whether true ferns (apart from the special group of the Primofilices) existed in the Carboniferous period. We can come to no conclusion, but may briefly sum up the arguments on either side. In favour of fern-affinities of the plants in question we have:

(1) The habit (unimportant, for undoubted Pteridosperms are just as fern-like); (2) the fructifications, almost the same as in living Marattiaceæ, and, as in them, usually borne on the ordinary frond; (3) the anatomy of stem and root, both altogether like that of ferns, and especially of Marattiaceæ.

Thus, in every respect, these Carboniferous plants appear like ferns. But the following are the arguments on the Pteridosperm side:

(1) The resemblance of the synangia of these plants to those of *Telangium*: this appears to be the point which chiefly influenced Kidston, *Telangium* being regarded as the male fructification of certain seed ferns; (2) *Crossotheca*, known in one case to have been the male fructification of a Pteridosperm, also occurs on Pecopterid fronds; (3) *Dicksonites* (=*Pecopteris Pluckeneti*), once universally accepted as a fern, probably Marattiaceous, is now known to have been a seed-bearing plant; (4) the instance of *Pecopteris Wongii*, already discussed, may prove to be conclusive, but the case is not yet closed.

Dicksonites is at present the only plant of the so-called Marattiaceous group which has been definitely proved to be a Pteridosperm. It is therefore of critical importance. The pollen-bearing organs are somewhat obscure. They appear to have been borne on the ordinary leaflets and to have consisted of tufts of sporangia, which Kidston compared to the synangia of *Telangium*. It would be of the utmost value to learn the anatomy of *Dicksonites* to compare with that of *Psaronius*, the type of stem referred to the 'Marattiaceæ.' In the absence of such knowledge, a comparison of the cuticular structure might throw light on the question. If *Dicksonites* showed complete agreement with the remaining "Marattiaceæ," we could scarcely doubt that all alike were Pteridosperms. This, however, is not yet proved.

In the meantime, an anatomist must continue

[2] Parts 5 and 6 were issued posthumously.

to be influenced by the old anatomical evidence from the completely fern-like structure of the *Psaronius* stems and roots. If *Psaronius* belonged to seed-plants, comparative anatomy would be discredited. Yet it has proved its value, for it was anatomical data which first put us on the track of the Pteridosperms, before the seeds were discovered.

The question of the evolutionary relations of the Pteridosperms, whether they were "ferns which had become Spermophytes" or an independent line of descent, cannot be settled until we know whether the tree-ferns of the Carboniferous were ferns indeed or seed-plants simulating them. A seed-bearing *Psaronius* would go far to resuscitate the former hypothesis, which of late years has seemed the less probable of the two. No such case, however, is as yet demonstrated. The whole question is in urgent need of further investigation.

Geometrical Art in South-east Europe and Western Asia.

By Prof. JOHN L. MYRES.

BETWEEN the vivid naturalism of Minoan art, the mature style of Crete and the South Ægean in the later Bronze Age, and the serene idealism of Hellenic art, in the great centuries from the sixth to the third, intervenes a style profoundly contrasted with both, popularly known as the Geometric Style of the Early Iron Age. It inherited something from Minoan art, and contributed more than appears at first sight to Hellenic; but in its maturity it was the negation of all that either Minoan or Hellenic craftsmen aspired to express. Such a group of facts, or sequence of events, presents a problem as fully worthy of scientific treatment as any crisis in geology or natural history: the problem, namely, of the apparitions and disappearances of geometrical art in the lands around the Greek archipelago. For the geometrical art of the Early Iron Age was not the only such occurrence; and its significance is best appreciated by comparison with other geometrical styles.

What we call style is approximation to a standard of achievement; and perfection of style is beauty in art. Geometrical styles come into being in various ways. In primitive Crete, as in other parts of the Mediterranean, vessels of clay were decorated with ornaments which were linear because incised, and rectilinear because they imitated basketry. Such skeuomorphic ornament is not 'geometrical' so long as its imitative intent is obvious; it becomes so as this intent is superseded by appreciation of the linear designs as pure forms and spatial constructions. Before this stage was reached in Early Minoan art, these linear designs were superseded by more or less naturalistic representations of plants and animals, scarcely restricted at all except by the surface of the decorated object.

Similarly, the painted pottery of Thessaly, probably derivative from a widespread Ukrainian culture between Danube and Dnieper, is decorated with lines and bands the prototypes of which—textiles or leatherwork—are uncertain, but the application of which, with utter disregard of the forms of the vessels, is the antithesis of early Ægean 'skeuomorphs.' This primitive style also perished early (with one possible exception) in conflict with the paintless 'gray-ware' of Orchomenus, and the almost paintless 'smear-wares' (*Urfirniss*) of the Greek mainland.

East of the Ægean, in the heart of Asia Minor, another painted linear style, still imperfectly known, influenced Syria and Cyprus late in the Bronze Age. It may be connected either with the Ukrainian culture or with that of Susa and other sites in the Persian hills and early Babylonia. It does not, however, seem to have affected the coast cultures of the Ægean until the Early Iron Age, and even then but slightly.

After great naturalistic achievements, Minoan ornament declined into mechanical and conventional abbreviations, and broke up into numerous local schools, during the troubled centuries from 1400 B.C. to 1100 B.C. or later; and it is as the sequel to this artistic collapse that the Greek geometrical style comes into being. It has been commonly supposed that the new style was introduced into Greek lands by 'northern invaders' from beyond the Danube, or at all events from Danubian countries. But recent discoveries, especially in Macedonia, have shown that, though an invasion occurred about 1100 B.C., its range was restricted, its effects were transitory, and the culture it introduced temporarily had no geometrical elements, other than a fondness for compass-drawn concentric circles, which had a fairly wide vogue in the mature geometrical repertory of the Ægean, and a far more general popularity in the contemporary art of Cyprus, where there is some reason to suppose that it arrived overland through Asia Minor from the same south-east European source. A second suggested source for the geometrical style of the Ægean is in certain scattered and belated survivals akin to the primitive Thessalian decoration, which have been detected in north-western Greece: and as the 'Dorian' invaders of peninsular Greece were traditionally derived from this region, these may represent the decorative style which they had before they came south.

It is difficult, however, to reconcile this explanation either with the sequence of styles in stratified deposits at Sparta, the most purely Dorian state in historic Greece, or with the geographical distribution of more or less geometrical styles in the South Ægean, or (most significant of all) with the very early and emphatic outbreak of geometrical art in Attica and its neighbourhood, which traditionally had been the refuge and rallying ground of non-Dorian and pre-Dorian elements from all parts of the invaded area. That the colonies propagated

[1] Summary of a discourse at the Royal Institution on Friday, Feb. 1.

overseas by these 'Ionian' refugees in conjunction with inhabitants of Attica itself did not share in that geometrical outbreak, is explained if it occurred after their founders had left Attica; and this is in accord with the contrast between Ionian and Attic types of safety-pin, and other elements of culture, and the similarities between Attic safety-pins and those of other districts where geometrical styles were established more or less effectively. Provisionally, therefore, the geometrical style may be regarded as an indigenous and local creation of that area of east central Greece where the disturbance and intermixture of older elements in the population seems to have been most intense; and as the artistic expression of the view of life enforced by the stresses of that crisis.

Characteristic of all geometrical art is the abstract quality of its ornaments: they represent no longer, nor even symbolise, any natural object, but have value through their mere forms or the relation which these forms bear to other forms which comprise them. Frequently an ornament and its background counterchange their functions; and secondary patterns emerge, such as the 'key-fret' and 'wave-coil,' wherein it cannot be said that there is neither design nor background, but only a positive and a negative element—for example, a black and a white—the combination of which *is* the pattern. In this aspect the Greek geometrical style was not so much a tradition as an invention; the first self-conscious, rationalist style in the history of art. The mere surface of the object, at the frontier between being and not-being, *plenum* and void—the form of the object, in complete abstraction from its substance—becomes itself the subject of artistic treatment; anticipating, and perhaps preparing the way for, the philosophical treatment of the same antithesis between form and substance.

A second characteristic is the rhythmical quality of the means employed to distinguish part from whole—the 'many' from the 'one' which they constitute—and attention is directed to the relation between the geometrical art of early Greek craftsmen—including the temple-architects—and the metrical inventions of epic and lyric poetry, the only other aspects of the higher life of that age which have been preserved.

Thirdly, the geometrical experiments in composition and artistic structure in two dimensions (whereas the frieze compositions of the Near East and Asiatic Greece, however elaborate, were essentially in linear series) initiates the progress of Attic and Argive schools of design, of architecture, and eventually of sculpture towards the ideals so nearly attained in the sixth and fifth century: to types of literary compositions best illustrated by Attic tragedians and the fifth century historians; and to remarkable experiments in political reconstruction of certain Greek city-states, and philosophical analysis of the structure of society and of Nature itself.

An Epic of Fastness.

MR. JAMES MORTON is an artist, an enthusiast, and a man of imagination, and yet he has chosen to be a textile manufacturer. With such a combination of qualities, there is little wonder that within scarcely more than two decades he has been responsible for an amazing change in the standard of colour fastness as applied to woven fabrics. More than to any other man do we owe it to him that to-day the colours of our fabrics are as sound and as permanent as the fibres of which they are made. The story of this development and that of the necessary dyes is unfolded in simple and almost poetic language in a paper read recently before the Royal Society of Arts [1]; it is one which should be read by every student of the present generation as worthy of ranking with similar stories of the great achievements of inventive industry in the past.

It was in 1902 that Mr. Morton, whose firm were makers of high-class furnishing fabrics, was impressed by the fugitive nature of the colours used, and in consequence was led to make exhaustive fading tests on coloured textiles from every source. The uniformly adverse result of these was staggering. It led Morton to institute a constructive campaign which has definitely left a permanent impression on the textile trade of the world. The scheme was to arrive at a range of colours, however small, from which fabrics could be prepared and guaranteed against fading from sunlight or ordinary washing. These, under the descriptive name of 'Sundour' fabrics, were first distributed by Messrs. Liberty in 1904. The early palette had a modest range of colours; it was greatly helped by the discovery in Germany of the first of the indanthrene vat colours about this time, whilst, in turn, the scope for these vat dyes was greatly increased by the market which the 'Sundour' fabrics had helped to create for them.

By 1914 the fadeless fabric business was firmly established with a world-wide reputation, when on the outbreak of War the manufacturers found themselves suddenly deprived of the supply of German dyes. How Morton first visited other dye-making concerns to learn their intentions in regard to the vat colours, and how he eventually set to work to make indanthrene blue and yellow for himself, must be read in the original paper. Such dauntless energy as he displayed was bound to succeed, particularly when coupled with a full and proper appreciation of scientific research. Next followed the manufacture of Solway Blue—the fastest of the acid wool colours—and then in 1919 Morton returned from having established his dye processes in America with the British rights of the air oxidation process for the manufacture of phthalic anhydride from naphthalene. He tells how his chemists did not at first value this, but that during the slump in 1920 and 1921, following the Sankey judgment which so nearly destroyed the infant dye

[1] History of the Development of Fast Dyeing and Dyes. A paper read before the Royal Society of Arts on Wednesday, Feb. 20.

industry, time was available to study its properties more fully. As a result the conversion of the anhydride into benzoyl benzoic acid and the transference of this into anthraquinone intermediates was discovered and the way was open to make these derivatives purer and cheaper than before and, indeed, to effect a revolution in the making of vat dyes. The greatest of all new discoveries arising out of this has been that of Caledon Jade Green, which is the only pure green of the anthraquinone vats and is further the fastest all-round colour of the whole vat series.

Doubly interesting to us now is the palette of the fast colours, for every one of them is full of the intensest new meaning. Using Mr. Morton's own words, "it tells of long arduous research, of high pressures and high temperatures, things attempted and done; it tells also of things yet to do that are full of hope and adventure which, after all, is real life."

We have seen in this brief outline how the desire to make the colours worthy of the designs they interpret and of the threads on which they are dyed, has led to the entry of a man, himself not a chemist, into the difficult field of making, under the handicap of war conditions, not only known dyes of great complexity, but ultimately of leading the world in the production of new dyes of greater fastness than any yet known. A singleness of purpose has characterised his effort throughout, thought of material gain has been remote, though we believe Mr. Morton has earned the greatest of all rewards, that of satisfaction.

Truly a worth-while story! E. F. A.

Obituary.

SIR HERCULES READ.

BY the death of Sir Hercules Read, which took place suddenly at Rapallo on Feb. 11, the world of archæology loses one of its most notable personalities. Possessed of an extraordinarily wide range of knowledge, he was recognised as a foremost authority in ethnography, in archæology, especially prehistoric archæology, and in fine art. His striking appearance and his charm, especially in presiding at a meeting or in addressing an audience, won him a wide circle of admirers. His qualities of character secured him many firm friends.

Charles Hercules Read was born on July 6, 1857, and was therefore in his seventy-second year. Becoming closely associated with Sir Augustus W. Franks at an early age, he joined the staff of the Department of Antiquities of the British Museum in 1880. Franks was then keeper of that Department, and on his retirement in 1896, Read succeeded him, becoming his residuary legatee on his death in the following year, and contributing his biography to the "Dictionary of National Biography."

Franks had contributed generously from his private resources to the national collections. They were no less indebted to Read, though his personal benefactions were on a smaller scale. He had the gift of informing with his own enthusiasm the group of wealthy men with whom he was closely in contact, and who benefited by his wide knowledge and taste in forming their own collections. It was through him that the little coterie known as "Friends of the British Museum" was formed, ultimately growing into the National Arts Collection Fund. Through this group many priceless objects were acquired for the national collections which otherwise would have gone to America. Among major acquisitions through his influence were the Waddesdon Bequest (collection of Baron Rothschild) in 1898, the Greenwell Collection of Bronze Age antiquities purchased by J. Pierpont Morgan in 1909, the bequest of painted enamels of the Rev. A. H. J. Barwell in 1913, and the plaquettes given by Mr. T. Whitcombe Greene in 1915. If Read's own gifts to his Department were less conspicuous for their pecuniary value, they were distinguished by the taste and judgment with which they were selected, especially where objects of Eastern art were concerned. These same qualities were exhibited in the formation of his own private collections, and justified the prices realised when they were dispersed a few years ago.

