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Science and the Human Factor.

In the present industrial depression there are many who regard rationalisation as on trial, and question the value of large industrial combinations. It is suggested that such combinations are themselves partly responsible for the increase in the volume of unemployment, and that they tend to ignore the human factor. While, however, it is freely admitted that rationalisation may and often does involve a temporary displacement of workers, the expansion in new directions which takes place as a direct result of more efficient management soon tends to absorb more than the number of workers displaced.

The issue is partly obscured by the tendency in some quarters to confuse rationalisation with mere industrial amalgamation and cartels. Scientific management is, however, a larger question even than rationalisation, in that it is of importance to industrial undertakings of every size; although, in theory at least, scientific management would itself initiate a policy of rationalisation if the facts in particular cases warranted it. The importance of scientific management under modern industrial conditions is, however, undisputed; and valuable work is being done in this field both by the International Management Institute and by the Institute of Industrial Administration.

Labour has now come to realise, to some extent, not only that science is much more than mechanical invention, and that scientific research is continually responsible for creating new industries and fresh employment, but also that under modern conditions the application of scientific methods of thought to the control of industry is of the utmost importance. In spite of the fact, however, that applied science has eliminated from certain of our industries some of the grosser forms of labour which were formerly accepted as a matter of course, and that, contrary to prediction, hours of work have been decreased and not increased, the essentially humanising influence of scientific thought and method in industry is still far from being appreciated. It is noteworthy, therefore, that in the scientific studies of management problems which are being carried out by the International Management Institute, the main object is to safeguard the human factor and, instead of viewing man as a piece of mechanism, as in Taylor's system, to adapt the machine to the man. The selected subjects for research have included, for example, welfare devices, the selection and training of workers, and accident prevention. Efficient business management to-day

and any true rationalisation policy are invariably characterised by a careful study of the human factors, which are, indeed, regarded as of supreme importance. It is now widely realised that industrial efficiency cannot be attained unless the conditions of work are such as to secure the health and intelligent interest and co-operation of the workers to the maximum extent.

The part played by science in securing improved and safer conditions of labour is often overlooked, but the work of the Industrial Health Research Board alone would demonstrate the importance of scientific research in this field. Industrial physiology, of course, is only one section of the field of scientific management, but it is the section in which the most important modern developments have occurred. During recent years, the study of industrial physiology and psychology has elaborated methods of preventing strikes and of promoting co-operation between the different organisations of production, which are to-day part of the scientific organisation of labour in America. These researches have the same object as the strict application of Taylor's principles in factory and workshops. The success of such work is demonstrated by the changed attitude of the workers, who recognise that attempts made to increase production have become more humane and devote more attention to the human side and the health of the operators.

Much of the work of the Industrial Health Research Board is only preparatory, but conclusions have already been reached which involve no revolutionary changes and, indeed, only place on a scientific and statistical basis the empirical practices of progressive firms. The value of such results is demonstrated by the fact that they have already been adopted in certain branches of industry, and more widespread acceptance would greatly increase their utility. For example, the American Bedaux system, which has already been introduced by a number of important firms in Great Britain, essentially incorporates the rest-pause, the value of which has been so conclusively demonstrated by the work of the Board, and settles the wage of the operative on the basis of the work he does and the compensatory rest period which should follow.

In spite of the complexity of the problem presented by industrial physiology, there is no reason to be dissatisfied with the rate of progress. On the contrary, the Industrial Co-ordination Committee appointed by the British Association at Bristol last year has drawn up a programme for the centenary celebrations in September which is designed to facilitate and co-ordinate the contribution of science to industry and its management. The programme includes five citizens' lectures and a series of meetings to discuss such subjects as research into management problems, the training of managers, physique, posture and environment in relation to work, and the contributions of science to economy and safety in transport.

This work on industrial health and conditions of work has a definite relation to the movement towards industrial safety which received so large a stimulus from the Conferences of the International Labour Organisation in 1928 and 1929, and particularly from the Industrial Safety Convention adopted at the latter Conference. Industrial health is not simply a matter of securing that adequate precautions are taken in the handling of toxic materials or of dangerous machinery. Science can do much to eliminate such risks, and it is well known that the accident rate in works where explosive or highly toxic substances are handled under pressures of hundreds of atmospheres or at very high temperatures is frequently below the average in industry. Indeed, for every case of poisoning by gases or fumes in the chemical industry, there are twenty-five accidents caused by falls or slips.

Statistics reveal that ninety per cent of industrial accidents are due to failure of the human element. Such failure may be manifested in two ways. In the first place, it is frequently due to ignorance of the existing dangers or of the precautions required. The cleaning and repair of containers, to which a session was devoted during the recent National Safety Week in Leeds, is a pertinent example. While the precautions to be observed in the handling of containers used for the storage and transport of such organic solvents as carbon disulphide, ether, benzene, and naphtha are comparatively well known in chemical industry, largely owing to its relatively high percentage of scientific personnel, they are far from being adequately known in the large number of other industries in which such solvents are widely used. The large number of trade or fancy names under which solvents are sold is an added danger and is frequently responsible for the omission of precautions. Even in the chemical industry itself, while the toxic and fire risks are well known, the danger of fire or explosion from the generation and accumulation of static electric charges by the flow of such solvents through pipe lines, etc., is frequently overlooked. One of the most important problems of industrial safety is the handling of the mass of vital information scattered through general scientific

literature and its presentation in a convenient form for use by those concerned.

A disaster like that at the chemical works at Castleford a year ago is fully investigated, but as many lives may be lost in a sequence of accidents during a year owing to a repetition of avoidable circumstances, without adequate publicity or investigation. Through lack of information as to the causes of such minor explosions or accidents, casualties may occur year after year in different countries before effective means of prevention are discovered. The publication, abstracting, and indexing of safety information is a formidable problem and awaits an organised attack by scientific workers, before the results of their researches can become freely available for the development of adequate safety measures in industries that are not static but continually expanding and changing as a result of scientific research.

Such important contributions of science cannot entirely eliminate the human factor in accidents. Not only is some slight failure of the human element—momentary neglect or carelessness—responsible for ninety per cent of industrial accidents, but also accidents are always unduly prevalent among a comparatively small number of workers. The evidence shows that absenteeism due to sickness is usually abnormally high among the same persons, and that on an average they are also less skilled at their work. Generally it may be said that those who are most suited to their work or environment react the most healthily to their environment, whether we measure the reaction by working efficiency or skill, tendency to sickness, or proneness to accidents.

It is thus evident that vocational selection is of outstanding importance as much from the point of view of industrial safety as from that of industrial efficiency. No more valuable work is being done by the National Institute of Industrial Psychology than that which it is carrying out in this field, and as a result of the application of scientific methods remarkable progress has already been made. In spite of the cramping influence of unemployment on the application of some of the newer methods of vocational selection and guidance which have been elaborated, it has been demonstrated that we can at any rate avoid placing in dangerous positions those peculiarly liable to accidents, and the policy of eliminating the unfit before and not as a sequence to accidents is not utopian. A classification into risk classes according to personal characteristics has already been indicated as possible.

During the last century, therefore, it may be said with confidence that the whole tendency of science has been towards the amelioration of conditions of work. Grosser forms of labour have been eliminated or transformed. Scientific measures of protection have been elaborated which have rendered innocuous industrial processes which would have seemed incredible a generation or two ago. Scientific research in industrial physiology and psychology is continually improving conditions of work so that both the health and efficiency of the worker are improved, and is now being applied to ensure that, so far as possible, young persons entering industry are fitted into occupations for which they are temperamentally suited.