Read's activities were not confined to the Museum. He was secretary of the Society of Antiquities from 1892 until 1908, and twice president of the Society, first from 1908 until 1914, and then from 1919 until 1924. In this capacity he was *ex officio* a Trustee of the British Museum, an office which might have entailed some difficulty had it not been for his correct and tactful attitude. He was president of the Anthropological Section of the British Association when it met at Dover in 1899, his address putting forward a suggestion for the foundation of an Imperial bureau for anthropology, which was perhaps one of his most momentous public pronouncements. He was also president of the Royal Anthropological Institute from 1899 until 1901, and again during the War from 1917 until 1919. He was president of the India Society. He retired from the British Museum in 1921, when a dinner was held in his honour, at which a volume of essays by his friends was presented to him. It was illustrated by his portrait from a drawing by Seymour Lucas, R.A., and 55 plates showing the most important and beautiful objects of art and antiquity acquired by his Department during his keepership.

Neither Read's inclinations nor his qualities led him in the direction of the writing of books. He was more at home in the delicate delineation of the distinctive qualities of objects of art or the discrimination in subtle lines of argument as to evidence of provenance which appeal to experts. Hence his literary contributions to knowledge appear in journals such as *Archæologia*. He was also, however, the author or part author of the guides to the archæological collections of the Museum, the early editions of which appeared directly under his inspiration. As one of the most active members of the Burlington Fine Arts Club, he took a large

part in organising the well-known exhibitions held by that body.

Read received the honour of knighthood in 1912. He was an LL.D. of St. Andrews, was elected to the British Academy in 1913, and had received honours from learned societies in nearly every country in Europe as well as the United States. He was buried at Rapallo.

MR. T. H. BLAKESLEY.

MR. THOMAS H. BLAKESLEY died on Feb. 13 at eighty-one years of age. To the older generation of physicists and electrical engineers he was well known. Much of his work has formed the foundations of great practical and theoretical developments which the younger generation accept with but little, if any, thought of the pioneers who initiated researches the results of which are affecting the everyday life of almost every nation.

Blakesley was the son of the Very Rev. J. W. Blakesley, Dean of Lincoln, and was educated at Charterhouse and King's College, Cambridge, where he graduated as a wrangler in 1869. He first went to Ceylon as an irrigation engineer, and then in 1885 he was appointed instructor in physics and mathematics at the Royal Naval College, Greenwich. In that year Blakesley published his classical work entitled "Papers on Alternating Currents of Electricity." In this treatise he gives many fundamental theorems. In particular, he describes how to measure alternating current power by means of his 'split dynamometer.' He describes fully how phase difference can be determined, and gives for the first time many of those geometrical methods of discussing alternating current problems which are now in everyday use all over the world. He made valuable contributions also to the mathematical theory of the transmission of electric power by cables and to long distance telephone working. In this connexion he recognised the importance of the hyperbolic functions and computed tables of their numerical values. The value of this work was appreciated by experts at the time, and translations of it were published in Germany, France, and Russia.

Blakesley was also greatly interested in the reform of the teaching of geometrical optics, and used to point out to his friends with great animation the 'absurdity' of some of the definitions of focal lengths, etc., then in vogue at Cambridge. His book on "Geometrical Optics" appeared in 1903. The principles, however, of his proposed reforms in optics he gave in a paper to the Physical Society of London in 1897. His paper to the same Society in 1907 on "Logarithmic Lazy-tongs and Lattice-works" was of a type which would have been much more appreciated by mathematicians of an earlier generation who liked 'mathematical recreations.' His synthetic spectroscope was a colour mixer of a refined type superimposing three homogeneous portions of the spectrum in one picture. An instrument of this type was presented to Finsbury Technical College by the Mercers' Company, of which Blakesley was master in 1902 and 1903.

Blakesley did good work as honorary secretary of the Physical Society of London for several years. For much of its success and present prosperity the Society is largely indebted to him. He did a great deal to encourage the friendly co-operation of academic lecturers with research physicists employed in industry which is greatly to their common benefit. He will be sadly missed by his friends.

MR. ABEL CHAPMAN.

SINCE his first work, "Bird Life of the Borders" appeared in 1889, and by its vigour, direct and humorous description, and evidence of close observation, gained the ear of the public, Mr. Chapman published many accounts of his travels, all equally robust and all equally popular. He was a sportsman-naturalist of the best type, as keen to note the ways of his quarry as to secure a trophy, and never likely to be led astray by the theories of professional scientific workers, whom, in a general way, he despised. His own theories, upon such subjects as the migration of birds and protective coloration, he defended with abundant confidence and even obstinacy, but they suffered from a lack of knowledge of the investigations of other workers in the same field.

Mr. Chapman's home at Houxty, in Northumberland, set in the heart of the Border country, afforded him fine opportunities of bird-watching, and his penultimate work, "The Borders and Beyond" (1924), like his earliest, dealt mainly with the natural history problems of his immediate surroundings. But he followed Nature far afield, and his hunting expeditions in Spain, Norway, East Africa, and the Sudan produced a series of interesting books, full of acute observations: "Wild Spain" (1893) and "Unexplored Spain" (1910), "Wild Norway" (1897), "On Safari in British East Africa" (1908), and "Savage Sudan" (1921). In 1896, with Mr. W. J. Buck, he published "The Art of Wildfowling." Only last year his final work appeared, "Retrospect," an autobiographical survey written with the old combativeness and reviewing the more interesting observations of his fifty-four hunting trips and home experiences.

Mr. Chapman was born in 1851 and educated at Rugby. He died at Houxty on Jan. 23, at the ripe age of seventy-seven years.

WE regret to announce the following deaths:

Surgeon-Capt. E. L. Atkinson, D.S.O., parasitologist to Scott's last Antarctic expedition (1910), on Feb. 20, aged forty-six years.

Dr. Harrison G. Dyar, custodian of Lepidoptera in the United States National Museum, a leading authority on American mosquitoes, on Jan. 22, aged sixty-two years.

Mrs. Arabella B. Fisher (*née* Buckley), secretary for eleven years to Sir Charles Lyell, the geologist, and author of several popular works on general science, on Feb. 9, aged eighty-eight years.

Sir George Fordham, author of numerous papers on archæology, natural history, and other subjects, and of volumes on the history of maps and road-making, on Feb. 20, aged seventy-four years.

Commdr. Giovanni Roncagli, honorary secretary general to the Royal Geographical Society of Italy, on Feb. 1, aged seventy-two years.

News and Views.

THE Council of the Royal Society, at its meeting on Feb. 21, recommended for election into the Society the following fifteen candidates: Arthur John Allmand, professor of physical and inorganic chemistry, King's College, London; Arthur Henry Reginald Buller, professor of botany, University of Manitoba, Canada; Charles Drummond Ellis, university lecturer in physics, University of Cambridge; Ronald Aylmer Fisher, head of Statistical Department, Rothamsted Experimental Station, Harpenden; George Ridsdale Goldsbrough, professor of mathematics, Armstrong College, Newcastle-on-Tyne; James Gray (Cambridge), fellow of King's College and lecturer in comparative anatomy, University of Cambridge; Cyril Norman Hinshelwood, fellow and tutor of Trinity College, Oxford; Augustus Daniel Imms, head of Entomology Department, Rothamsted Experimental Station, Harpenden; Peter Kapitza, assistant director of magnetic research, Cavendish Laboratory, Cambridge; William Dickson Lang, keeper of the Department of Geology, British Museum; John Mellanby, professor of physiology, University of London; Henry Stanley Raper, professor of physiology, University of Manchester; Harry Ralph Ricardo, consulting engineer; Harold Roper Robinson, professor of physics, University College of South Wales, Cardiff; Frederick William Twort, professor superintendent of the Brown Animal Institution, London.

THE place taken by some of the best of our English timbers and the increasing use being made in Great Britain of some of the finest quality Empire timbers is well shown in the great new building known as Imperial Chemical House, Millbank, London, a special view of which took place on Friday, Feb. 22. Amongst the English timbers used are walnut veneers, chestnut, oak, sycamore, lime, and holly. The Empire woods include Australian silky oak, Australian black bean, Rangoon teak, Indian laurel wood, British Columbian timber, Canadian maple, Canadian yellow pine, Canadian spruce, Tasmanian timber, and Honduras mahogany. Of the English timbers, the chairman's room is panelled with English walnut veneers which it is said could scarcely be equalled by any other walnut veneers in the world. Certain rooms on the same floor are panelled with English chestnut key-jointed centres, built-up plywood panels. The conference rooms are panelled throughout with English oak which is of a higher quality than the finest Austrian wainscot oak. The first floor conference room is panelled with Australian silky oak, a beautiful wood which should have a more extended use in England. Another conference room is panelled with Australian black bean, the wood of which has a very beautiful figure. This panelling has a Renaissance design.

THE whole of the skirtings in the new building which is to house Imperial Chemical Industries, Ltd., including nearly 2½ miles of corridors, and in all the rooms with the exception of the panelled rooms, are made of English sycamore. For the elaborate carvings in the Gibbons manner English limewood has been used, whilst English hollywood is employed for the inlaid work in certain bath and changing rooms and lavatories. For dormer windows, staircases, and doors, teak is the timber employed. The room to be used by Lord Reading, one of the directors, is panelled with Indian laurelwood, which shows the striking beauty of the unusual figure of this timber. British Columbian timber has been used for the parquet flooring in some of the stories, including the great refectory. Tasmanian timber is used in the basement, and Canadian maple for the flooring in the squash rackets and badminton courts. Certain of the panelled rooms in white wood have been made from the best Canadian pine. The backings for the best panels, such as the walnut veneers, etc., are made from Honduras and West African mahogany. Finally, the great flagstaff, nearly 90 feet high, is made of Canadian Pacific coast spruce. It will be apparent that this magnificent building provides an important object-lesson in the utilisation of some of the finest timbers in the Empire.

IT is satisfactory to note that the interest in the application of scientific methods to industrial problems is beginning to receive financial expression. It was announced a few days ago that the trustees of the estate of the late Mr. C. Heath Clark had decided to make a contribution of £10,000 to the National Institute of Industrial Psychology for the promotion of education in London. The problems connected with the application of psychology to industry fall into two categories: (*a*) Those that involve the application of already well-established generalisations to a particular problem; (*b*) those for which as yet no generalisation is known. Employers are often quite willing to avail themselves of the help of the Institute for problems of the first order, but seem to be either unable or unwilling to help in the solution of those of the second, for these involve the slow and laborious accumulation of data for which no immediate value can be assigned. It is therefore necessary, if research is to go forward, that there should exist some fund which can be applied to problems involving more detailed study.

THE Institution of Mechanical Engineers, before which Prof. A. S. Eddington recently delivered the Thomas Hawksley lecture on "Engineering Principles in the Machinery of the Stars," was founded in 1847 at Birmingham with George Stephenson as its president. Thirty years later its increasing activities led to its removal to London, and its present fine headquarters in Storey's Gate has been the scene of many notable gatherings. The president this year is Mr. R. W. Allen, of the Queen's Engineering Works, Bedford, while the president-elect is Mr. Daniel Adamson of Manchester. Its membership is more than 10,000 and its income about £30,000 per annum. It has initiated and carried out much important research work; it has representatives on numerous conferences, boards, and institutions; it maintains various provincial and overseas branches, and in conjunction with the Board of Education it conducts

examinations for National Certificates and Diplomas in Mechanical Engineering at more than one hundred technical schools and colleges. The Thomas Hawksley Lecture was founded by the late Charles Hawksley (1839–1917) to commemorate the centenary of the birth of his father, Thomas Hawksley (1807–1893), one of the most distinguished waterworks engineers of his time, who served as president of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. One of the greatest works with which he was associated was the Lake Vyrnwy Scheme, North Wales, for the water supply of Liverpool.

ONE hundred years ago a young musician, Louis Braille, blinded at the age of three, overcame his difficulty by the invention of a system of six dots whereby it was possible to emboss music, literature, and numerals. Braille was born at Coupvray, near Paris, in 1809, and died in 1852, having been a pupil and for twenty-six years a professor in the Institution des Jeunes Aveugles at Paris. In connexion with the centenary of the invention, the National Institute for the Blind, which has issued millions of copies of music, books, etc., is appealing for funds for its work. The appeal is addressed primarily to musicians, and it is proposed to have a performance of Mendelssohn's famous "Hymn of Praise," written in 1840 in connexion with the erection of the monument to Gutenberg on the fourth centenary of the invention of printing. It is in this work that the words "The night is departing" occur.

THE first public school for the blind was established in Paris in 1784, the first in England was that at Liverpool opened in 1791, and the first in London dates from 1799. That in Paris was founded by Valentine Haüy (1746–1822), the brother of the famous crystallographer René Haüy (1743–1822), and it was Valentine Haüy who began printing in embossed characters for the blind. Many men of science have suffered from blindness. Galileo and Euler became blind. Nicholas Saunderson, for a long time Lucasian professor of mathematics at Cambridge, was blind from the age of one; and H. M. Taylor, at the time of his death in 1927 senior fellow of Trinity College, Cambridge, did most remarkable work by translating mathematical volumes into Braille after he became blind at fifty-two years of age. The Belgian physicist Plateau became blind at the age of forty-two, but with the aid of his wife and son continued to carry on his work in physiological optics and molecular physics, and at the age of seventy-two published a valuable contribution to the knowledge of capillary attraction.

A NEW scientific expedition to the Antarctic under the leadership of Sir Douglas Mawson is now being organised. The *Times* announces that the British government has given the *Discovery*, and that the Australian government is providing the necessary funds. The government of New Zealand is also contributing. The expedition is designed to explore the region between the Ross Sea and Enderby Land and to continue the work carried out in that area by Sir Douglas Mawson and Capt. J. K. Davis in the Australasian Antarctic Expedition of 1911–14. Capt. Davis is again to go with Sir Douglas Mawson and will be in command of the *Discovery*. Much of the coast-line towards Enderby Land is still unknown, and Enderby Land itself has never been visited since its discovery in 1832. Aeroplanes will be useful for inland survey. The study of meteorological conditions will enable the relationships between the climates of Antarctica and Australia to be determined more accurately. Much attention will be paid to the distribution of whales, in view of the spread of commercial whaling to those waters. The expedition will sail from Australia towards the end of this year. The combination of aeroplane reconnaissance and detailed ground work should result in discoveries of the highest value.