Such progress has inevitably improved the relations between science and labour, and those relations would become more intimate if scientific workers addressed themselves more whole-heartedly to the work of education. Upon their efforts the increasing expansion and application of the investigations of the Industrial Health Research Board and of the National Institute of Industrial Psychology largely depend. The success of industrial safety work depends fundamentally upon the co-operation and enthusiasm of the scientific and management staff in industry. Nor can the human aspects of rationalisation and its insistence on co-operation be more effectively served and fully influence industrial developments than through the power which scientific workers can exert through their privileged position in industry and their devotion to that ideal of service to which the spirit of science is kin.

The Problem of Butterfly Migration.

The Migration of Butterflies. By C. B. Williams. (Biological Monographs and Manuals.) Pp. xi + 473. (Edinburgh and London: Oliver and Boyd, 1930.) 21*s.* net.

FOR many years naturalists have known that the author was collecting material for this work, and have looked forward with great interest to its appearance. His own experiences have been prolonged and varied—gathered during considerable periods of residence in Trinidad, Egypt, and the north-eastern area of Tanganyika Territory. He has thus been able to compare the phenomena of migration presented by different butterflies in different parts of the world, as well as those presented by the same species during successive seasons in the same area. He has also diligently collected records of migration wherever they could be found. The difficulty in tracing the numberless references

to the subject must have been immense, and an exhaustive treatment of the literature in any reasonable time, impossible; for, as the author points out, "owing to the way in which they strike the general public, records of large flights of butterflies appear to be particularly frequent in popular magazines, and it is recognised that many such accounts must have been missed". He therefore appeals to naturalists for help by sending references direct to him or by publishing the data in some convenient journal under a suitable title. "Few things", he writes, "are more exasperating than to discover that one has overlooked an important record of butterfly migration which was described in a popular book, 'Through Malayan Mud in a Motor', or—still more unforgivable—in a serious entomological paper entitled, let us say, 'New Diptera Nematocera from Tasmania'!" It is to be hoped that these words will receive the attention they deserve, and that the author will be given all possible help in his important and interesting inquiry.

The scope and general treatment of butterfly migration in this work may be inferred from the Contents, which show that, after a brief introduction, the volume is arranged in five parts: I., A preliminary discussion giving a general outline of the subject, and, in a second chapter, describing flights in progress; II., migration treated according to species, the evidence being given in ten chapters, of which the last treats of migratory moths: two chapters, vi. and viii., are devoted respectively to *Danaida plexippus* and *Vanessa cardui*, the chief migrant butterflies; III., migrations considered geographically—a single chapter, in which certain special areas are treated; IV., general discussion in seven chapters, dealing respectively with the nature of migratory flight, the condition and behaviour of migrants, causes of the start, determination of route and goal, comparison with other animals, general problems, summary, conclusions, and future work. Part V. contains an admirably full bibliography, followed by four indices on general subjects, species, countries, and authorities quoted.

It will be clear from the above abstract that the work is well arranged and comprehensive, and that any one of the vast number of records which are included can be easily found. It is, in fact, a rich mine of information on a fascinating subject, and this leads to the only serious general criticism of the volume. The author appears to have been so intent on the admirable plan of collecting and setting before us all the available data, that he rarely 'lets himself go' on the relatively few observations which seem to be especially illuminating. Thus, on the interesting subject of "Butterflies resting on the Sea" (p. 342), the observations of F. Muir and J. C. Kershaw, although conducted upon moths, certainly throw more light on this aid to migration than any of those quoted. These naturalists were on a voyage from Hong Kong to Ceram, and on Nov. 29, 1908, were about 190 miles S.S.E. of the Lower Cochin China coast and about 120 miles from the Great Natunas. "About 10 A.M.", Mr. Muir wrote, "we noticed many small moths settled over the deck and all in *perfect* condition, as if just hatched. At first we suspected that they were bred in the ship, but soon discovered that they were coming on board in numbers. . . . They had the power of resting on the surface of the sea—even in the broken water around the bows of the boat—and then rising and continuing their journey." Sixteen small moths belonging to four species, and including one delicate 'Plume', were collected. The naturalists believed that these had flown from "the Lower Cochin China coast, and, if no bad weather turned up, would reach the various islands, and even Borneo, in fair numbers". All four species had a wide range, unaccompanied by marked local variation, over tropical Asia and the islands to the south—facts to be reasonably explained by the power of distribution in the manner described above (*Proc. Ent. Soc. Lond.*, pp. xxxviii-xl, 1909). The reference to these observations is to be found in the bibliography but, unfortunately, not under the names of the observers. It may be added that comparatively heavy moths can also rise in flight after coming to rest on the surface of the sea, as observed by C. L. Collenette in the Gulf of Panama (*ibid.*, **3**, p. 65, 1928). That the resting-place is not without danger is shown by a Hawk-moth taken from the stomach of a fish in Suva Harbour, Fiji, and presented to the Hope Collection by Lieut. L. H. Mosse-Robinson.

Again, the existence of a social stimulus leading butterflies of other species to join a migrating stream, a subject briefly alluded to on p. 353, appears to be proved by another significant observation made by Mr. Muir, who describes "the sweeping up of the non-migrating butterflies on a Papuan island when a migratory flight from another island passed over it. In this instance, in which more than a single species was involved, it is evident that the social stimulus, and this alone, availed to compel the non-migrating butterflies to become migrants—with such success indeed that the island was comparatively depleted of these species after the migratory stream had passed" (*ibid.*, **4**, p. 19, 1929). In this instance the bibliographical reference omits the

observer's name and also, unfortunately, gives no clue to his illuminating observations.

In the important discussion (Chapter xvi.) of the conditions determining the start of a migratory flight it would have been well to refer back to pp. 96 and 97, where observations on the overcrowding of Pierine breeding-places are quoted—those of Robinson in India and Pitman in Uganda—or even better, to have quoted or transferred the relevant passages. The words of the last-named naturalist might also with advantage have been added to the quotation on p. 97—" It struck me at once that such a breeding area must most certainly be the source of some of the numerous Pierine migrations so frequently witnessed in this part of Africa " (*ibid.*, 3, p. 45, 1928). The suggestion of a perennial source is also supported by the fact that the butterflies sent home were shown by their small size to have been starved, and that similar dwarfed specimens had been received two years before from a migratory flight of the same species encountered far to the south of the great breeding-ground in the West Nile Province (the old Lado Enclave) so graphically described by Pitman (*ibid.*, p. 46). Referring to the overcrowding witnessed by Robinson and Pitman, the author writes on p. 97 : " There is little doubt that it is from such mass breeding areas that flights start, but apparently in both these cases conditions were not, or had not been, suitable for bringing about a migration. If one such area could only be watched for a continued period we might learn much as to the origin of migration." Until such prolonged observations can be carried on, we shall rarely be offered the direct evidence of flight from an overcrowded area. Occasionally, however, by a happy accident a naturalist has been present at the critical period. Thus, Sir Guy Marshall has recorded that the migration of another Pierine butterfly (*Catopsilia florella*) was actually taking place from a Rhodesian valley where the conditions were those described by Robinson and Pitman (*ibid.*, p. xiv, 1921). Here, too, it would have been well if this brief but important record had been quoted and referred to in the bibliography under the name of the observer.