A PAPER was read before the Surveyors' Institution on Feb. 4, by Mr. H. J. Vaughan, on "The Significance of the Timber Merchant in Estate Forestry." Mr. Vaughan, who is now managing a large estate, in addition to taking a keen interest in the planting and growing of trees, has had the somewhat unique experience of having spent two years in close association with a large firm of English timber merchants in the south of England. He says, in his opening paragraph, that "it seems to me that some even of our eminent foresters tend to lose sight of the saw-bench when advocating and putting into practice schemes of afforestation or re-planting." After glancing at the sporting and amenity aspects of woodlands, Mr. Vaughan pointed out that what the timber merchant wants is a regular and trustworthy source of supply of his raw material, and that the management of private woodlands in the past has not fulfilled this desire. This is the cause to some degreee of the low prices offered to owners for their trees, and for the high freights charged by railways for the carriage of timber. After contrasting some of our best hardwoods with the softwood conifers, Mr. Vaughan said he doubted whether Great Britain would ever be able to compete with the Scandinavian countries in this class of material. In discussing the work of the Forestry Commissioners and their concentration on planting softwoods and purchase of land for this purpose, Mr. Vaughan expressed the opinion that it would be better to concentrate on growing hardwoods wherever possible, some of our native trees of this class having a real superiority, rather than to try to meet a questionable world famine with what is bound to be a very small proportion of our total requirements of coniferous softwoods for building and for constructional work. Mr. Vaughan considers it a wrong policy to plant conifers on areas where valuable hardwoods would grow.

THE Department of Entomology of the British Museum (Natural History) has recently received through Mr. P. A. Buxton, of the London School of Hygiene and Tropical Medicine, specimens of a new genus and species of parasitic Hymenoptera (Ichneumonidæ), bred from the grubs of *Cladocera migro-ornata*, a beetle used by the Bushmen of the Kalahari Desert, South Africa, as an arrow poison. The Trustees of the Museum have approved the purchase

for the Department of Geology of part of the skeleton of the horse-like mammal *Moropus*. This is one of the Chalicotheres, distantly related to the horses, which they resembled in their rather small head and long neck. The fore-limbs were long compared with the hind-limbs, so as to give the trunk a giraffe-like pose. Like the horses, they were herbivorous, but they had claw-like hoofs, three on each foot. Chalicotheres have been obtained from early Tertiary times onwards, from Europe, Asia, Africa, and America. Hitherto the Museum had only some incomplete remains from India, and a single claw from Central Africa. The individual now acquired came from the Middle Tertiary of North America. It stands as high as a large horse, but the bones are far more massive. Recent additions to the mineral collection of the Museum include some crystallised sprays of native gold in calcite from Torquay, Devonshire, discovered and presented by Prof. W. T. Gordon.

PROF. F. O. BOWER, F.R.S., made "The Evolutionary Relation of the British Ferns" the subject of his presidential address to the Yorkshire Naturalists' Union at York on Dec. 8. The address is published in full in the *Naturalist* for January 1929, and is of very great interest to British botanists, as the following citation will indicate: "Having this year completed nearly half a century's research on 'Ferns,' and summed it up in three volumes in which the aim has been to reconstruct their chief evolutionary sequences upon a foundation of Organography, it seemed not inapt to use the present opportunity for placing our British Ferns in their probable relation to the Class at large. I believe this has never yet been done." Both task and man were most apt to the occasion, a memorable one for the Union; a large meeting listened to a most delightful and stimulating address which did not restrict itself to the written word, but often diverged into a most interesting and relevant commentary upon the slides used in illustration, which were made from the plates of Sir William Hooker. Prof. Bower pointed out that in Great Britain we have only some forty species out of a total of 6000, but these are representative of half the families and about one-eighth of the genera. "This is probably the consequence of the position of Britain on the extreme fringe of a great continental area." Many of the largest fern genera are monotypic with us. Prof. Bower discussed this interesting fact, concluding that probably the majority of these British ferns "represent vestiges of a richer flora of the past, and that the species themselves have, by their more ready adaptation, or by more hardy constitution, been able to subsist in surroundings from which their congeners have retired beaten." "In fact, they symbolise the tenacious and adaptable race of men that inhabits these islands."

PROF. J. A. FLEMING gives interesting personal recollections of Sir Joseph Wilson Swan in the *Journal of the Institution of Electrical Engineers* for February in connexion with the invention of the carbon incandescent electric lamp. In particular, he points out that one of the carbon incandescent lamps shown by Swan at an Exhibition in Newcastle-on-Tyne on Dec. 18, 1878, is still preserved in the Science Museum at South Kensington. It is necessary to distinguish between patent priority, which is often a mere matter of luck or promptitude, and that scientific or technical priority which is based upon achievements, exhibitions, public statements, or the evidence of contemporary workers. Scarcely any invention springs into existence in full completion. In many cases inventors may with justice claim to have originated some part of an invention. It was thus with the invention of the electric lamp of small candle-power. The 'subdivision of the electric light' was the problem which the electricians of 1878 had to solve. In 1879, Fleming was scientific adviser to the Edison Telephone Co., and in 1882 he was appointed in the same capacity to the Edison Electric Light Co. and to the Edison and Swan Co. In his opinion the credit for the epoch-making invention of the electric lamp cannot be solely attributed to T. A. Edison. Sir Joseph Swan is, without doubt, one of those whose names are inscribed high up on the roll of fame. For all future time his name will be connected with the invention of the carbon filament electric lamp.

DURING the summer meeting last year at Glasgow of the Institution of Electrical Engineers, many members visited the works of the British Aluminium Co. at Tulloch and Fort William. The company has two hydro-electric stations in operation, that at Foyers on Loch Ness, opened in 1896, and a second at Kinlochleven, on Loch Leven, opened in 1909, while a third and much larger one is being erected about a mile from Fort William. This is not only of interest on account of its size and its various engineering features, but also as an example of the use of water-power for manufacturing in a remote area dominated by the mountain Ben Nevis. The most notable piece of construction has been the boring of the tunnel from the valve shaft at the Treig Dam to Fort William, 15 miles in length. Commenced in the summer of 1926, the last shot opening the tunnel was fired on Feb. 9, the work having proceeded from 23 faces by means of vertical shafts and horizontal adits. From the surge chamber on the hill above Fort William the water will be conveyed by three steel pipes, at a maximum head of 800 ft., to the power-house, which will eventually have turbines of a total capacity of 120,000 h.p. The catchment area is 303 square miles in extent, the rainfall over which varies from 50 inches per annum in the northern part to 160 inches on the summit of Ben Nevis. A short description and a map of this important scheme was given in *Engineering* for July 6 of last year. Though the tunnel is now bored, about half of it still remains to be lined with concrete.

THE Annual Summary of the World's Shipbuilding, issued by Lloyd's Register, is a statistical return of great value affording an indication of the progress of this great industry in all countries. The summary for 1928 deals with the ships launched during the year, their tonnage, classes, types and machinery, and includes tables showing the tonnage launched for many

years back. Shipbuilding is an industry liable to very great fluctuations, and one which, owing to the War, experienced great difficulties. The fluctuations will probably always occur, for the demand for ships varies with many factors, but it is a satisfactory feature of last year's return to find that the tonnage launched in Great Britain and Ireland was 53·6 per cent of the world's tonnage of about 2,700,000 tons. The tonnage launched in 1893 was about one million tons, in 1903 it rose to two million, in 1913 to three million, and in 1919 to more than seven million tons. Of this seven million tons about half was built in the United States, but after 1921 shipbuilding in the United States sank to a much lower level, and last year the tonnage launched in that country amounted to only 86,000 tons. The growth of the mercantile fleets of the world can be seen by comparing the total tonnage of 42,514,000 tons of 1914 with the 61,594,000 tons of 1928. Remarkable changes in ships have taken place also. Oil tank ships in 1914 amounted to 1,479,000 tons, in 1928 to 6,544,000 tons ; motor ships totalled 234,000 tons in 1914, and 5,432,000 tons in 1928 ; while steamers fitted for burning oil totalled 1,310,000 tons in 1914 and 19,000,000 tons in 1928. The largest vessels launched during 1928 were the German Atlantic liners *Bremen* and *Europa*, of 46,000 tons each.

WE have received the first number of the *Journal of Nutrition*, edited by J. R. Murlin, assisted by an editorial board of ten well-known American experts in this branch of science. It is to be published every two months by the American Institute of Nutrition, the president of which is E. F. Du Bois ; at present one volume of about 500 pages will be issued each year. The first number (September 1928) contains articles by H. M. Evans, "The Effect of Inadequate Vitamin B upon Sexual Physiology in the Male" and "Relation of Vitamin E to Growth and Vigour" ; by E. V. McCollum and collaborators, "The Distribution of Vitamin E" ; by B. Sure, "A Detailed Study of the Rôle of Vitamin B in Anorexia in the Albino Rat" ; and by the editor, "Vital Economy in Human Food Production," etc., some of which we hope to refer to in more detail later. The *Journal* is well got up, with a portrait of Lavoisier on the cover, and is clearly printed. The science of nutrition has expanded so greatly in the last few years that there is undoubtedly room for another journal dealing solely with this subject ; the composition of the editorial board should ensure that it maintains a high scientific outlook. It can be obtained in Great Britain from Messrs. Baillière, Tindall and Cox.

AN article on the marine biological laboratory at Seto, Japan, its equipment and activities, with remarks on the fauna and flora of the environment, appears in the *Memoirs of the College of Science, Kyoto Imperial University*, Series B, vol. 3, No. 3 ; 1927. The laboratory, which is affiliated to the departments of zoology and botany of Kyoto University, was opened in 1922. It consists of a number of separate buildings—an aquarium open to the public, a students' laboratory, two research laboratories, and a dormitory capable of accommodating thirty persons. Up-to-date equipment is installed throughout, and individual research rooms are furnished with electricity and running salt and fresh water. For the collection of material the laboratory possesses, in addition to three rowing boats, one vessel of 19 tons capacity, fitted with masts and sails and equipped with a 25 h.p. semi-Diesel gas engine. Up to the present the staff has been engaged mainly in making faunistic surveys of the various collecting grounds. A preliminary survey of the littoral and inshore areas has already been completed, but that of the deeper waters has not yet been fully worked out. Spring and summer vacation courses —attendance at which is compulsory—are provided for students of biology at the University, and a summer course is also provided for teachers of biology in public schools.

THE Report of the United States Coast and Geodetic Survey for the year ending June 30, 1928, in addition to the usual record of work, mentions several new features. The demand of air maps has led to a new branch of the department's work. Already several sheets of recognised flying routes have been published and others are in preparation. A big development in this branch of survey work is anticipated. In coast surveys considerable use is now being made of echo sounding with the fathometer, for which the claim is made that it allows work to be done twice as quickly as by any other means. It is now used in eight survey vessels which can work at full speed, and stop only when temperatures or water samples are required. In connexion with echo sounding, a further development is sound ranging in order to fix positions in thick weather. The use of this method allows hydrographical work to be continued almost regardless of weather conditions and throughout the twenty-four hours. The report gives a number of charts showing the state of field work up to the end of the year under consideration.

THE recent series of illustrated post cards of British trees issued by the Natural History Museum, as F 22—F 28, contain excellent photographs and illustrations of trees, long familiar in Great Britain, if not necessarily native. In each series two photographs show the appearance of a fine example of the tree in winter and in summer, whilst two more coloured illustrations depict and analyse flower and fruit. These cards, with their accompanying descriptive leaflet, together with an exhibit of British-grown trees in a bay in the Central Hall of the Natural History Museum at South Kensington, to which the leaflet refers the reader, should help to make the city dweller more alive to the beauty and interest of the trees of the countryside.

APPLICATIONS for the Government Grant for scientific investigations must be made to the clerk to the Government Grant Committee, Royal Society, Burlington House, W.1, upon the requisite form, by Mar. 31.

DR. KARL JORDAN, curator of the Entomological Department of the Zoological Museum at Tring, has been elected president of the International Commission

on Zoological Nomenclature, in succession to Prof. F. C. Monticelli, deceased. Prof. Fillipo Silvestri, of Portico, Italy, has been elected a member of the Commission in succession to the late Prof. F. C. Monticelli, of Naples.

THE new-year issue of *The Fight against Disease*, the organ of the Research Defence Society, reminds us that the Society has now been in existence for twenty-one years. An interesting correspondence between Lord Knutsford and the Hon. Stephen Coleridge on diabetes and insulin treatment appears in this number.

A CATALOGUE issued by Mr. Francis Edwards, High Street, Marylebone, of books on the voyages of Captain James Cook, contains several items of great interest. One entry is the original painting by J. Webber, who was artist in the *Resolution*, of the death of Captain Cook in Hawaii. This picture is well known from the engraving by Bartolozzi. Another item is the manuscript log-book of H. Roberts, who as mate of the *Resolution* was in charge of the pinnace which took Captain Cook ashore for the last time. The log runs from October 1778 to November 1779, when Capt. King demanded for the Admiralty all log-books and diaries kept on board the ship.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant in the Electrical Engineering Department of the Coventry Municipal Technical College—The Director of Education, Council House, Coventry (Mar. 8). A head of the Building Department of Rutherford Technical College, Newcastle-upon-Tyne—The Director of Education, Northumberland Road, Newcastle-upon-Tyne (Mar. 9). A head of the Engineering Department of the Technical Institute, Gillingham—R. L. Wills, 15 New Road Avenue, Chatham (Mar. 9). A woman lecturer in education in the Department of Education of the University of Bristol—The Secretary, Department of Education, The University, Bristol (Mar. 11). A lecturer in engineering at the Technical College, East London, South Africa—The High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (Mar. 12). A Tancred student in physic at Gonville and Caius College, Cambridge—E. T. Gurdon, 28 Lincoln's Inn Fields, W.C.2 (Mar. 12). A director for the Harcourt Butler Institute of Public Health, Rangoon—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Mar. 13). A professor of botany in the University of Birmingham—The Registrar, The University, Birmingham (Mar. 16). A horticultural lecturer and adviser under the Bucks County Council—The Agricultural Organiser, Education Sub-Office, Aylesbury, Bucks (Mar. 16). A professor of philosophy in the University of Lucknow—The Registrar, The University, Lucknow (Mar. 17). An assistant lecturer in economics in the University College of North Wales—The Registrar, University College of North Wales, Bangor (Mar. 18). An assistant inspector in connexion with agricultural and horticultural education and research—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Mar. 18). A lecturer in metal mining in the Mining Department of the University of Birmingham—The Secretary, The University, Birmingham (Mar. 23).

ERRATUM.—Obituary of Dr. J. W. L. Glaisher in NATURE of Jan. 26, p. 135, col. 2, line 8 from bottom: for 1910 read 1901.

Our Astronomical Column.