A few points of systematic interest and a good many mistakes in the spelling of names, although but a very small proportion of those which appear, will require adjustment in a later edition. Thus, *Danaida plexippus*, the great North American 'Monarch' which has spread to so many parts of the world, is treated on p. 149 as if it were the same species as a much smaller Danaine, the Oriental *D. genutia*. Although the two butterflies are closely related and the latter represents the Old World ancestor of the former, there can be no doubt that they are *now* entirely distinct. *Libythea*, which has unfortunately given its name to a sub-family (Libytheinæ) of the Erycinidæ, as shown on p. 242, has now been removed from this family and placed among the Nymphalidæ. The following mistakes in spelling were noted : *limniacea* for *limniace* (36, 80), *camadera* for *camadeva* (40), *erithronius* for *erithonius* (49, 460), *Pinacopterix* for *Pinacopteryx* (99), *gidaca* for *gidica* (105), *aglaiæ* for *aglaia* (116), *napae* for *rapae* (125), *Synchlœ* for *Synchloe* (126), *Telechina* for *Telchinia* (240), *andromycha* for *andromache* (240), *Cymathœ* for *Cymothoe* (285, and œ elsewhere), *Sarangesia* for *Sarangesa* (401), *berenica* for *berenice* (403), *vitelline* for *vitellina* (408). These collected errors will create an unfair impression unless it is remembered that they are very few as compared with the great number of names printed in the volume. Nearly all the verified references were found to be correct, although " Carpenter " did not appear on page 137, given in the index. Also, the reference on p. 354 (l. 8) to a publication in 1922 should have been given as 1921, correctly quoted in the bibliography.

The preparation of this most valuable work has been an immense labour and its appearance will lead to rapid advance in our knowledge of the subject, leading to that noble fate which the late G. H. Verrall described in arresting words : " The finest monograph is the one which will be soonest out of date ! "

E. B. P.

Robert Hooke.

Early Science in Oxford. By R. T. Gunther. Vol. 8 : *The Cutler Lectures of Robert Hooke.* Pp. vii + xii + 391 + 18 plates. (Oxford : The Author ; Magdalen College, 1931.) 25*s.*

ROBERT HOOKE was an Oxford man, for he was a servitor at Christchurch, and an assistant to Boyle there, before he came to London to work for the newly founded Royal Society. Hence the appropriateness of this volume, which might otherwise escape us ; for Hooke, living all the best known period of his life at Gresham College, as Gresham professor, and as Curator of Experiments to the Royal Society, as surveyor of the City of London and architect of some of its buildings, even as a Westminster boy, seems essentially a Londoner.

The Cutler Lectures, which were founded to give Hooke " wherewith to scolay ", offered an occasion for him to publish his many-sided ideas. As

Dr. Gunther says, the volume in which they are collected has now become exceedingly rare. Hence he has reproduced the whole in facsimile; or nearly in facsimile, for, though every page and diagram has been photographed, there is almost as wide a difference in flavour between this book and the original of it as there would be between the original Robert Hooke and a modern waxwork image of him. Still, we have Hooke's words, and they deserve some attention, for he was a very remarkable man, and has passed into the history of science as a jealous and querulous claimant for originating discoveries that other people perfected.

It is quite possible that Hooke was a difficult man in his personal relations; but there is nothing in this volume to justify the reputation that has clung to his memory so persistently. His mind was one of extraordinary fertility, and there seems to have been no branch in the seething physical discoveries of the second half of the seventeenth century in which he did not mingle, and to which he did not contribute. Hence he usually found himself in competition with others; but even in the controversy with Hevelius on the advantage of using optical aids to enhance the value of the divisions of an astronomical instrument, he was not only right, but also appears to have written no word that was less than civil or that one would wish to withdraw. Nor, in saying so, need we allow for the somewhat ferocious manners his times permitted. Everyone knows that he was inventive and industrious, but not everyone that he wrote as a man of careful, judicious type, who knew exactly where theory ended and what could be done with the practical resources then at command.

Hooke's misfortune was that he covered the whole field of scientific curiosity, and that in every branch of it there were better, if more limited, men than he. He was a good astronomer, but Hevelius and even Flamsteed were better. He appears to have been a beautiful mechanic, with a fine sense of design, but the brothers Constantine and Christian Huygens were even finer. He was a distinguished architect, but not to be mentioned with Wren. Finally, he had a penetrating insight into physical theory, only to be utterly outclassed by Newton.

'Hooke's Law' for the restitutive force of springs, with its application to the production of synchronous watch-balances, and the bending moment for beams, we find here. Though many of the other matters are controversial, and need not now concern us, possibly the most remarkable of his anticipations is that contained in the first of these lectures. It is largely unknown, because its outcome was negative. It is a search for stellar parallax, as a practical verification of the Copernican theory, such as afterwards led Bradley to the discovery of aberration, and it is conducted on exactly the same star, γ Draconis, and by exactly the same method, a fixed vertical telescope. It was carried out with all the thoroughness and forethought and skilful design that would have ensured success, had it been anywhere within reach.

R. A. S.

Surveying Methods.

(1) *Applied Aerial Photography.* By Capt. Ashley C. McKinley. With a Chapter on Oblique Aerial Surveys (Canada), by A. M. Narraway. Pp. xiv + 341. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1929.) 25*s.* net.

(2) *La topographie sans topographes: traité de photogrammétrie.* Par F. Ollivier. Pp. xviii + 301. (Paris: Éditions de la *Revue d'Optique théorique et instrumentale*, 1929.) 42 francs.

(3) *Mesure optique des distances et méthode des coordonnées polaires avec étude spéciale du tachéomètre auto-réducteur Bosshardt-Zeiss.* Par Rodolphe Bosshardt. Traduit par Prof. Maurice Delessert. Pp. 172. (Genève: Georg et Cie, 1930.) n.p.

(1) THE title of the first of these books is ill-chosen. The subject is the technique of air photography for topographical purposes. There are brief excursions into map reading and plotting, but they, like the bibliography, are but notes by an amateur for amateurs. On the other hand, the technique of flying, photographing, developing, indexing, 'mosaicing', and the like, shows the hand of an experienced and practical man. Mr. McKinley knows his own subject. He is an enthusiast, for he thinks that the "*exclusive* use of ground surveying will . . . become obsolete". On the other hand, he realises that "no one factor has retarded advancement . . . so much as the assertion of exaggerated claims". He writes for an American audience, describes American aircraft and cameras, and uses such words as "restitution" (of air photographs) and such expressions as "dividing the polyconic projection into rectangles". Enough has been said to show that Mr. McKinley's book will be a useful one for pilots and photographers; but of small value to the surveyor who has to apply these photographs to his map-making.

A final chapter by Mr. Narraway, Dominion Land Surveyor of Canada and Aerial Surveys Engineer,

describes the perspective grid (oblique photograph, small scale) mapping method, originally suggested by the late Dr. Deville and used with such success in the mapping of the Laurentian Plateau.

(2) Commandant Ollivier deserves our thanks. He deals with ground photo surveying—from Laussedat and Deville to Van Orel, and from photogrammetry to the stereoautograph—and he promises another volume to deal with air photo survey. History, instruments, precision, errors, methods, processes, and results are all as clear and logical as one expects from the best French books. It is perhaps not very important that the author's lack of interest in foreign methods and personalities is equally French.

This is, for its compass, the clearest guide to the subject which has appeared. It is all to the good, too, that Commandant Ollivier is an enthusiast. The comparisons with ground methods are, however, exactly on a parallel with those of Deville. Neither the one nor the other knows how small scale topography should really be done. But that is not the point. Anyone who wants the theory and practice of photo surveying can get it from this book, and will be very interested ; but let him remember two points which are not brought out. First, you cannot survey if you cannot see, and therefore you cannot use photo surveying in a forest or in a flat country of hedgerow timber ; and secondly, photographic methods are essentially medium scale. They offer little, if any, advantage to the property surveyor or the small scale topographer.