SPECTRA OF MINOR PLANETS.—*Lick Observatory Bulletin*, No. 407, contains an investigation of this subject by Mr. N. T. Bobrovnikoff; he used a one-prism spectrograph on the 36-inch refractor. As might be expected, the light of the small planets is wholly reflected sunlight; there are no absorption bands as in the giant planets. The violet and ultra-violet regions are generally very weak as compared with the spectra of *G*-type stars. There is evidence of difference of composition of different planets; thus Ceres is bluer than Vesta, the maximum of intensity of the latter being much further towards the red end; the values given are: Ceres, λ4800; Vesta, λ5300. It has been deduced both by changes of light and of spectrum that Vesta rotates in $5^h\ 55^m$. The suggestion is made in the article that minor planets may be comets that have lost their gaseous envelope; but it should be remembered that Halley's comet was invisible when in transit over the sun in May 1910, whereas any solid body of even a few miles in diameter would have been detected, the comet being near the earth.

MAGNITUDES OF STARS IN THE CAPE ZONE CATALOGUE.—The importance of the accurate determination of magnitudes both for statistical purposes and for the deduction of spectroscopic parallaxes has been more fully realised during the last two decades. The Cape Observatory has lately published a volume which gives the photographic magnitudes of 20,843 stars in the Cape Zones (Declination $-40°$ to $-50°$), the Harvard spectral type and photometric and photographic magnitudes being given for comparison.

Very careful experiments have been made at the Cape of the photographic effects of different exposures, different intensities of light, and different brands of plates. Kron gave an exponential formula with different values of the exponents for different brands of plates. This is adopted with the simplification that Kron's a_1, a_2 are each assumed equal to 0·25 for all brands of plates. The quantity I, known as the 'optimal intensity,' is, however, considerably greater in slow than in fast plates. The mean difference (irrespective of sign) between Cape and Hertzsprung is 0·07 mag.; the difference from Harvard for 16 stars in the south polar sequence is +0·07 mag.

The satisfactory conclusion is reached that if there is on a plate one star the magnitude of which is known from extraneous sources, the magnitudes of the other stars on the plate can be deduced. The zero point of the Cape system was derived from the Harvard visual system corrected for colour. There is found to be a marked tendency for the colour indices to group themselves round four maxima the positions of which are −0·04 mag., +0·38 mag., +0·84 mag., +1·30 mag. It will be seen that they are nearly equally spaced.

Research Items.

DUGONG FISHING IN MADAGASCAR.—M. G. Petit publishes in the *Bull. et Mém. Société d'Anthropologie de Paris*, T. 8, Sér. 7, fasc. 4-5-6, some further observations on the ritual of dugong fishing in south-west Madagascar. Small light outriggers, extremely mobile, are employed, the fishermen being two in number to each, a harpooner who stands in the bow being in command. Before setting out, the harpooner consults the *Sitily* as to whether conditions are favourable, and he is provided with a talisman (*Ody*). This is used first to consecrate a vessel of sea water, and is then placed in the prow and covered with a piece of old net to protect it. The sea water is used to sprinkle the canoe, while invocations are addressed to it, and to the harpoon and its ropes. It is also used to wash the head and hands of the fishermen. As soon as the day for fishing has been fixed, the fishermen must abstain from all contact with their wives, and must not touch food prepared or water drawn by them. The fishermen are in fact in a magical state, of which the serious nature is indicated by the fact that to miss the dugong not only entails misfortune for the village, but will be followed by the death of a member of the fishermen's family. When the animal has been brought to land, its body is scrupulously hidden from the sight of women and children. The body is dismembered by an old man, and the blood carefully collected and divided into three parts, one poured on the sand by the canoe, one into the sea, and the third smeared on the prow of the canoe, the harpoon and the rope. The flesh is eaten on the beach, first by men and, when they are satisfied, by women and children, but no knife, fork, or other utensil must be employed, nor must anyone spit or blow the nose. The carcase must be buried, this being done with ceremony, as neither beast nor bird, but only man, must eat the flesh or pick the bones. If the animal is female, connexion is enjoined on the fishermen, a custom which is found on the east African coast, and in a Chinese account of the Aino of Sakhalin in relation to women-fish, presumably seals.

THE STARLING IN THE UNITED STATES.—The European starling, set free in New York in 1890 and 1891, has since 1910 spread rapidly throughout the United States, so that it seems likely to colonise all the country east of the Rocky Mountains, and, should it pass the Continental Divide, to prosper also on the Pacific coast. With such an extension of range possible, it is important that the economic influence of the bird should be properly understood, and E. R. Kalmbach supplies the needed information in a U.S. Department of Agriculture *Farmer's Bulletin* (No.1571, December 1928). His conclusion is that most of the starling's habits are either beneficial to man or of a neutral nature. Field observation has established the fact that the time spent by starlings in destroying crops or in molesting other species of birds is extremely short compared with the endless hours they spend searching for insects or feeding on wild fruits. It is admitted that the bird damages cherries and certain other small fruits, and that its roosting habits make it objectionable in cities, but it is claimed that these are the results of overabundance rather than pronounced tendencies for harm on the part of the individual bird. Such conditions are local and should be remedied by local control, such as the destruction of the roosts, or if that be not possible, by fumigation—a tricky and perhaps dangerous proceeding—or on a small scale by trapping.

EVOLUTIONARY SIGNIFICANCE OF PARASITES.—Prof. R. Hegner (*Quart. Review Biol.*, **3**; 1928) discusses the protozoa found in man and in monkeys. He states that of the four genera of amœbæ that live in man, three are represented in monkeys and the fourth has probably not yet been discovered on account of its rarity. Four of the six well-authenticated species of human amœbæ are indistinguishable from four of the species found in monkeys. Among the intestinal flagellates of monkeys are five species that are indistinguishable from five of the seven species which live in man. The ciliate *Balantidium coli* which lives in man is probably the same species that has been recorded from various species of monkey. All three species of human trypanosomes seem to be present as natural parasites of monkeys, but the Leishmanias have not been reported from monkeys. Malarial parasites that occur in monkeys resemble the three species that live in man. Thus sixteen of the twenty-five species of human protozoa have been described from monkeys. One genus of ciliates (*Troglodytella*) and one *Babesia* occur in monkeys but not in man. Comparison of human protozoa with those of mammals other than monkeys shows that they can be distinguished without difficulty; for example, the intestinal amœbæ and flagellates of the rat and the rat trypanosome are not identical with any species of human protozoa. If the proposition is valid that close relationships of parasites indicate a common ancestry of their hosts, then the facts available furnish evidence of importance in favour of the hypothesis that monkeys and man are of common descent.

FISH STATISTICS FROM LATVIA.—The Section of Fish and Fisheries Industries of the Ministry of Agriculture has continued its fish statistics for 1927 in Latvia (*Bulletin statistique des pêches maritimes de Lettonie*. Année 1927, Rédigé par V. Miezis, Riga, 1928). The report is in Latvian and in French. Tables are given relating to the various catches in the years 1924–27, for the months in 1927, giving the total weight in kilograms of the fish taken and their money value, the quantity of fish month by month in 1927 and according to districts, details of the boats and gear, number of fishing days, and the state of the fishing each month; also the number of seals killed is included (84 in 1927, mostly from the Kolkas region). At the end there is a useful list of the names of the fish in Latin, Latvian, French, German, and Russian. Herring form the largest part of the fishery, then flat fish, salmon and salmon-trout, cod and *Zoarces viviparus* being sometimes in greater numbers than the salmon. Sprat and eels are also caught. The herring fishery for 1927 is the largest of the four years, the other years in order being 1925, 1926 and 1924; the order for flat-fishes and turbot is 1926, 1925, 1924 and 1927.

HALOGEN COMPOUNDS AND TOAD TADPOLES.—Mr. Shinryo Ohfuchi describes the effect of chlorides, bromides, and iodides, and also of feeding with thyroid substance, on the toad *Bufo vulgaris formosus* ("Effect of Halogen Compounds on the Growth of the Tadpole of *Bufo vulgaris formosus* B." *Science Reports of the Tôhoku Imperial University*, 4th Series (Biology), Sendai, Japan, vol. 3, No. 4, Fasc. 1, 1928). The halogen compounds, sodium and potassium chlorides, bromides, and iodides, were mixed with the pond water in bowls, and algæ were given in every vessel. All the tadpoles were fed on cow's liver, except those fed on the thyroid extract. Liver and each culture medium, with algæ, were renewed every day. It was found that, in general, chlorides tend to accelerate the growth of the body at first, later to retard. Bromides

retard at first, later accelerate. Iodides retard the growth of the trunk and hind limbs but tend to increase the tail dimensions, thus indicating a longer period during atrophy of the tail. Metamorphosis is hastened by feeding with extract of thyroid, but potassium iodide in the water does not have the same effect.

MOLLUSCA FROM NEW ZEALAND.—Mr. A. W. B. Powell in two papers describes three new volutes and five new land shells from New Zealand (*Proceedings of the New Zealand Institute*, vol. 59, Part 2, 1928). The larger recent volutes of New Zealand are separable into two main groups, one occurring in shallow and the other in deeper water. Two of the new species belong to the first group, the members of which show much variation and are characterised by a projecting callus-plate on the columella, the deeper water species having none. The radula of the Volutidæ is of a simple degenerate type, but it is possible to detect slight differences in the single central tricuspid tooth which remains in nearly all species. These differences in shape of base and length of cusps help the author to separate the species, but as the teeth of the radulæ of other molluscs are known to be variable, it is well to be careful in attributing importance to these slight differences until many specimens have been examined. The land shells described in the second paper are interesting, but the shells only are described. *Murdochia aranea* is a beautiful little snail with delicate white riblets showing up on a reddish brown background. *Cavellia spelæa* is the largest species of the genus as yet found, measuring 5·25 mm. across. It is a sub-fossil species found in a cave together with *Moa* bones, and also with the common bush snail *Charopa coma*.

GROWTH REGULATING ACTION OF THE LEAF.—R. Dostál has of late years developed a theory as to the significance of the metabolism of the leaf as a correlating influence upon growth. Whilst some striking experiments have recently been described by this worker, in which the normal periodicity of scale and leaf production in the annual cycle of the leafy shoot of the tree has still been maintained under very exceptional external conditions, many of the experimental data which were associated with the development of this view will be found in a long paper published in the *Acta Soc. Scient. Nat. Moraviæ, Cechoslovakia*, 3, 83-210, 1926. In general, his view is that the growth of the axillary or terminal shoot primordium is very much influenced by the metabolism of the subtending leaf, and he examines the various marked changes in development of the shoot that follow upon mutilation or other experimental modification of the normal activity of this leaf. He also analyses, in experiments with *Circæa intermedia* and *Scrophularia nodosa*, the different morphogenetic quality of different regions of a shoot, as exemplified by the different results obtained when similar regeneration experiments are carried out with isolated nodes from different regions of the same shoot.

GRASS FIRES AND PLANT SUCCESSION IN SOUTH AFRICA.—During the present year the vegetation of South Africa will have, perhaps, a special interest to many readers of NATURE, and attention may be directed to the memoirs on the Botanical Survey of South Africa, which are being issued by the Department of Agriculture under the general direction of Dr. I. B. Pole Evans, Director of the Botanical Survey. *Memoir* No. 12, recently issued, by Ernest E. Galpin, upon the Springbok Flats, raises in an interesting manner one very controversial South African problem —the practical significance of annual burning of grassland. Galpin's conclusion is that acacia trees will gradually spread over the whole Springbok Flats, so that the grassland will become more or less dense acacia scrub. The cause of this change of vegetation is traced in a large measure to the suppression of the custom of annual veld burning, as European methods replace traditional native ones. The soil probably increases in humus with the suppression of the fires, but if the result is too intractable acacia scrub, it may be unfortunate, and the traditional native practice of burning thus prove to be justifiable. On the other hand, on the poorer grassland of the neighbouring veld, which stands higher than the rich loams and fertile grasslands, burning seems to be a very harmful practice. The wind then catches the exposed surface of the sandy soil and carries it forward, so that the sand veld is encroaching on the richer cultivable land as the result of frequent fires. Galpin has described a very interesting and rare new plant, *Cucumis humofructus*, Stent, which buries its fruit in the ground as it ripens as the result of negatively geotropic growth curvatures in the stalk.

CHLOROPHÆITE AND PALAGONITE.—The discussion of the nature of these and related mineraloids and of the terminology to be applied in specific cases, is continued by Martin A. Peacock and R. F. Fuller in the *American Mineralogist*, July 1928, and by L. L. Fermor in the *Rec. Geol. Surv. India*, Part 2, 1928. Dr. Fermor presents a general formula—

$$2\tfrac{1}{2}H_2O \,.\, 5R_2O_3 \,.\, 20SiO_2 + n(RO \,.\, H_2O) + (80 - 4n)H_2O$$

—representing a series in which not only chlorophæite and palagonite find a place, but also certain other amorphous or micaceous minerals. The two other authors claim that ferric oxide is strongly dominant in chlorophæite, whereas alumina is abundant in palagonite. The former they regard as a result of hydrothermal action on basic constituents of basalts and dolerites ; whereas palagonite is interpreted as a gel produced by the hydration of sideromelane. They propose that sideromelane should be retained as a specific name for clear, pale-coloured basaltic glass, as distinct from tachylyte, which is deep brown, opaque, and even microscopically turbid. Fermor, advocating the view that palagonite falls within the chlorophæite series, naturally points out that the term chlorophæite has twenty years' priority, and should therefore be adopted as the mineraloid name. Palagonite, he thinks, should be used as a rock name, and sideromelane he regards only as a variety of tachylyte. Much of the existing confusion doubtless arises as a consequence of basaltic alteration products and mesostatial material having been called palagonite when terms like chlorophæite and delessite would probably have been more appropriate. Chlorophæite, in the sense of Peacock and Fuller, is now a well-established term, but palagonite can no longer be used without a careful explanation of what it is meant to imply.

ATMOSPHERIC OZONE.—The issue of the *Proceedings of the Royal Society* for Feb. 4 contains Dr. G. M. B. Dobson's third report of the work of himself and of his collaborators on the ozone of the atmosphere. In this they have been mainly concerned with the fluctuations of the ozone content in typical cyclones and anticyclones, and their extensive data are summarised in a convenient set of maps and tables which, apart from their intrinsic interest, should be of great value when they can be subjected to detailed analysis in conjunction with other meteorological records. Dr. Dobson has already found at least two important connexions with other phenomena. One of these, which was suspected previously, and has now been confirmed, is that there is a small but definite tendency for days with much ozone to be associated with

magnetically disturbed conditions. The other has been found by studying the ozone records in relation to the movements of the large air masses, as diagnosed by the Norwegian Meteorological Institute. It appears that polar air has a high ozone content and tropical air a low ozone content, and since the weather records are essentially obtained from data which refer to the troposphere, whilst the centre of gravity of the ozone layer is probably at a height of from forty to fifty kilometres, the ozone measurements thus give evidence that the large tropical and polar air currents extend to a great height and bring their own stratosphere with them. The study of cyclones and anticyclones has now been abandoned, as it is felt that further work in this field must be left to larger organisations, and the recording instruments have been sent to a number of scattered stations in the northern and southern hemispheres, in an attempt to find how the ozone varies over the surface of the earth.