(3) Here we have a Swiss book on a third, equally important, aspect of surveying, that of optical methods of measuring distance—methods which lend themselves obviously to a subsequent plotting by polar co-ordinates. British surveyors of the past were content to class tachymetry as a method giving, roughly, errors of the order of one part in five hundred. Modern telemeters (for which the base, or graduated staff, is held horizontally, thus escaping the troubles of unequal refraction) have greatly increased its possibilities. Were Great Britain faced with original property surveying at the present time, there is no doubt that optical measures would be given their chance, and engineers and other large scale surveyors will do well to explore their possibilities.

Mr. Bosshardt's book is well designed, clear, and definite in its analysis of errors and description of instruments, and those who read French with greater facility than German will find excellent reading in Prof. Delessert's translation.

Our Bookshelf.

A List of Official Chemical Appointments : compiled by direction of the Council of the Institute of Chemistry and under the supervision of the Publications Committee. Seventh edition, revised and enlarged. Pp. 402. (London : Institute of Chemistry, 1931.) n.p.

"OFFICIAL Chemical Appointments", now in its seventh edition, has firmly established its right to a place on the most accessible shelf of the chemist's library. Moreover, since it catalogues the personnel of professional chemical services in connexion with State and municipal administration, it is consulted with increasing frequency by official, educational, and commercial authorities. The new edition of some 400 pages, compiled under the auspices of the Institute of Chemistry, is divided into four parts. The first gives information concerning the activities of official establishments employing chemists in the British Isles, with a list of holders of the appointments (with degrees and universities). In this section are found, for example, the universities and schools, Government departments, water boards, industrial research associations, the National Physical Laboratory, public analysts, etc., and similar appointments in Northern Ireland and the Irish Free State. In the second part, appointments in the Empire overseas are recorded.

The third portion deals with societies and institutions, briefly referring to their objects, regulations for admission, etc., as well as mentioning the names of their officers. The fourth section contains a list of acts of Parliament, orders, regulations, etc., affecting official chemical appointments, and is followed by indexes of names and places, unfortunately marred by long errata lists arising from the printer's oversight. Subsidiary to its real utility as a book of reference are the pleasure which one may find in a study of the movements of one's former colleagues and acquaintances and the interest to be derived from the unexpected association of names with places.

God and the Universe : Eddington, Jeans, Huxley and Einstein. By Chapman Cohen. With a Reply by Prof. A. S. Eddington. (Issued by the Secular Society, Ltd.) Pp. 133. (London : The Pioneer Press, n.d.) Paper, 2*s*. ; cloth, 3*s*.

THE issues raised in this book are too important to be discussed casually in a few lines. The relation between religion and science is, of course, a very old problem. But the amazing developments of physical theories are apt to give a new setting to it. When scientific workers find themselves in a philosophical mood, they indulge in offering their readers some tentative suggestions about the theological extension of their particular science. So we get Eddington's scientific approach to religion, Huxley's religion without God, Jeans's mathematical God, and perhaps Einstein's Spinozistic God. Philosophers should be thankful to men of science for such indications ; the more so as they are not forced upon one by their authors with the same mental pressure often displayed by

metaphysicists. Because scientific workers do not present their conclusions in this respect as binding and final, philosophers must return the courtesy and treat them, for example, in the same dignified spirit as that shown in Sir Arthur Eddington's reply to Mr. Cohen's criticisms. His case would have been perhaps stronger if Mr. Cohen had shown more modesty and less partisanship in his statements and in his professional defence of materialism and free thought. But when he starts off by proclaiming that after his criticisms of "very many" books by scientific workers aiming at reconciliation of science and religion, their authors decided generally that "discretion was the better part" and that "silence in their case spelt safety", one may pertinently wonder whether Mr. Cohen should be taken as a safe guide in philosophy, and whether he is qualified to pay compliments to that section of the Christian clergy whom he denounces as "dishonest" for acclaiming these men of science as being witnesses on behalf of God. T. G.

Acoustics of Buildings: including Acoustics of Auditoriums and Soundproofing of Rooms. By Prof. F. R. Watson. Second edition, revised. Pp. x+155. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 15*s*. net.

IT is not a great many years ago since the satisfaction of acoustical requirements was purely a matter of empiricism. Here and there a scientific worker such as Rayleigh could explain the underlying principles; but seldom could an acoustic triumph, like the Free Trade Hall, Manchester, be acclaimed, nor could dependent data be obtained even from that; consequently, neither analysis nor synthesis came to our aid and architects were but blind leaders of the blind. Wallace Sabine, however, introduced a new era into acoustical research, and now it is by no means uncommon to secure success. Prof. Floyd Watson's treatise is a welcome contribution to the synthetic treatment of the subject. Whether it is better to secure original acoustic satisfaction or to correct acoustic failures, admits of no argument. In either case, the author's work has the merit of showing the way. The value of wires and sounding boards is almost entirely discounted in the light of modern investigation. The concluding argument is interesting, in its recommendation that Sabine's advice (remembering the varying size of the audiences) to effect a compromise, is the desirable procedure. For practical purposes the use of the different sound-absorbing coefficients is of the greatest value.

P. L. M.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1930. Edited by Dr. M. Epstein. (New Series, Vol. 172.) Pp. xii+313+176. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 30*s*. net.

THE new issue of this useful book follows the usual plan of arrangement, which, combined with a detailed index, make reference easy. The bulk of the volume records the political and social history of Great Britain, the Empire, and other countries. The summaries are both full and readable, and omit no matter of importance in any part of the world. The second part is devoted mainly to retrospects of literature, science, art, law, and finance during the year.

Science has ten pages for its share, divided between the biological sciences, including anthropology, and the physical sciences. Much interesting matter and many broad views are crowded into these pages, and some of the more important books of the year are mentioned. The public document printed in full this year is M. Briand's memorandum on the organisation of a regime of European Federal Union, with the report by the French Government on the inquiry. The volume concludes with biographical notes of eminent persons who died during the year.

Number: the Language of Science. By Prof. Tobias Dantzig. Pp. xi+260+11 plates. (London: George Allen and Unwin, Ltd., 1930.) 10*s*. net.

THE author of this interesting book has achieved a difficult task with much distinction, in showing that number, which is considered as the 'driest' topic on earth, could be made the basis of a profoundly human story. From the use of finger-prints to the invention of transfinite numbers, we are told how the theory of numbers, born in religious mysticism, has passed through a period of erratic puzzle-solving before it acquired the status of a science. Yet the book is not a technical history of the subject; so that it should interest not only mathematicians but also the wider circle of those who like to ask themselves how science has come about. Symbols are scarcely used; but the historical method has been freely introduced to bring out the rôle intuition has played in the evolution of mathematical concepts. This novel and pleasant presentation of an intricate subject is a great credit to its author. T. G.

L'Art nègre: à l'Exposition du Palais des Beaux-arts du 15 novembre au 31 décembre 1930. Par J. Maes et Dr. H. Lavachery. Pp. 32+48 planches. (Paris: Les Éditions G. Van Oest, 1930.) 30 francs.

THIS book, primarily a guide to the section of Negro art in an exhibition held at Brussels at the end of 1930, consists of two brief but adequate essays on the main characteristics of African art. M. Maes deals with the sculptural art of the Belgian Congo, and Dr. Lavachery with that of the remainder of Africa: a not unfair division of labour in view of the importance of the Congo as an art centre. It will be remembered that from here came the wooden statuettes which have had such a marked effect in modern European art and æsthetics. The plates figure a large number of examples. Excellent as is the text within its limits, the plates alone make this something more than a mere guide-book and worthy of permanent preservation.

Letters to the Editor.

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

Atomic Weight of Cæsium: Use of the Word 'Mass-spectrograph'.

THE first mass-spectra obtained from cæsium by means of a hot anode showed only one line of mass number 133. As I pointed out,[1] the conditions of the experiment precluded any accuracy of measurement sufficient to decide whether the chemical atomic weight then and since accepted, 132·81, did or did not represent the weight of the atom. Quite recently, K. T. Bainbridge,[2] using Dempster's method of analysis, has confirmed the simplicity of cæsium to such a degree as to make him confident that no other isotope exists to the extent of 0·3 per cent. As he points out, on this view the atomic weight of 132·81 would imply a packing fraction of $-14{\cdot}3$. Such a figure would be so completely abnormal that it seemed desirable that it should be tested by direct and trustworthy means.

The obvious method is to photograph Cs 133 between Xe 132 and 134. To be really convincing, the lines must be produced during the same exposure, and as the alkali metals and the inert gases are, from the point of view of mass ray technique, the extreme and mutually exclusive types of element, this is by no means easy. After many trials, I have now succeeded in making a form of discharge tube capable of producing the anode rays of cæsium at the same time as the gas rays of xenon. Furthermore, by varying the quantity of the latter element present and the times of exposure, mass-spectra have been obtained which enable the masses to be compared with an accuracy of 1 in 10,000. The results are conclusively against any abnormality. If we assume the packing fraction of xenon to be $-5{\cdot}3 \pm 2{\cdot}0$, as already determined, that of cæsium is $-5{\cdot}0 \pm 2{\cdot}0$, the weight of the cæsium atom ($O^{16} = 16$) is 132·933, and using Naudé's factor of 1·25 in 10,000 to transform to the chemical scale we get

$$\text{At. Wt. of Cæsium} = 132{\cdot}91 \pm 0{\cdot}02.$$

In further reference to Bainbridge's letter, I should like to lodge an objection to his application of the word 'mass-spectrograph' to Dempster's form of analysis. This word I coined in 1920 to describe an instrument which by its peculiar sequence of electric and magnetic fields eliminated the effect of varying velocity and gave a spectrum dependent upon mass alone. Dempster's apparatus, described two years earlier, is essentially an application to the analysis of positive rays of the well-known and widely used principle of semicircular magnetic focusing. Such an instrument gives a magnetic spectrum which depends upon momentum and not upon mass *per se*. The fact that it is the standard method for determining the energies of beta particles makes this sufficiently obvious. The use of the word mass-spectrograph, unqualified in any way, to an apparatus not using in any manner the principle implied in it, appears to me to be a misleading and undesirable practice.

F. W. ASTON.

Cavendish Laboratory, Cambridge,
May 16.

[1] *Phil. Mag.*, **42**, p. 440; 1921.
[2] *Phys. Rev.*, **36**, p. 1668; 1930.

Petroleum and Alpha Radiation.

IN NATURE of Feb. 28 (**127**, p. 317) reference was made to my recent address before the American Association for the Advancement of Science,[1] as reported by Science Service. Lest the 'novelty' of the possible rôle of alpha radiation in the interaction of hydrocarbons in the earth's crust obscure its true relative importance, I should like to make a further communication and to suggest a new way of accounting for the absence of free hydrogen in natural gases.

In the first paper of Lind and Bardwell on the action of alpha particles on saturated hydrocarbons,[2] it was pointed out that similar reactions *must* take place in the earth's crust if conditions exist where alpha particles bombard hydrocarbons. While these conclusions were then based on experiments with gaseous hydrocarbons, there was indirect evidence that the reactions extend also to the liquid members. More recent work by W. T. Richards[3] in the laboratory of Sir Ernest Rutherford gave direct proof that this is true not only for liquid but also for solid paraffins and that hydrogen is the principal gaseous product. Calculations from Richard's results[4] showed that even the quantitative yield of hydrogen per ion pair is certainly not less than half of that in the gases.

Hydrogen is therefore the most abundant gas produced by the reaction, and since Lind and Bardwell had shown[5] that it does not interact further with unsaturated hydrocarbons under alpha radiation, it becomes an important criterion of reaction unless it is removed in some other way.

The fact, however, that free hydrogen is conspicuously absent in natural gases (except in some volcanic regions) led us to conclude that the problem of its disposal must be met before even a partial radioactive origin of petroleum could be accepted. Under catalytic conditions which are quite possible, hydrogen could recombine with liquid unsaturates, but this would account for less than half of it, assuming the initial hydrocarbons to have been saturated, since all the hydrogen liberated in condensation to higher saturates would still remain free.

If, however, the original hydrocarbon (or hydrocarbons) be assumed to have been unsaturated (or if unsaturates have been produced from saturates by the thermal elimination of the necessary amount of methane), the complete catalytic removal of hydrogen under high pressure and high temperature conditions becomes possible, because the amount of hydrogen liberated by alpha rays is much smaller from the unsaturates—far less than the amount required for saturation. Moreover, we do find petroleum to contain unsaturated members, possibly indicating an initial excess of unsaturation.

Although this suggestion as to disposal of the hydrogen may be regarded as making the radioactive origin of part of our petroleum more probable, the abundance of methane in natural gases associated with petroleum seems to indicate that the *thermal* interaction of hydrocarbons at high pressures and temperatures suggested by Prof. H. A. Wilson[6] is perhaps the more prolific source of petroleum, since, according to his theory, *methane* would be the lower terminal member.

The recent note on this subject in NATURE also raised the pertinent question: . . . "is radioactivity a potential function in the type of environment and at the comparatively shallow depth in the crust which modern views seem now to imply for the birth of the oil globule?" It scarcely appears possible to answer this question definitely, but certainly we would not be justified in a negative answer. The distribution of a low radium content in the earth's crust is so general and so constant that its action extended over

geological periods of time may be very considerable, independent of depth. Actual radium or thorium determinations in oil sands are not available but are quite desirable. There can be no doubt of some degree of association of radioactive material with hydrocarbons. Bohn [7] has reported about 2×10^{-10} curies of radon per litre in two samples of California crude oil, and Spence [8] has pointed out an apparently significant association of uraninite with a solid hydrocarbon, thucolyte, and also with liquid oil, so that the process of condensation may be still proceeding, or as he says: "the mineral has not yet reached stable form".

In conclusion, hydrocarbons, either gaseous, liquid, or solid, must be modified in the earth's crust, just as in the laboratory, whenever they are exposed to alpha rays. The general character of the reaction is one of condensation to higher members, with elimination of hydrogen (and methane). The absence of hydrogen in the gases associated with petroleum is not proof of the absence of such action of alpha rays, because hydrogen might well be removed catalytically by combining with unsaturates which may have originated as such or have been produced from saturates by the elimination of excess of methane. Unfortunately, we have at present no absolute criterion as to the relative importance of the radioactive effect.

S. C. LIND.

University of Minnesota,
School of Chemistry,
Minneapolis,
Mar. 24.

[1] *Science*, **73**, Jan. 19, 1931.
[2] *J. Am. Chem. Soc.*, **48**, 2344; 1926.
[3] *Proc. Camb. Phil. Soc.*, **23**, 516; 1927.
[4] "Chemical Effects of Alpha Particles and Electrons", 2nd edit., 1928, p. 150.
[5] *J. Am. Chem. Soc.*, **48**, 1564.
[6] *Proc. Roy. Soc.*, A, **124**, 16; 1930.
[7] *J. Franklin Inst.*, **210**, 461; 1930.
[8] *Amer. Mineralogist*, **15**, 499; 1930.