TWO MILLION VOLT BATTERY.—At the Trafford High Voltage Laboratory of the Westinghouse International Co. there is now in operation a two million volt battery which is used for testing the strings of insulators used for suspending the transmission lines on 220 kilovolt systems. The pressure obtained is not an alternating pressure obtained by transformers, but a unidirectional damped discharge. Instead of using ten groups of condensers as was done last year, twenty are now used. They are charged in parallel by means of large thermionic power tubes and discharged in series. In order to measure the voltage, the spherical electrodes have each to be fifty-nine inches in diameter. The set is of great use in determining the performance of lightning arresters and in the design of cable and transformer insulation to withstand electric surges due to lightning or other causes. The shape of the protective rings round the strings of insulators used on 220 kilovolt systems was determined by experiment, very definite results being obtained. In addition to their electric tests, the strings of insulators are subjected to a mechanical tension of 20,000 lb. A descriptive note of this battery is given in the *Westinghouse International Magazine* for February under the heading of the "World's Most Powerful Lightning Generator."

THE SHAPES OF MOLECULES.—The effective area which a molecule presents to a slow electron depends very markedly on the relative velocity of the two particles, and it has now been shown conclusively that, quite apart from the excitation of quantum transitions, classical kinetic theory cannot account for the nature of the collisions, and fails in particular to explain the apparent transparency of many substances for very slow electrons. In the first number of the new series of the *Annalen der Physik*, E. Brüche has given a review of the results obtained up to the present in this field, including a description of his own recent work upon ammonia and water-vapour. The collected curves showing the molecular area as a function of the speeds of the incident electrons are very instructive, and exhibit regularities which indicate that the details of the collisions are determined both by the atomic constitution of a compound and by the structure of its outer shell of electrons. Perhaps the most remarkable of these is the close correspondence between the curves for methane and for krypton. Dr. Langmuir and Prof. A. O. Rankine had already commented upon this similarity in other connexions, and more recently it has been found that their ionisation potentials are also not much different, being 13 volts for the atom, and 14·6 volts for the molecule. This resemblance to an inert gas evidently indicates that the molecule of methane possesses a high degree of symmetry, and, in the opinion of E. Brüche, affords good evidence for the old model for methane in which the four hydrogen atoms were placed at the angular points of a regular tetrahedron, and the carbon atom at its centre.

FIREDAMP EXPLOSIONS WITHIN CLOSED VESSELS.—The Safety in Mines Research Board has previously studied the effects of firedamp explosions within closed vessels, such as the casings of electrical switchgear, but has now extended this investigation to explosions in vessels divided into intercommunicating compartments (S.M.R.B., Paper No. 49, by C. S. W. Grice and R. V. Wheeler. London: H.M. Stationery Office). Beyling, in Germany, has shown that the ignition of an explosive mixture in one compartment may cause a considerable rise of pressure in another, and this result has been confirmed. An explosion of a mixture of firedamp and air in a comparatively large volume and propagated through a narrow opening into a smaller compartment, may lead to the rapid development of a high pressure, and violent explosions can be caused in this way by even weak mixtures of methane and air. Casings containing inter-connected compartments are therefore unsuitable for use in mines.

PROPERTIES OF BREEZE AND CLINKER AGGREGATES.—Further work that has been carried out on breeze and clinker aggregates is described by F. M. Lea in *Bulletin of the Building Research Station*, No. 5 (London: H.M. Stationery Office). The properties of such aggregates are dependent upon the amount and nature of combustible material present. Unburnt or partially burnt coal in breeze or clinker concrete is a frequent cause of failure, and the presence of only 4 per cent of coal may be responsible for serious damage. The coal causes expansion of the concrete during setting and maturing, and ultimately cracking results. Small quantities of sulphur do not appear to cause appreciable disintegration, although they may increase the rate of corrosion of reinforcement in the concrete. The presence of dust in the aggregate results in a longer period of setting, since more water is required for mixing purposes, but does not cause subsequent unsoundness. The *Bulletin* also describes methods of sampling and testing breeze and clinker aggregates in the field.

THERMAL DECOMPOSITION OF AMMONIA.—Baly and Duncan (1922) claimed that ammonia gas obtained by rapid evaporation of the liquid is less rapidly decomposed by a hot platinum wire than that produced by slow evaporation. This effect was attributed to the existence of two kinds of molecules in equilibrium in liquid ammonia, all the molecules being assumed to pass into the form with the higher energy content on slow evaporation, while on rapid evaporation the equilibrium was supposed to persist in the gaseous state. This work has been repeated by W. A. Stringfellow, who describes his results in the *Journal of the Chemical Society* for January. These results do not confirm those of Baly and Duncan, practically no effect being observed in place of a 25-50 per cent decrease in reactivity with rapidly evaporated ammonia. The addition of water vapour did not produce the great increase in decomposition observed in the earlier work. Stringfellow suggests that as Baly and Duncan apparently did not exhaust their reaction vessel before filling it with ammonia, a rapid inflow of gas would not sweep out the air so completely as a slow stream. The presence of adsorbed gases on the platinum wire might then account for the inhibition of the reaction observed when rapid evaporation took place. The existence of different species of gaseous ammonia appears to be very unlikely.

Cruise of the *Carnegie*.

THE non-magnetic yacht *Carnegie*, which left Washington last May for a three-year magnetic and electric survey of the oceans, has now completed the first unit of her voyage—that of encircling the North Atlantic. In three letters to the Carnegie Institution of Washington (published by the Press Service Bureau), Captain Ault, who is in command both of the ship and of the Expedition, describes the progress of the work so far accomplished. The first place was Plymouth, reached only after encountering severe storms, then Hamburg, Iceland, Greenland, Newfoundland and Barbadoes. Oct. 9 was the date planned for arrival at Panama, and as these letters were being finished the ship was about 140 miles from that place, and the date was Oct. 9, thus keeping well to the schedule.

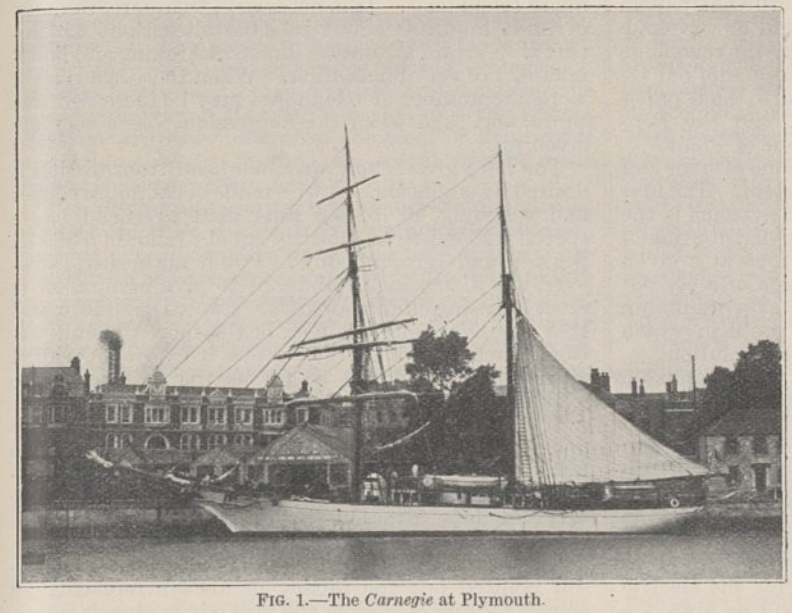

FIG. 1.—The *Carnegie* at Plymouth.

The work is in full swing. In this cruise a large amount of additional research in physical oceanography and biology is undertaken. Every other day a magnetic station is occupied for compass declination, inclination, and horizontal intensity. On alternate days an ocean station is occupied for water samples (salinity, hydrogen ion concentration, phosphate content, oxygen content) and temperature, with, occasionally, bottom samples and tow-nets.

The magnetic declination or compass variation at 135 stations has been determined, and the inclination and horizontal force at 49 stations, mostly near stations of former cruises. Atmospheric electric observations have been made daily and many photographic records of continuous daily changes in the electric potential gradient: also eight 24-hour series of observations of conductivity, ionic content, and penetrating radiation. Three hundred and thirty determinations of the depths of the sea have been made with the sonic depth-finder. This electrical apparatus for measuring the depth of the ocean floors records the time required for sound waves, from an oscillator mounted on the hull below the water line, to reach bottom and be reflected back to the surface. Checks with the wire soundings show that the accuracy of the depth-finder is within expected limits.

For biological studies, tow-nets at surface, 50 m. and 100 m. depth are taken, and the new Pettersson plankton pump, after several improvements, has been included as a regular instrument at each ocean station. This is so arranged that it can be worked at a given depth by the release of a 'messenger,' the power being supplied by a 30-pound weight on the end of 100 m. of wire wound on a reel on the pump. 150 litres of water is strained through a small silk net attached to the pump. When all the wire has run out the pump is closed off and hauled to the surface. Salinities are now determined by means of the salinity bridge by the evening of the day on which the samples are taken. Continuous records of both wet-bulb and dry-bulb temperatures or change of humidity at three positions have been secured. The 'boom walk,' as used by Beebe (two 30-foot booms with net between extending from the ship's side), enables the naturalist to walk out over the water and use the dip-net and tow-nets outside the disturbances caused by the wash of the ship.

On Aug. 7 a station was occupied at the edge of the Grand Banks of Newfoundland in the cold Labrador Stream, which at that point had a depth of 130 m. At the surface the temperature was 52° F., but at a depth of only 170 feet the thermometer fell to 34°. Three days later in the Gulf Stream the water surface temperature was 79°F.

Those who have seen the stores of spare apparatus on board have possibly marvelled at their numbers; careful provision fully justified when one realises the risk of loss every time an instrument is used. One such instance is recorded by Dr. Ault, when a bottom sampler, eleven Nansen water-bottles, and twenty-two deep-sea reversing thermometers were lost by the breaking of a wire about 2½ miles down.

FIG. 2.—Working the Pettersson plankton pump.

The *Carnegie* is happy in having contact by radio with America, England, France, Holland, and Germany.

The Expansion of Telephone and Supply Systems.

THE problems that arise in connexion with the expansion of telephone systems are in some respects analogous to the corresponding problems in the supply of electric lighting. The Institution of Electrical Engineers therefore arranged on Jan. 10 that papers on each of these subjects should be read at the same meeting so that the solutions adopted by the telephone engineers might be compared with those adopted by the supply engineers. The title given to each paper was "The Anticipation of Demand, and the Economic Selection, Provision, and Lay-out of Plant."

Mr. J. G. Hines discussed the telephone system and Capt. Donaldson the electric power system. The first problem that has to be solved in both systems is the forecasting of the probable number and distribution of subscribers that will exist in a given area at a given time. Once this is settled, the provision of a lay-out which will ensure an efficient service at a minimum cost over this period is a technical problem which should admit of a rigorous mathematical solution.

Secondary problems arise, however. In connexion with telephony there is the 'busy hour,' and in connexion with electric supply there is the 'peak load.' In trunk line telephony the difficulty is sometimes met by having a special tariff so as to induce subscribers to communicate at the less busy hours, and occasionally, in electric supply, by means of meters which register more rapidly at stated times. There are many points of dissimilarity between the two problems. When a house has been wired for the electric light, it is most probable that there will be always a user in that house. In the case of telephone supply, especially in private dwellings, a change of occupier usually results in the telephone circuit serving the premises being given up. This involves recovery of the apparatus and the temporary or permanent abandonment of all the internal wiring, which is always provided by the Post Office.

In large cities high-class property is often found next door to poor dwellings. Before the period covered by the Post Office forecast has expired, the smaller properties may be pulled down and replaced by blocks of flats or business premises, each requiring many telephones. It is necessary, therefore, to make detailed inquiries about possible alterations to property. Certain businesses like stockbroking and bookmaking are very fluctuating. When there is a rush of work the number of telephones may be increased five times, and then when the depression comes they are given up.

The data given show why overhead transmission is desired by engineers. A wire made of cadmium copper and weighing 40 lb. per mile used overhead has a speech transmission efficiency equal to that of a 200 lb. per mile underground cable. Public authorities, however, are increasingly reluctant to give permission to erect poles in public footways. Capt. Donaldson said that the telephone problem is the more difficult, because each consumer must have his own individual pair of wires at least so far as the first telephone exchange.

If the electric lighting stations built twenty-five years ago had been ten times larger, it would have been in the country's interest. The replacement of reciprocating engines by the turbine has made it possible to accommodate considerably larger units of supply in the original engine rooms, but in many cases considerable alterations have had to be made. Capt. Donaldson pointed out the fallacy of always replacing an engine by one of double the size; it is always necessary to assume that one engine may be out of commission. Hence the maximum reserve of power is obtained when all the engines are of equal size. The general situation is rapidly passing out of the hands of the smaller undertakers. Power engineers by careful study of the yearly loads can make reasonably accurate forecasts of the demand for some years in advance.

The Rubber Research Institute of Malaya.

THE first issue of the *Quarterly Journal of the Rubber Research Institute of Malaya*, Kuala Lumpur, January 1929, bears witness to the very active steps that have been taken to put the new Research Institute into working order. The director, Dr. G. Bryce, arrived in Malaya to take up his duties in September 1926. Some local appointments were made during the autumn of that year, and the other officers of the station were gradually brought in during 1927 and 1928, the seventeenth appointment being made in November 1928. By June 1927 the heads of the chemical, pathological, botanical, and soils divisions of the Institute were appointed, and engaged in visiting the neighbouring rubber research stations in Sumatra and Java. Temporary laboratory accommodation was provided by adapting a bungalow, and four months after the arrival of the heads of divisions in Malaya they had presented programmes of work for their respective divisions for the consideration of the Board of Control.

In this first issue of the *Quarterly Journal*, brief summaries of the work of the different divisions are given, for the period up to Sept. 30, 1928. These show that the officers appointed have lost no time in grappling with the many-sided problems presented by the commercial cultivation of the rubber plant, and the preparation of the latex for market.