IT is well that Dr. S. C. Lind directs attention to certain points in his theories which it was not possible within a limited space to deal with in my recent notice of his work, if only to promote a wider interest in the potentiality of radioactive stress in determining the trend of development and composition of petroleum. The hydrogen question is certainly a difficult one to dispose of, especially in view of the comparative rarity of this gas in a free state in natural gas, a point I have been at pains to verify from diverse published records, but Dr. Lind's suggestions are helpful, if not actually convincing. One would like to know, however, what sort of catalysts he has in mind which might be presumed to exist in the oil environment and to be capable of promoting reaction whereby the hydrogen is eliminated. Are they organic or inorganic? If the former, can we invoke bacterial aid, in which case the agent is doubtfully catalytic? If the latter, would not careful analysis of the source-rock reveal some competent mineral substance?

Perhaps petroleum technologists have not, on the whole, accorded alpha radiations that place in their theories of oil genesis which their importance in other realms of science would seem to indicate. Comparatively little attempt has been made to explain the strong radioactivity of certain crude petroleum samples tested when 'fresh' from the oil wells, or in another direction to follow up the results of the work of Himstedt and Kraus on the absorptive capacity of petroleum and petroleum products, for example, kerosene, for radium and thorium emanations.

These points have not only a chemical, but also a geological significance, especially in view of the lack of data, as Dr. Lind remarks, on radium and thorium determinations in actual oil sands. Here we are on practically virgin research territory. It would be highly instructive to carry out such determinations on those sands or other reservoir rock from which strongly radioactive petroleum had been derived; and from the petrographic point of view, apart from other factors involved, the existence of, perhaps, an unusually prominent radioactive mineral content, for example, zircon, might suddenly prove of more than passing interest. On the other hand, whatever be the function of the alpha radiation in the complex process of petroleum genesis, its novelty will wear rapidly with many if it is to be made the instrument of exhumation of the inorganic theory of origin of petroleum, which a decade of geological opinion at least has served to bury.

THE WRITER OF THE NOTES.

Prehistoric Man in Kenya.

READERS of NATURE will have seen in Sir Arthur Keith's new book entitled "New Discoveries relating to the Antiquity of Man" a chapter dealing with my discoveries in East Africa, and may have been surprised to find in it certain statements which cannot be reconciled with the accounts of these discoveries as given by myself in lectures to various scientific societies since my return to England in December 1929.

Unfortunately, a few misunderstandings have crept into Sir Arthur's account. For this I take the blame; for although, when working on my human material at the Royal College of Surgeons, I have on frequent occasions discussed anatomical details with Sir Arthur, I have never—though I had not realised the fact until now—explained to him in detail the geological and archæological evidence obtained during the 1928–29 season, which very materially altered some of the provisional conclusions at which I had arrived in the previous season.

In my forthcoming book "The Stone-age Cultures of Kenya", and in two other reports now in preparation, the details of the discoveries up to the present time will be set out clearly. Meanwhile I should like to rectify certain points. At Bromhead's site (which Sir Arthur refers to as Elmenteita I. on p. 181) we found human remains associated with a lithic industry, which I called Elmenteitan, and with pottery. There was also found at the site—but not really *in situ*—a stone mortar which in 1927 misled me into suggesting a relationship between this culture and that at the Nakuru site. Later, however, I found clear evidence that the said stone bowl was derived from elsewhere, and thought I had made this fact quite clear. Unfortunately, Sir Arthur somehow overlooked this fact.

Bromhead's site belongs to our Makalian post-pluvial wet phase which I *provisionally* correlate with the Bühl Stadium. But although pottery certainly occurs at this period—and also earlier—I have no suggestions of agriculture or of village sites until the next wet phase, the Nakuran, which I date as *c.* 850 B.C.

Again, it is evident from Sir Arthur's account of Gamble's Cave, p. 164 ff., that my field reports have been misunderstood. The deposits marked *silts* in his diagram are in fact *œolian sands*. It is true that, for a few months in 1927, I regarded them as *silts* owing to their fine stratification, but the fact that they were of æolian origin was recognised in 1927 and the interpretation of the cave section altered accordingly before the 1928–29 season began.

Also, the culture sequence given for Gamble's Cave II. is not quite accurate. The sequence in Gamble's Cave II. was as follows: The uppermost prehistoric occupation level contained an Elmenteitan industry

with pottery as at Bromhead's site. The occupation level beneath this, and separated from it by three barren layers, including one of æolian sand, consisted of a sparse Kenya Stillbay industry (formerly called late Kenya Mousterian) without pottery. Beneath this was the so-called third occupation level, which is the level from which the skeletons were obtained, and the industry is *late* upper Kenya Aurignacian.

Beneath this again, and separated from it by a layer of fallen rock, was a thick occupation level with a very rich upper Kenya Aurignacian industry. Both these upper Kenya Aurignacian levels yielded a few pieces of crude pottery—a surprising but unquestionable fact.

Most of the skull measurements quoted by Sir Arthur were, unfortunately, taken from provisional reports prepared in the field, the measurements having perforce been taken without accurate instruments and before the skulls were properly cleaned, and in many cases they have proved to be misleading. The cranial capacities quoted were also first approximations obtained in the field by using the Lee-Pearson formula. As the authors of the formula have pointed out, its average error for the individual skull is 3–4 per cent and it may be so much as 10 per cent. In the case of the Kenya skulls, the thickness of the bone and other considerations rendered the error still greater, as subsequent direct measurements have proved. For example, the capacity of Elmenteita A was found to be only 1290 c.c., instead of 1480 c.c. as estimated by formula and quoted in Sir Arthur's book.

On p. 169 we read: "In Gamble's Cave, Mr. Leakey found evidence of man living there before the last great pluvial period and of repeated occupation throughout the whole length of the period". This was once my assumption, at the time when I had mistaken the æolian sand-beds for silts, and before the discovery of the beach gravel with *Corbicula africana* as the lowest deposit in the cave. This interpretation was abandoned in 1927. The evidence shows that the cave was formed by the high 510-ft. lake during the second maximum of the Gamblian pluvial, which I *tentatively* equate with the Würm glaciation. It was occupied during the decline of the second maximum of the Gamblian pluvial by the makers of the upper Kenya Aurignacian culture, and later by the race who made the Kenya Stillbay culture. Later still, during the Makalian post-pluvial wet phase, which is separated from the decline of the Gamblian pluvial by an arid period, represented in the cave section by more than a foot of æolian sand, it was occupied by the makers of the Elmenteitan culture.

On p. 120 Sir Arthur says: "Now at the Elmenteitan sites (*i.e.* the upper occupation level of Gamble's Cave II. and Bromhead's site) were discovered pottery and stone bowls, evidence I think that the ancient occupants of these floors were already agriculturalists. The Nakuru site is later, it is post-pluvial." Now the Elmenteitan culture certainly has pottery but no indication of agriculture, nor has it stone bowls, as I have explained above, which do not occur until the Nakuran wet phase *c.* 850 B.C. Moreover, we now know that the wet period which was contemporary with the Elmenteitan culture was not a pluvial period, although I did formerly regard it as that, but only a post-pluvial wet phase which I call the Makalian. The evidence which I have obtained certainly convinces me that pottery was in use in Kenya long before the dawn of agriculture, and somewhat earlier than in Europe, or even in Egypt, and that by the Makalian wet phase (which equals, I think, Bühl Stadium *c.* 12,000–10,000 B.C.) pottery was fairly well advanced. When, however, we remember that in predynastic Egypt the Badarians and Tasians had very fine pottery, much more advanced than my Elmenteitan pottery, at a date which Sir Arthur on p. 227 gives as *c.* 5000 B.C., and that—to quote his words—"Even at this early time the Egyptians were a settled people, living in villages, sowing, reaping, grinding, spinning, weaving, and making *pottery of the highest finish*" (the italics are mine), it is surely not so improbable that in Kenya we should have *cruder* pottery at an *earlier* date.

Of Sir Arthur's reasons for hesitation (p. 171) in accepting the antiquity ascribed by me to certain stone age cultures of East Africa, "particularly those discovered at Nakuru and in the later sites at Elmenteita", the chief seems to be the belief that I am dating *agriculture* in Kenya back to 12,000 B.C. But this is not my view at all. Pottery is certainly present in the Elmenteitan culture and earlier, but the earliest date I suggest for agriculture in Kenya is *c.* 850 B.C., when it is associated with imported beads, possibly of Egyptian or Mesopotamian origin.

L. S. B. LEAKEY.

St. John's College, Cambridge,
April 16.

As I regard the discoveries made by Mr. Leakey in East Africa as of the highest importance for those of us who are inquiring into the antiquity of man, I should be sorry if in any way I have misrepresented his facts or his inferences. For my purpose his chief discovery is represented by the deepest burials in Gamble's cave. I am relieved to find that in attributing to these burials—the oldest found by him—an approximate contemporaneity with those of the Cromagnon people of Europe, I have not misled my readers. I did take extreme pains by a close study of his field reports and of all his published communications to ascertain not only his facts but also his inferences, and my failure must be due in part to the rapid evolution which Mr. Leakey's own knowledge has undergone, and must continue to undergo, in the light of his additional discoveries. I am very glad he has been given this early opportunity of putting his present opinions, as well as corrections of my errors, before readers of NATURE.

One point to which Mr. Leakey directs attention is of particular interest. Hitherto, I have followed the opinion of orthodox archæologists and have supposed that pottery was born of agriculture. When pottery was found associated with human remains, I have hitherto supposed that people who practised the art of agriculture were represented. In the light of discoveries made in Kenya by Mr. Leakey, and in palæolithic Europe by other archæologists of the highest repute, it does seem probable that the invention of pottery may have antedated the discovery of agriculture and that there may be no necessary correlation between these two arts.

ARTHUR KEITH.

Royal College of Surgeons
of England,
London, W.C.2, April 29.

Potential Temperature and Entropy at the Base of the Stratosphere over the British Isles.

THE English upper air data have lately been examined to discover what correlation exists between the potential temperature of the air at the boundary between the troposphere and stratosphere and some of the other variables of the upper air. Since the entropy of dry air is proportional to the logarithm of its potential temperature, we may, in so far as correlation coefficients are concerned, use the terms entropy and potential temperature indifferently. The actual data below are given in terms of the latter, but in the

final conclusion it is more convenient to employ the former.

The period chosen for examination was the eight years 1922–29, during which a homogeneous and reliable series of observations was available. A selection was made by including only cases in which the tropopause was definitely marked, either (as in most cases) by an inversion, or by an isothermal layer. In the former cases the boundary of the troposphere was taken at the point of minimum temperature, in the latter at the base of the isothermal layer. One hundred observations were utilised.

Denoting the several variables dealt with by suffixes thus :

Pressure at a height of 9 km. .	Suffix 3
Height of the tropopause .	,, 4
Temperature at the tropopause	,, 5
Pressure at the tropopause .	,, 6
Potential temperature at the tropopause . . .	,, 7

and denoting standard deviations by σ and correlation coefficients by r, the following table was obtained, taking the departures of the variables in all cases from their crude means :

r.	σ.	Means.
$r_{34} = +0{\cdot}82$	$\sigma_3 = 11{\cdot}0$ mb.	307 mb.
$r_{36} = -0{\cdot}70$	$\sigma_4 = 1{\cdot}21$ km.	11·0 km.
$r_{37} = +0{\cdot}89$	$\sigma_5 = 6{\cdot}3°$ A.	215° A.
$r_{47} = +0{\cdot}82$	$\sigma_6 = 37{\cdot}8$ mb.	228 mb.
$r_{56} = +0{\cdot}79$	$\sigma_7 = 9{\cdot}9°$ A.	329° A.

Some of these values were also worked out taking the departures from the smoothed monthly means, with the following results :

$r_{34} = +0{\cdot}82$	$\sigma_3 = 8{\cdot}5$ mb.
$r_{37} = +0{\cdot}82$	$\sigma_4 = 1{\cdot}12$ km.
$r_{47} = +0{\cdot}81$	$\sigma_7 = 7{\cdot}7°$ A.

Apparently no attempt has been made heretofore to correlate potential temperature in England with other variables, and it is interesting to observe the high values which appear. The question arises as to the meaning of the intimate connexion which is indicated between the potential temperature, or entropy, at the tropopause and the pressure at 9 km. The latter is a variable closely related to nearly all the variables of the upper air, and its value on any occasion may be taken as a good criterion of the pressure conditions prevailing ; a high pressure at 9 km. is associated with an anticyclone, a low one with a cyclone.

Remembering that departures of a variable from its mean value may range up to twice its standard deviation, and occasionally more, we may infer from the second table that the potential temperature at the tropopause may vary by as much as 16° Abs. on either side of a monthly mean ; which implies that at any one station a variation of 20°-25° may easily take place in a week or so. The corresponding changes of entropy are about 60 or 80 units on a mean value of 1200.

It is not easy to alter the realised entropy of a mass of air in the upper atmosphere, for there is not, at the best, enough water vapour in it to effect by condensation more than a trifling change. Hence, when such a large systematic difference is found between the entropy at the tropopause over a cyclone and over an anticyclone, the inference is strong that the air is of different origin in the two cases. Considering particularly the case of the anticyclone, in order to find air of the same entropy over an adjacent cyclone it would be necessary to penetrate well into the stratosphere. Layers of air in the stratosphere are, however, very difficult to rearrange relatively to each other, on account of the enormous stability prevailing there, and hence it would seem that the air just below the stratosphere over an anticyclone must have come comparatively recently from a region of lower latitude, where the entropy at all levels is relatively high. It is important to notice that whether this be the true explanation or not, we are clearly dealing with a very systematic tendency, and not merely with the results of special cases.

This analysis assumes that radiation has a negligible effect in producing changes of entropy in the upper air. Such a hypothesis seems reasonable when it is considered that over the polar regions all the radiative conditions tend towards low temperature, but that, nevertheless, the stratosphere is relatively warm. In our own latitudes, cyclones and anticyclones succeed each other, grow and die in periods measured in days, and the time element scarcely seems sufficient to allow of radiation being very effective in changing the entropy by the large amounts required.

I am indebted to Sir Napier Shaw for helpful suggestions connected with the subject matter of this letter.

L. H. G. DINES.

Kew Observatory, Richmond,
April 30.

Substandard Wave-length Determinations with Reflection Echelons.

ACCURATE intercomparisons of wave-lengths in terms of the red cadmium primary standard have hitherto been made mainly by means of the Fabry Perot interferometer. As no metal or alloy having a high reflection coefficient in the violet and ultra-violet has been discovered, its application in this region is strictly limited, since the fringes are then relatively broad.

The reflection echelons, which have been developed by me in conjunction with Messrs. A. Hilger, Ltd., during the last few years, can be used for this purpose. The general method can be made clear from Fig. 1.

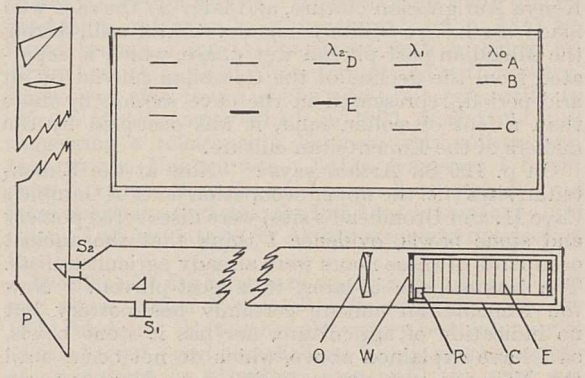

FIG. 1.