The bulk of the journal consists of articles by various officers of the Institute upon many of the interesting problems that arise in connexion with research upon the growing and preparation of rubber. Besides being of interest to the rubber planters, many of these articles have special interest to botanists, colloid chemists, and other investigators of agricultural and industrial problems, who are not directly concerned with the rubber industry. Occasionally, however, a certain obscurity of expression makes some of these articles difficult to follow, and particularly if the Research Institute wishes to carry interested growers with it in its investigations through the medium of its journal, it would seem worth while to expend more time and trouble upon the form in which these investigations, often themselves of great intrinsic interest, are described in print.

Dr. Haines discusses a topic of very general interest in countries with a tropical rainfall when he reviews the pros and cons of methods of silt pitting as a means of defence against excessive soil erosion. Experience which this investigator obtained in the classic experimental fields of Rothamsted is here utilised to visualise a soil problem specially characteristic of tropical and sub-tropical conditions. The botanical division reports much active work upon vegetative propagation. Mr. Mann, fresh from his contact with methods of

fruit culture at the Experimental Station at Long Ashton, near Bristol, discusses the conditions governing successful bud unions in Malaya, where vigorous growth of shoot and scion at the time of union, together with fair humidity in the weeks following the budding operation, seem the most essential conditions for success.

Messrs. A. R. Sanderson and H. Sutcliffe give an account of some very valuable selection work on rubber they have had in progress before the formation of the Institute. These experiments confirm the general impression that the selection of high yielding stock on any other basis than the yield of dry rubber over a long period of tapping, can, as yet, only be made with considerable uncertainty.

The creation and propagation of high yielding strains —which Dr. Weir, the head of the pathological division, reminds the reader may be at any time required endowed with resistance to some newly introduced pathogen, such as the South American leaf blight, which Dr. Weir has studied in its native habitat—can obviously not be neglected by the Rubber Research Institute. Mr. Morris states that during a season's observations no pollen-carrying insect has been seen to visit the female flowers of *Hevea*, which, it must be remembered, is not of Malayan origin, but an introduced plant isolated from its normal insect visitors. Artificial pollination is successful between various selected clones, and a few seedlings have thus been obtained for further trial, but self-pollination within the clone is usually negative in result. The further analysis of the conditions, both internal and external, that contribute to successful pollination and fertilisation, is a promising field of investigation.

Many other points of detail as to the chemical properties of the rubber, its preparation and various commercial defects, diseases of cover crops, of young, budded plants, etc., are dealt with in this first number of the new journal. There is no doubt that if this standard is maintained, the *Quarterly Journal* of the new Rubber Research Institute will be a publication of permanent scientific value.

Association of Technical Institutions.

THE annual general meeting of the Association of Technical Institutions was held in the Grocers' Hall, London, on Feb. 22 and 23. As is customary, the installation of the president took place at the opening session, and, distinguished as have been the occupiers of the presidential chair in the past, the new president, Sir J. E. Kynaston Studd, is one of whom the Association may be justly proud. By a happy chance, the year of his presidency coincides with his year of office as Lord Mayor of London. But it is not only the civic honours that are his which distinguish him in and qualify him for his new office. For some years now his activities in connexion with the Regent Street Polytechnic, of which he is president, have been well known.

Since he was therefore in a position to speak to the Association as an expert, Sir Kynaston Studd's presidential address was expected to be one of unusual authority. Nor was his audience disappointed. His review of the work of such recent committees as the Balfour Committee on Trade, the Malcolm Committee on Education and Industry, and the Emmott inquiry into technical education and industry, was broad and illuminating. The conclusion he drew from the reports of these committees may be summarised by saying that, although the Board of Education is now in a position as a result of the work done to do much to help technical education to attain the greater place it merits in our system, a great deal of the task of getting industry to come more and more to the technical college for informed help must be borne by such associations as the A.T.I. In connexion with all this, he did not attempt to minimise the work done by the Atholl Committee on Examinations, but it was clear that he was closely in touch with the views of the majority of those engaged in technical education when he suggested that examinations are the least important part of the work of technical education. We were glad, too, to note that he pressed home a vital point to which attention has already been directed in these columns (see NATURE, Nov. 12, 1927, p. 681; and July 28, 1928, p. 121)—the status of the craftsman must be equal to that of any other worker; an end which will be difficult to attain unless industry is prepared to guarantee the same conditions of permanency to craftsmen as it does to clerks and others of the administrative staffs.

Papers read and discussed during the meetings included "Broadcasting and its Relation to Further Education," by Mr. C. A. Siepmann, of the B.B.C.; "Industrial Safety," by Sir Gerald Bellhouse, H.M. Chief Inspector of Factories; and "Technical Training for Women," by Miss E. E. Cox, of the L.C.C. Barrett Street Trade School.

In connexion with the paper on industrial safety, a visit was arranged to the Home Office Industrial Museum, where safety devices are set out in admirable fashion. Few people, as Sir Gerald Bellhouse pointed out in his paper, realise how big a toll accidents make upon industry. Yet the most recent figures show that 156,974 accidents (of which 973 were fatal) were reported during 1927 to the Factory Department. Out of these cases, those which come within the Factory and Workshop Acts mean that each year about £2,500,000 is paid in compensation: additional administrative, legal and medical costs must bring the figure to not less than £5,000,000 per annum. Statistics such as these should in themselves be sufficient to make employers, employees, staffs, and students of engineering schools in universities and technical colleges desire to visit the Home Office Industrial Museum, where may be seen all the best methods of preventing danger to life and limb which have become incidental to industrial processes.

University and Educational Intelligence.

CAMBRIDGE.—Mr. E. N. Willmer has been appointed University lecturer in physiology.

The following grants have been made from the Balfour Fund:—£100 to Dr. C. M. Yonge, for researches at Honolulu and elsewhere in reference to his experiments on the Great Barrier Reef; £50 to Mr. F. S. Russell, for researches on the plankton of the Great Barrier Reef region.

Birbai Sahni, Emmanuel College, has been approved for the degree of doctor of science.

LEEDS.—Mr. F. J. Dent has been appointed gas research chemist in the Department of Coal Gas and Fuel Industries in succession to Dr. A. Parker, who has resigned in order to take up a responsible post with the Water Pollution Section of the Department of Scientific and Industrial Research. Mr. Dent has been working in the Department under Prof. J. W. Cobb for the past two years upon the gasification of special cokes in oxygen, and upon heat treatment in hydrocarbon and other gases as a factor influencing the reactivity of coke.

LONDON.—An offer by the trustees of the late Mr. C. H. Clark of a sum of £10,000 for the establishment of a lectureship in the history and progress of preventive medicine and tropical hygiene has been accepted. The Prime Minister has forwarded a grant of £1000 from the Beaverbrook Fund for Medical Research, to be applied to the purposes of, and administered under, the scheme for the Thomas Smythe Hughes Medical Research Fund.

Dr. T. G. Hill, reader in plant physiology at University College, has been appointed to the University chair of plant physiology, tenable at University College, as from Aug. 1 next. He is the author (with Dr. P. Haas) of "An Introduction to the Chemistry of Plant Products" (1913), and of numerous papers on the structure and development of the higher plants, oxidative processes, etc., in botanical and other journals.

Dr. E. J. Salisbury, reader in plant ecology, has been appointed to the Quain chair of botany, tenable at University College, as from Aug. 1 next. His recent publications include papers on the influence of earthworms on soil reaction, geographical distribution of plants, and the causes and ecological significance of stomatal frequency.

Prof. W. E. Le Gros Clark, professor of anatomy at St. Bartholomew's Hospital Medical College, has been appointed as from Sept. 1 next to the University chair of anatomy tenable at St. Thomas's Hospital Medical School.

Sir John Dewrance, Prof. W. T. Gordon, Dame Helen Gwynne-Vaughan, and Sir John Snell are among the recently appointed fellows of King's College.

OXFORD.—All Oxford men who have worked in the University Museum will be gratified that the degree of M.A. *honoris causa* has been conferred on Alfred Robinson, assistant to the secretary to the curators, and a well-known figure to all science students in Oxford for the last fifty years.

At a forthcoming meeting of Congregation, decrees will be proposed expressing the gratitude of the University (1) for the gift, received through the Prime Minister, of £1000 from Lord Beaverbrook for the furtherance of medical knowledge, and (2) for the bequest by the late Prof. A. W. Scott of £4322 to be applied for the furtherance of physical science.

SHEFFIELD.—Applications are invited for an Ironmongers' Company Research fellowship, value £500, and for two Ironmongers' Company Research Scholarships, each of the value of £150, particulars of which can be obtained from the Registrar, The University, Sheffield. The latest date for the receipt of applications is April 1.

WALES.—Applications are invited from graduates of the University of Wales for five fellowships, each of the annual value of £200 and tenable for two years. The applications must be received not later than June 1, by the Registrar, University Registry, Cathays Park, Cardiff.

THE New York correspondent of the *Times* has announced three important gifts for education in the United States. North-Western University is to receive about £1,600,000 under the will of Mr. Milton H. Wilson; New York University has received an unrestricted endowment of £200,000 from Mr. and Mrs. Percy S. Straus; and Newhaven Hospital, which is affiliated to the Yale School of Medicine, has received £400,000 from the General Education Board of New York City, to be devoted to a new laboratory and dispensary and a service unit.

Calendar of Patent Records.

March 4, 1633.—On Mar. 4, 1633, Richard Delamain petitioned Charles I. that, in accordance with a promise given by the king two years earlier, he might have the sole making of a "mathematical instrument extracted from the logarithms and projected in circles for the speedy operating of mathematical practices." The petition passed the Signet Office on the same day, but no patent is enrolled, and it is uncertain whether this first patent for a slide rule was ever actually issued. Delamain was not the first inventor of the slide rule. The credit for this belongs to William Oughtred, who, according to his friend and translator, William Forster, had invented the instrument some years before and had not published the invention because "it is a preposterous course of vulgar teachers to begin with instruments, and so instead of artists to make their scholars only doers of tricks and as it were juglers; to the despite of art, losse of precious time, and betraying of willing and industrious wits unto ignorance and idleness."

March 5, 1825.—On this date there was granted to W. H. James, one of the pioneers of railway transportation, a patent for a system of train propulsion in which all the axles throughout the train were driving axles, longitudinal shafts on the carriages operating the wheels through bevel gearing and being connected to each other by universal couplings, the front shaft being driven by a steam engine or other agent. An experimental line was laid down on which inclines of 1 in 12 were successfully negotiated, but the system was never adopted on the railways of Great Britain.

March 6, 1648.—During the last few years of Charles I. the ordinary machinery of granting patents broke down, and there are no entries in the printed indexes for the period 1642–49. The patent granted to Sir William Petty on Mar. 6, 1848, for his invention of double and multiple writing, was issued by the authority of an ordinance of the "Lords and Commons assembled in Parliament," which formed the warrant to the Solicitor-General and to the Commissioners of the Great Seal. Petty seems to have had some difficulty in securing the adoption of the invention, for in the following year Parliament is petitioned by one Henry Morris to grant Petty and Morris "either a tax of 2*d.* a ream on paper, or 2*s.* 2*d.* on 60 skins of parchment for a few years, or else £1500 or £2000 down for their services, or some good office."

March 6, 1916.—Rustless steel first attracted public attention when stainless table-cutlery was introduced in 1914, though the importance of chrome and of nickel alloys had long been recognised. The remarkable properties of high chromium iron were, however, not fully realised until the researches of Harry Brearley of Sheffield, which resulted in the production of a steel containing between 9 and 16 per cent chromium and not more than 0·7 per cent carbon, which was practically untarnishable and could be forged, rolled, hardened, and tempered, under commercial conditions. Brearley's discovery was published before a British patent was applied for, but he obtained patents in Canada and the United States, the application in the latter country being filed on Mar. 6, 1916.

March 8, 1859.—A satisfactory cotton-harvesting machine has yet to be discovered, and most of the world's cotton is still picked by hand, but of the many attempts to solve the problem, the pneumatic picker has had the greatest amount of success. The first patent for a pneumatic harvester was granted in the United States to John Griffin on Mar. 8, 1859, steam being employed to produce the vacuum.

Societies and Academies.

LONDON.

Royal Society, Feb. 21.—**P. Kapitza**: The change in electrical conductivity in strong electric fields (Parts 1 and 2). The change of resistance in a transverse field at temperatures of room, of solid carbon dioxide and ether, and of liquid nitrogen, has been studied in many metals. It follows the same law in all of them. The formula obtained gives a square law in weak fields and a linear law in stronger fields. Change of resistance follows a linear law with increasing field, but in weak fields it is masked by disturbances existing in the metal equivalent to an internal magnetic field. This additional resistance is independent of temperature, while the ideal resistance has a constant value for a given temperature for each metal, independent of its physical and chemical state. The additional resistance is identical with the residual resistance which is observed at very low temperatures. Supraconductivity is a general phenomenon in all metals, but is masked by additional resistance, which disappears at very low temperature in certain metals.—**R. R. Nimmo** and **N. Feather**: An investigation of the ranges of the long-range α-particles from thorium C and radium C, using an expansion chamber. 'Extrapolated' ranges 9·90 and 11·70 cm. in standard air were obtained for the long-range α-particles from thorium C in the ratio of 1 : 5·1. 541 particles have been observed belonging to these groups. In addition, 9 had ranges between 12·5 cm. and 17 cm., and 13 had longer ranges. The range of the most abundant group of long-range α-particles from radium C was measured as 9·16 cm.; it is likely that there are others with ranges 8·1 cm., 10·0 cm., and 11·0 cm. respectively. Nearly 500 long-range particles from radium C were recorded.—**C. R. Burch**: Some experiments on vacuum distillation. The method of evaporative distillation can be applied to the derivatives of petroleum. An elementary kind of fractionation is possible. Petroleum derivatives of exceedingly low vapour pressure can be prepared.—**E. C. C. Baly** and **N. R. Hood**: The photosynthesis of naturally occurring compounds (4).—**B. W. Currie** and **R. Alty**: Adsorption at a water surface (1).—**W. G. Palmer**: Some adsorption isothermals for a plane platinum surface.—**B. Lambert** and **A. M. Clark**: Studies in gas-solid equilibria.—**G. C. Laurence**: Relative velocities of the alpha-particles emitted by certain radioactive elements.—**H. W. Thomson** and **C. N. Hinshelwood**: The mechanism of the homogeneous combination of hydrogen and oxygen.—**E. G. Dymond** and **E. E. Watson**: Electron-scattering in helium.—**E. T. Hanson**: Diffraction and resonance.—**S. Goldstein**: (*a*) The forces on a solid body moving through viscous fluid. (*b*) The steady flow of viscous fluid past a fixed spherical obstacle at small Reynolds' numbers. Oseen's equations for the flow of a viscous fluid at small Reynolds' numbers past a fixed spherical obstacle are solved completely, and a table given of the resulting values of the drag coefficient.—**J. Taylor**: On the chemical interaction of ions, and the 'clean-up' of gases at glass surfaces under the influence of the electrical discharge.—**H. M. Macdonald**: The total reflection of electric waves at the interface between two media.—**L. Hartshorn** and **D. A. Oliver**: On the measurements of the dielectric constants of liquids, with a determination of the dielectric constant of benzene. An accuracy of 1 in 10,000 is obtained, using a capacity method. The method requires a comparatively large volume of liquid. For very pure liquids in small quantities, a comparison method is used. The dielectric constant of benzene is 2·2825 at 20° C., with a probable error of ± 2 parts in 10,000, mainly due to difficulties of obtaining a sample absolutely free from water.—**J. W. Fisher**: The wave equation in five dimensions.—**E. Griffiths** and **J. H. Awbery**: Measurements of flame temperatures.—**K. Lonsdale**: The structure of the benzene ring in $C_6(CH_3)_6$. The benzene ring in this compound is similar in shape and size to the six-carbon ring in graphite, the nuclear carbons having a diameter of 1·42 A. Three of the valencies of aromatic carbon are co-planar, the ring itself and all the side chain carbon atoms lying in the (001) cleavage plane. The puckered or 'diamond' type of benzene ring, and Morse's model are inadmissible.

Geological Society, Feb. 6.—**E. St. J. Burton**: The horizons of Bryozoa (Polyzoa) in the Upper Eocene beds of Hampshire. Special horizons on which an abundance or deficiency of bryozoan remains occur are indicated within the three divisions of the Barton Beds (Lower, Middle, and Upper Barton). A recurrent facies of sedimentation may be coincident with the reappearance of species on higher horizons in the series.—**M. Black**: The upper estuarine series of Yorkshire. The Estuarine Series of Yorkshire is of deltaic rather than estuarine origin, and bears a close resemblance to the Coal Measures. The Upper Estuarine Series is best exposed in the coast-section between Gristhorpe and Cloughton (Yorkshire), where the sequence can be made out. It is possible to distinguish between autochthonous plant-beds and allochthonous, or drifted, ones. The former are rare in the Upper Estuarine Series. The drifted plant-beds are much better developed. Among these, a definite relationship exists between the type of sediment and the flora which it encloses. The plant-fragments seem to have behaved as a sediment transported by the water of the distributaries.

Society of Public Analysts, Feb. 6.—**T. P. Hilditch** and **Eveline E. Jones**: The fatty acids and component glycerides of some New Zealand butters. The procedure consisted in oxidising the butter fat by means of permanganate under conditions in which all unsaturated components were transformed into acidic products, whilst glycerides containing only saturated fatty acids remained unaltered. These fatty acids were recovered and their composition determined.—**A. Scott Dodd**: A new test for boric acid and borates. The pink coloration produced by adding mannitol and methyl red or sofnol indicator No. 1 to a neutral solution is characteristic of boric acid, a distinct reaction being obtained with so little as 0·2 mgm. The only substances causing any interference with the distinctness of the reaction are phosphates, arsenates, chromates, and tungstates, which make it difficult to ascertain the exact point of neutrality.—**B. E. Dixon**: The determination of small quantities of beryllium in rocks. The chief obstacle to the accurate determination of small quantities of beryllium in silicate rocks is the difficulty of separating it from titanium. This difficulty has been overcome by the use of *p*-chloroaniline, which will precipitate titanium completely.

DUBLIN.

Royal Dublin Society, Jan. 22.—**W. R. G. Atkins** and **H. H. Poole**: The photoelectric measurement of the illumination in buildings. The vertical illumination was measured simultaneously in an exposed position and in the building. The percentage ratio when the sun is obscured is called the 'daylight factor.' A dwelling-house and an old church were examined. The illumination in the former was less than 1 per cent

in most places, rising to 7 per cent just inside large windows, or 14 per cent with the photometer sloped towards the light. The factor in the church varied from 0·02 to 0·86 per cent, or, with sloped photometer, from 0·03 to 1·85 per cent. It seems to be futile to use special glass, transparent to ultra-violet light, in the usual type of dwelling-house in windows which do not, at some time of the day, receive direct sunlight.—**H. H. Poole**: A modified form of radium emanation apparatus. The apparatus in use in the Irish Radium Institute for pumping off emanation and drawing it into capillary tubes for therapeutic purposes has been modified so as to render its action more automatic, thus reducing the exposure of the operator to the radiations, and enabling the work to be carried on by a succession of less highly skilled workers than were required with the apparatus in its old form.

Royal Irish Academy, Jan. 28.—**P. J. Nolan** and **C. O'Brolchain**: Recombination of ions in atmospheric air (Part 1). Investigation of the decay coefficient by Schweidler's method. The linear recombination law for small ions in atmospheric air is verified. The recombination coefficient between small ions and nuclei is not constant. The variation does not appear to be connected with the concentration of dust particles in the air.—**P. J. Nolan**: Recombination of ions in atmospheric air (Part 2). The law of recombination of ions and nuclei. The relation between the rate of production of ions in atmospheric air and the equilibrium concentrations of small ions and nuclei is best represented by the equation $q = an^2 + \zeta n\sqrt{N}$ where $\zeta = 55 \times 10^{-5}$. The results of field observations generally support the proposed equation.

EDINBURGH.

Royal Society, Feb. 4.—**N. B. Eales**: The anatomy of a fœtal African elephant, *Elephas africanus* (*Loxodonta africana*) (Part 3). The contents of the thorax and abdomen, and the skeleton. A detailed specification of the Proboscidea is given, anatomical differences between *Elephas* and *Loxodonta* are noted, and the relationships between the Proboscidea and other orders of mammals are discussed. The group has numerous features of a primitive nature, in which it exhibits resemblances with the Rodentia, Sirenia, Hyracoidea and the Primates. The nearest relatives were the ancestors of the modern Sirenians.—**A. D. B. Smith** and **J. R. Brown**: Rôle of inbreeding in the development of the Jersey breed of cattle. Inbreeding has played a small part in the construction of the breed in England. Sewall Wright's coefficient now stands at only 3·9 + 0·3 as compared to the Clydesdale breed of horses with 6 and Shorthorn cattle with 26. Cows with annual lactations of more than 1000 gallons in less than a year are significantly less inbred, having a coefficient of only 1·85. Possible reasons are: (1) miscellaneous inbreeding does not produce good results in yield; (2) heterosis between two strains; (3) inheritance of milk yield may not be in a common autosomal manner, but may be sex linked, in which case only certain types of inbreeding would be effective.—**A. W. Greenwood** and **J. S. S. Blyth**: An experimental analysis of the plumage of the brown Leghorn fowl. Whereas the plumage typical of the male is developed independently of the gonad and depends for its maintenance on a certain level of thyroid functioning, both gonad and thyroid play a part in regard to that of the female: the former stimulates the latter to a higher level of activity than that present in the male and so indirectly causes a hyperthyroid effect on the feathers. At the same time it modifies this condition by acting directly on the feathers and restricting the deposition of melanin into pencillings.—**C. W. Stump**: A human blastocyst *in situ*. The blastocyst was obtained from the body of a woman aged forty-six years. It was fixed the day after the death of the mother, who was killed by a motor-car accident, but was slightly injured. Examination of the sections of the blastocyst and of the reconstructions made from the sections, place it in Bryce's group *D* of human blastocysts, which, now, with the addition of this new specimen, named H 381, and Stieve's Hugo specimen, includes thirteen blastocysts of relatively similar age.

GENEVA.

Society of Physics and Natural History, Dec. 6.—**Rolin Wavre**: The formula of Clairaut relative to geodesy. The author obtains Clairaut's formula by a method much simpler than those hitherto given. His calculation has the double advantage of not requiring the use of spherical functions and of making an approximation only at the last stage of the new and rigorous formulæ.—**Pierre Dive**: Internal movements of the terrestrial fluid. The author applies the formulæ recently established by him, on the laws of rotation of a heterogeneous fluid with a density increasing with the depth, to the case of the earth. Geophysicists admit that the continents should be considered as a light scoria floating on a denser viscous mass. The calculations of M. Dive give increases of velocity at a depth of 100 kilometres of 5·3, 7, 8·6, 9·5 cm. per second for surface densities of 3, 2·6, 2·5, 2·4 respectively. Of two continental masses floating in the viscous underlayer, the larger and more deeply submerged will be carried towards the east with a greater velocity. This movement is certainly much reduced by the viscosity, not taken into account in the calculations. This calculation gives a concrete and simple explanation of the tangential force which geologists have long considered as the principal factor in the deformations of the solid part of the globe.—**Adrien Jayet**: The age of the lower portion of the sub-lithographic limestones of the calcareous Alps of Haute Savoie. The lower part of these limestones, styled Senonian in the explanation of the geological map of France (1/80,000), merge laterally into fossil-bearing Cenomanian layers. Hence there is not, at the point where the latter are missing in the series, an interruption in the series. It is a matter of a lateral change of facies in a continuous sedimentary series.

VIENNA.

Academy of Sciences, Nov. 16.—**J. E. Hibsch**: The geological age of the sands and sandstones of the Bohemian Mittelgebirge, hitherto held to be Middle Oligocene.—**K. Menge**: (1) A theorem on the length of an arc.—(2) The general separation theorem.

Nov. 22.—**W. J. Müller** and **O. Löwy**: The theory of passivity phenomena. (4) The dependence of the specific time of passivation for iron on the concentration and nature of the electrolyte.—**R. Dworzak** and **T. Lasch**: Cyclo-acetals.—**F. Heritsch**: *Michelinia Abichi* from the upper carboniferous of Nassfeld in the Carnic Alps.—**D. Poerner-Patzelt** and **A. Pischinger**: The behaviour of the structures of striated muscle fibres towards acids. Muscles of various sorts were used in acetate–acetic acid buffers and with known hydrogen ion content and afterwards examined microscopically.—**K. Przibram**: A colour change by pressure (piezochromy) in fluorite. Green fluorite powdered and then compressed at 10,000 kgm. per sq. cm. becomes violet.—**L. Kober**: Mesozoic breccias in the upper schist cap of the Sonnblick and Glockner group.

Official Publications Received.

BRITISH.

Canada. Department of Mines: Mines Branch. Diatomite: its Occurrence, Preparation and Uses. By V. L. Eardley-Wilmot. (No. 691.) Pp. viii+182. (Ottawa: F. A. Acland.) 30 cents.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 385, January. Pp. 125-216+xxxvi. (London: E. and F. N. Spon, Ltd.) 10*s.* 6*d.*

The British Electrical and Allied Industries Research Association (Incorporated). Eighth Annual Report, October 1, 1927, to September 30, 1928. Pp. 71. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 14: On the Structure of *Palaeacis*. By Dr. Louis B. Smyth. Pp. 125-138+plates 6-8. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2*s.*

The Proceedings of the Physical Society. Vol. 41, Part 1, No. 226, December 15, 1928. Pp. viii+112. (London.) 7*s.* net.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1928. Pp. 24+12 plates. (Bristol.)

Western Australia. Annual Progress Report of the Geological Survey for the Year 1927. Pp. 39+11 plates. (Perth: Fred. Wm. Simpson.)

The Why and Wherefore of Farming: a Course for Elementary Schools in Rural Economy. By Dr. B. A. Keen. Course 1: Broadcast from London and Daventry, Fridays, September 21st–December 14th (omitting October 26th), 2.30-2.55 p.m. Pp. 32. 1*d.* Course 2: Broadcast from London and Daventry, Fridays, January 18th–March 15th, 2.30-2.55 p.m. Pp. 36. 1*d.* (London: British Broadcasting Corporation.)

Proceedings of the Royal Society of Edinburgh, Session 1927–1928. Vol. 48, Part 3, No. 16: The Lattice Points of a Circle. By Prof. J. R. Wilton. Pp. 191-200. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1*s.*

Department of Scientific and Industrial Research. Report for the Year 1927–28. (Cmd. 3258.) Pp. v+217. (London: H.M. Stationery Office.) 4*s.* net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 4, No. 1, January. Pp. 102+7 plates. (Cambridge: At the University Press.) 12*s.* 6*d.* net.

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 39, Part 4, January 21st. Pp. 369-503+viii. (London: Edward Stanford, Ltd.) 5*s.*

Rubber Research Institute of Malaya. Quarterly Journal, Vol. 1, Nos. 1 and 2, January. Pp. 120. (Kuala Lumpur.) 1 dollar.

Journal of the Indian Institute of Science. Vol. 11A, Part 14: Oil from the Seeds of *Adenanthera pavonina*—A Source of Lignoceric Acid. By S. M. Mudbidri, P. Ramaswami Ayyar and H. E. Watson. Pp. 173-180. (Bangalore.) 8 annas.

Southern Rhodesia: Geological Survey. Bulletin No. 11: The Geology of the Country around the Lonely Mine, Bubi District. By A. M. Macgregor. Pp. 96+7 plates. Short Report No. 23: Interim Report on the Geology of the Chromite Deposits of the Umvukove Range, Lomagundi District. By F. E. Keep. Pp. 10+3 plates. (Salisbury, S. Rhodesia.)

FOREIGN.

Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History, Yale University. Scientific Results of the First Oceanographic Expedition of the *Pawnee*, 1926. Vol. 2, Art. 5: Mollusks from the Gulf of California and the Perlas Islands. By Lee Boone. Pp. 17+3 plates. Vol. 2, Art. 6: Echinoderms from the Gulf of California and the Perlas Islands. By Lee Boone. Pp. 14+9 plates. Scientific Results of the Third Oceanographic Expedition of the *Pawnee*, 1927. Vol. 3, Art. 3: Deepsea Fishes of the Order Iniomi from the Waters around the Bahama and Bermuda Islands; with Annotated Keys to the Sudidae, Myctophidae, Scopelarchidae, Evermannellidae, Omosudidae, Cetomimidae and Rondeletidae of the World. By Albert Eide Parr. Pp. 193. (New Haven, Conn.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106a: Ergebnisse aerologischer Beobachtungen. 15, 1926. Pp. iv+46. 2.50 fl. No. 104a, Supplement: Oceanographische en meteorologische Waarnemingen in den Indischen Oceaan, December, Januari, Februari (1856–1910). Tabellen, Waarnemingen Noord van O°, (1856-1923). Pp. iv+36. 1.25 fl. No. 108: Seismische Registrierungen in De Bilt. 13, 1925. Pp. ix+52. 1.00 fl. (Utrecht: Kemink en Zoon.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 23, Part 2: Chemical Studies on the Brewing Barley. By Yukihiko Nakamura. Pp. 29-86. (Tokyo: Maruzen Co. Ltd.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 168-169: On the Mode of Areal Distribution of Gliding Sparks on a Surface coated with Granular Conductor, by Ukitirô Nakaya; On the Mechanism of Gliding Spark, by Torahiko Terada. Pp. 237-264+plate 8. 40 sen. No. 170: Physico-chemical Studies on Bioluminescence. 6: The Mechanism of Luminescence in the Cypridina Luciferin and Luceferase Suggested. By Sakyo Kanda. Pp. 265-269. 15 sen. Supplement, Vol. 9, No. 7: A Trial to remove Hydrogen from Higher Fatty Acids. By Tsuneo Suzuki and Torao Kurita. Pp. 5-6. 10 sen. (Tokyo: Iwanami Shoten.)

Japanese Journal of Physics: Transactions and Abstracts. Vol. 5, No. 2. Pp. 67-101+15-24. (Tokyo: National Research Council of Japan.)

Berichte der Deutschen Chemischen Gesellschaft. Jahrgang 62, Nr. 1. Pp. vi+295. (Berlin: Verlag Chemie G.m.b.H.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1571: The European Starling in the United States. By E. R. Kalmbach. Pp. ii+27. (Washington, D.C.: Government Printing Office.) 5 cents.

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Special Bulletin No. 181: A Study of Town-Country Relationships. By C. R. Hoffer. Pp. 20. Special Bulletin No. 186: Chrysanthemum Breeding. By Elmer D. Smith and Alex. Laurie. Pp. 30. Technical Bulletin No. 94: A Study of Gelatins and their Effect on Ice Cream. By P. S. Lucas and E. C. Scott. Pp. 24. (East Lansing, Mich.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 17: Bulletins of the Bureau of Education, 1906-1927; with Index by Author, Title and Subject. By Edith A. Wright and Mary S. Phillips. Pp. ii+65. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the United States National Museum. Vol. 74, Art. 1: New Diptera or Two-winged Flies from South America. By J. M. Aldrich. (No. 2746.) Pp. 25. Vol. 74, Art. 9: Moniezia, a Genus of Cestode Worms, and the Proposed Reduction of its Species to Three. By E. Leonard Taylor. (No. 2754.) Pp. 9+5 plates. Vol. 74, Art. 20: A new Species of Trichostrongylid Worm of the Genus Cooperia from the Carabao in the Philippine Islands, with a Review of the Genus. By Benjamin Schwartz. (No. 2765.) Pp. 5+1 plate. (Washington, D.C.: Government Printing Office.)

Institut de France: Académie des Sciences. Annuaire pour 1929. Pp. 386. (Paris: Gauthier-Villars et Cie.)

Division of Fish and Game of California. Fish Bulletin No. 12: The Weight-Length Relationship of the California Sardine (*Sardina caerulea*) at San Pedro. By Frances N. Clark. Pp. 59. Fish Bulletin No. 13: Seasonal Average Length Trends at Monterey of the California Sardine (*Sardina caerulea*). By Carroll B. Andrews. Pp. 13. (Sacramento, Calif.: California State Printing Office.)

CATALOGUE.

Catalogue of Scientific Books and Publications of Learned Societies. (No. 323.) Pp. 58. (Cambridge: W. Heffer and Sons, Ltd.)

Diary of Societies.

FRIDAY, MARCH 1.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—J. S. Fraser and E. D. D. Davis: Discussion on The Acute Ear: Microtia and Atresia of the External Meatus.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Informal Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Prof. T. P. Hilditch: Recent Advances in our Knowledge of the Structure of the More Common Fats.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—W. Lawson: The Rotor Bearings of Electricity Meters.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle-upon-Tyne), at 7.15.—Sir Joseph Isherwood, Bart., and others: Do the Rules of Classification Societies tend to improve Shipbuilding and Engineering in this Country?

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—S. E. Hollingworth: Evolution of the Eden Drainage in the South and West.—M. Chatterjee: The Accessory Minerals in the Bodmin Moor Granite.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—L. S. Atkinson: The Control of Electric Lifts.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at 51 West Regent Street, Glasgow), at 8.—E. C. Philbrow: Inspection.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. G. M. Slot: Deaths under Anæsthetics, with Special Reference to their Pathology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Robert Robertson: Infra-Red Spectra.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (Birmingham Conference on Chromium Plating).

SATURDAY, MARCH 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (I.).

MONDAY, MARCH 4.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Prof. Hans Przibram: Quanta in Biology.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. A. R. Short: Recent Literature concerning the Origin of Species.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—H. R. Lordly: The Waterproofing of Concrete Structures.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—A. H. R. Fedden: Air-cooled Engine Repairs and Layout.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Loughborough College), at 7.—G. L. B. Hall: Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—L. J. Hunt and others: Discussion on Variable-Speed Alternating-Current Motors.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Capt. J. M. Donaldson (Power Systems), J. G. Hines (Telephone Systems), and others: Discussion on The Anticipation of Demand, and the Economic Selection, Provision, and Layout of Plant.

HUNTERIAN SOCIETY OF LONDON, at 7.30.—Prof. A. W. Sheen: Some Aspects of the Surgery of the Spleen (Hunterian Oration).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. L. Hill: Modern Methods of Heating and Ventilation.

ROYAL SOCIETY OF ARTS, at 8.—Sir Thomas M. Legge: Thirty Years' Experience of Industrial Maladies (Shaw Lectures) (III.).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Prof. A. R. Ling: Recent Advances in the Chemistry of Polysaccharides and Allied Compounds.

SURVEYORS' INSTITUTION, at 8.—F. L. Thompson: Recent Developments in Town Planning.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Mrs. Gordon Gallien, J. W. Cornwall, and C. C. Rose: The Kalambo River and Falls-

TUESDAY, MARCH 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. G. Forbes: Past and Present Diphtheria in England and Wales, with Special Reference to the London Metropolis (III.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Evolution and the Problem of Species (VI.).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—B. N. Schwanwitsch: Studies on the Wing-pattern of *Catagramma* and Related Genera of South American Nymphalid Butterflies.—Dr. R. Broom: Note on the Milk Dentition of *Australopithecus*.—J. W. Low: Contributions to the Development of the Pelvic Girdle. III. The Pelvic Girdle and its Related Musculature in Monotremes.—J. S. Dunkerly: A Note on Parasites and the Natural Selection Theory.—S. Hirst: Additional Notes on Australian Mites of the Family Trombidiidæ, with Descriptions of New Forms.

INSTITUTION OF CIVIL ENGINEERS, at 6.—C. Gribble: Impact in Railway Bridges, with Particular Reference to the Report of the Bridge Stress Committee.

LONDON NATURAL HISTORY SOCIETY (at Winchester House), at 6.30.—W. H. Spreadbury: Common Birds of London's Country.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. B. Wedmore, Dr. W. B. Whitney, and C. E. R. Bruce: An Introduction to Researches on Circuit Breaking.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—W. L. Shand: Pictorial Impressions in Italy.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—W. S. Ascough: Pistons.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—A. E. L. Chorlton: The Heavy Oil Engine on Road and Rail.

ROYAL SOCIETY OF MEDICINE (Pathology Section) (Laboratory Meeting in Pathological Department, St. Thomas's Hospital Medical School), at 8.—J. Bamforth: Two Cases of Purpura with Unusual Blood Pictures for which Splenectomy was Performed.—R. J. V. Pulvertaft: Experiments with Streptococcal Toxin and Hæmolysins.—J. O. Oliver: Group Complement Fixation with the Gram Negative Cocci.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—Dr. M. Smith-Petersen, Sir Robert Jones, and others: Discussion on The Diagnosis and Treatment of Low Back Pain.

TELEVISION SOCIETY.—Annual General Meeting.

WEDNESDAY, MARCH 6.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. R. Campbell Thompson: Assyrian Remedies for Diseases of the Ears.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. M. M. Ogilvie Gordon: The Structure of the Western Dolomites (Lecture).

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (in Demonstration Room, Science Museum), at 5.30.—H. O. Clark: A Comparison between French and English Windmills.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Capt. P. P. Eckersley and A. B. Howe: Single Wave-length Working.

WOMEN'S ENGINEERING SOCIETY (at 41 Cadogan Square), at 6.—Lady Bailey: Flight round Africa.

UNIVERSITY OF GLASGOW ALCHEMISTS' CLUB (at Glasgow University), at 7.—Annual General Meeting.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall), at 7.—Dr. B. J. Owen: The Desiccation of Vegetable Material.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—A. L. Andrew: The Cryoscopic Method for the Detection of Added Water in Milk.—Christine Mary Fear: The Alkaloid Test for Tannin.

ROYAL SOCIETY OF ARTS, at 8.—T. Purvis: Commercial Art: its Value in Business and Art.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.—Prof. T. M. Lowry and A. G. Nasini: The Molecular Dimensions of Organic Compounds. Part I. General Considerations.—A. G. Nasini: The Molecular Dimensions of Organic Compounds. Parts II. and III.—Prof. W. A. Bone and R. P. Frazer: A Photographic Investigation of Flame Movements in Carbonic Oxide-Oxygen Explosions.—H. S. Patterson, Prof. R. Whytlaw-Gray, and W. Cawood: Some Observations on the Condensation of Water on Smoke Particles; The Process of Coagulation in Smokes; The Electrified Particles in Smokes; The Structure of Complex Smoke Particles.—*Papers to be read in title only*:—J. G. Semple: Cremona Transformations of Space of Four Dimensions by Means of Quadrics and the Reverse Transformations.—T. L. Ibbs and A. A. Hirst: The Thermal Conductivity of Gas Mixtures.—D. M. Newitt, B. J. Byrne, and H. W. Strong: Equilibrium in the System Methyl Alcohol–Hydrogen–Carbonic Oxide.—Prof. W. A. Bone, F. R. Weston, and D. A. Winter: Further Experiments on the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part III.—Dr. E. K. Rideal and O. H. Wansbrough-Jones: An Investigation on the Combustion of Platinum.—R. W. Ditchburn and F. L. Arnot: The Ionisation of Potassium Vapour.—Prof. O. W. Richardson and P. M. Davidson: The Spectrum of H_2: the Bands Analogous to the Parhelium Line Spectrum.—R. C. Johnson and R. K. Asundi: A New Band System of Carbon Monoxide.—Prof. H. A. Wilson: The Theory of Cracking Petroleum.—Prof. T. H. Havelock: The Dispersion of Double Refraction in Quartz.—Prof. A. Fowler: The Arc Spectrum of Silicon.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. B. Verney: Polyuria (Goulstonian Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Rev. W. H. Draper: The Use of Language and its Difficulties.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—C. N. H. Lock: Airscrew Body Interference.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (Annual Meeting) (at Bristol University), at 7.30.—Chairman's Address.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—W. T. Griffiths: 'Theory,' 'Practice,' and Nickel.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—E. S. Ritter: Picture Telegraphy (Lecture).

CHEMICAL SOCIETY, at 8.—F. G. Mann: The Stability of Complex Metallic Salts.—A. B. Manning: The Determination of Unsaturated and Aromatic Hydrocarbons in Light Oils and Motor Spirits.—S. Glasstone: Studies of Electrolytic Polarisation. Part VII. Complex Cyanides. (*a*) Silver. Part VIII. Complex Cyanides. (*b*) Copper.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Annual General Meeting.

FRIDAY, MARCH 8.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3.15.—W. H. Nuttall: Rubber and its Commercial Applications.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—W. H. Moreland: The Indian Peasant in History.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. S. Chapman: Solar Streams of Corpuscles: their Geometry, Absorption of Light, and Penetration.—N. Goryatscheff: Occultations of Stars by the Moon, observed at the Tomsk University Observatory during the Year 1928.—Prof. S. Chapman and V. C. A. Ferraro: The Electrical State of Solar Streams.—Y. Ohman: Astronomical Consequences of the Polarisation of Fluorescence.—W. H. McCrea: The Hydrogen Chromosphere.—C. L. Janssen: Provisional Elements of the Binary System β. G.C. 12307.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. N. V. Sidgwick: Chemical Linkage.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. E. Griffiths and J. H. Awbery: The Dependence of the Mobility of Ions in Air on the Relative Humidity.—Prof. A. M. Tyndall: Some Unsolved Problems relating to the Mobility of Gaseous Ions—followed by a General Discussion on the Mobility of Ions.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. A. Hall: Bromide Papers.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. H. Hole: Road Transport (Chairman's Address).

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (jointly with Leicester Association of Engineers) (at Secular Hall, Leicester), at 7.30.—Dr. J. Newton Friend: Science in Antiquity.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—D. F. Campbell and W. S. Gifford: Progress in Electric Furnaces.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—S. T. Kinsman: The Fastness to Light of Lake Colours.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. F. Tout: The Place of Women in Later Medieval Civilisation.

SATURDAY, MARCH 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford Molecular Motions in Rarefied Gases (II.).

PUBLIC LECTURES.

FRIDAY, MARCH 1.

UNIVERSITY COLLEGE, at 5.15.—Dr. F. A. Freeth: The Four Component System in Peace and War.

SATURDAY, MARCH 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth Davis: English Food, Past and Present.

MONDAY, MARCH 4.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE, at 4.45.—Sir Alan Cobham: Adventures in Empire Flight.

LEEDS UNIVERSITY, at 5.15.—Prof. D. M. S. Watson: Animal Flight.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.30.—Dr. A. M. Ramsay: The Eye in General Medicine. (Succeeding Lectures on Mar. 6 and 8.)

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—A. W. Street: Recent Developments in the Marketing of Agricultural Produce.

TUESDAY, MARCH 5.

UNIVERSITY COLLEGE, at 5.30.—Prof. Karl Pearson: The Heredity of Albinism, illustrated by Recent Work on Albino Dogs and their Offspring.

THURSDAY, MARCH 7.

UNIVERSITY COLLEGE, at 5.15.—Prof. Hans Przibram: Concerning Laws in Animal Morphology. (Succeeding Lectures on Mar. 11, 14, and 18.)—At 6.—S. A. Hill-Willis: Concrete Roads.

40 TORRINGTON SQUARE, W.C.1, at 5.30.—N. B. Jopson: The Early Civilisation and Religion of the Slavs.

FRIDAY, MARCH 8.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Assyrian Studies in the Present and Future.

SURVEYORS' INSTITUTION, at 5.30.—Prof. J. S. Huxley: Heredity and Society (delivered in connexion with the Institution of Professional Civil Servants).

SATURDAY, MARCH 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. W. Sloley: The Cave-Artists of the Stone Age.