The light from a complex source enters the horizontal slit S_1 and, after total reflection at the quartz prism, leaves the objective O to fall on the echelon E as a parallel beam. It is then diffracted and, returning through O, forms a complex pattern on the vertical slit S_2 of the quartz spectrograph, which makes a coarse separation of the lines. With a wide slit S_2 the appearance of the photographic plate P will be similar to the inset diagram. A is the image of S_1 as reflected by a long narrow platinised reflector R that is made to be an integral part of the echelon E. B and C are the m_0th and $(m_0 - 1)$th order of the same wave-length λ.

If, in addition to the cadmium line λ_0, two other wavelengths λ_1 and λ_2 are fairly accurately known, the order of interference for any line can be determined by Benoit's method of exact fractions. Since the dispersion is uniform, the order at A would be $\left(m_0+\frac{AB}{BC}\right)=m_0+f_0$, and similarly for λ_1 the order at its reflection image is (m_1+f_1). In cases such as λ_2 when only one order appears, the distance between its orders d_2 can be found either by a subsidiary exposure in which the pressure in the pressure chamber C has been slightly altered, or use may be made of the fact that the distance between the orders of λ_2 is equal to that for λ_0 multiplied by the ratio λ_2/λ_0. If the latter method be used, any change in the magnification of the spectrograph must be allowed for.

We then have

$$(m_0+f_0)\lambda_0=(m_1+f_1)\lambda_1=(m_2+f_2)\lambda_2=(m_n+f_n)\lambda_n$$

and the correct integer value of m_0 can be found by trial in the usual manner. Having found the product $(m_n+f_n)\lambda_n$ for a given echelon, the accurate value of the wave-length of any approximately known line is given immediately by measuring the fractional part, which in general is simply given by the ratio of two distances; thus the method is far quicker than in the Fabry Perot interferometer, which involves the determination of the squares of diameters of rings.

The criterion of the accuracy of a method is the accuracy within which the fractional part can be determined. In the earlier trials, the reflected images were obtained from the (unsilvered) quartz window W of the pressure chamber. This proved to be relatively far too strong, especially in the far ultra-violet, and a narrow strip reflector R has now been incorporated. With a 25 plate echelon of 1 mm. step and 0·7 cm. plate thickness and an achromatic quartz fluorite objective of 160 cm., it was found in favourable cases that the distances involved could be repeatedly measured with differences not greater than 0·001–0·002 mm. At 6500 A. the order separation BC is about 1 mm., so that the fractional part is obtained to within 0·001–0·002, giving a final wave-length accuracy of 0·0003–0·0006 A. Due to the increasing order of interference, the possible accuracy for very sharp lines at 2000 A. is 0·0001–0·0002 A.

A perfectly constructed and adjusted Fabry Perot interferometer, of the same separation and with films giving a reflection coefficient $R=0{\cdot}90$, should have approximately equal resolving power, yet in practice one is quite satisfied if the fractional parts can be determined to within ten times the above values. There are probably two reasons for the discrepancy:

(1) The dispersion of the interferometer varies rapidly, especially near the centre, giving rise to an unsymmetrical fringe, the centre of which cannot be accurately located.

(2) The local errors in the interferometer (due to a great extent to variations in phase change because of slight variations in silver thickness) are purely cumulative owing to multiple reflection. Since the echelon plates are made individually, the effect of any small residual errors tends to vanish on an average.

In contradistinction to the older method, it will be noticed that no correction need here be applied for the variation of phase change with wave-length, and by evacuating the pressure chamber, 'vacuum' wave-lengths can be directly obtained.

When dealing with somewhat broad lines, additional precautions have to be taken; these will be described in detail elsewhere.

W. EWART WILLIAMS.

Wheatstone Laboratory,
King's College, Strand, W.C.2,
April 28.

Intensity of Forbidden Transitions in the Alkalis.

IN a recent paper,[1] one of us (A. F. S.) calculated the intensity of $1S-3D$ transitions in the alkalis. These were attributed to quadripole radiation, since they are forbidden by the selection principle for dipole radiation.

Through an oversight, the experimental work of Prokofjew [2] was not mentioned in this paper, although it gives perhaps the most complete available confirmation of the theory. Prokofjew measured the ratio of the dispersion of the forbidden $1S-3D$ and permitted $1S-2P$ lines, and thereby determined their intensity ratio.

A comparison of Stevenson's calculated and Prokofjew's experimental values of the intensity ratio shows:

	$\frac{1S-3D}{1S-2P}$ calc.	$\frac{1S-3D}{1S-2P}$ obs.
Li	$2{\cdot}8\times10^{-6}$	..
Na	$2{\cdot}0\times10^{-6}$	$2{\cdot}5\times10^{-6}$
K	$1{\cdot}5\times10^{-6}$	$3{\cdot}7\times10^{-6}$
Rb	$2{\cdot}1\times10^{-6}$	$3{\cdot}2\times10^{-6}$
Cs	..	$2{\cdot}3\times10^{-6}$

These ratios seem to agree well, considering the difficulties encountered in determining the dispersion, and the approximations involved in the theoretical calculations.

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[1] *Proc. Roy. Soc.*, **128**, A, p. 591.
[2] *Zeit. f. Phys.*, **57**, p. 387.

Raman Spectra of Gases.

USING a stout silica tube capable of standing pressures up to 50 atmospheres as the container, I have successfully photographed the Raman spectra for a number of gases. Perhaps the most interesting case studied is that of acetylene; wave-number shifts 1974 and 3372 are observed in agreement with the vibration numbers 1975 and 3365 recently derived by Mecke [1] from a study of the ultra-violet absorption spectrum.

Nitrous oxide gas gives two Raman frequencies, 1283 and 2226. The first is an inactive frequency and has already been noted by Dickinson, Dillon, and Rasetti.[2] The second frequency comes out very feebly and coincides with the active frequency noted by C. P. Snow [3] in infra-red absorption. The frequencies obtained agree closely with those recently observed by McLennan, Smith, and Wilhelm [4] in liquefied nitrous oxide.

A curious feature of the results obtained with carbon dioxide gas is that the intensity ratio of the lines with shifts 1288 and 1389 (both inactive) is observed as 1 : 3, whereas Dickinson, Dillon, and Rasetti (loc. cit.) record it in their paper as 10 : 15. The cause of the discrepancy is not clear.

Oxygen and nitrogen gases have also been studied, with results agreeing with those of Rasetti. The order in which the five gases studied are mentioned above is also in the order of the intensity of the brightest Raman line appearing in each when comparable pressures and exposures are used. It may be significant that along the series nitrogen, oxygen, carbon dioxide, nitrous oxide, and acetylene there is also a rapid increase in the optical anisotropy of the molecule.

The state of polarisation of the Raman lines has also been studied with the gases carbon dioxide and acetylene. It is found that the strongest lines ascribable to a linear vibration of the molecule are nearly completely polarised. The 'wings' appearing on either side of the exciting mercury lines, which represent the rotational Raman spectrum, are, however, practically unpolarised, as is to be expected from the theoretical work of Manneback.[5]

S. BHAGAVANTAM.

210 Bow Bazar Street, Calcutta,
April 18.

[1] *Zeit. f. Phys.*, **64**, 173; 1930.
[2] *Phys. Rev.*, **34**, 582; 1929.
[3] *Proc. Roy. Soc.*, A, **128**, 294; 1930.
[4] *Trans. Roy. Soc. Canada*, **24**, 197; 1930.
[5] NATURE, **125**, 88; 1930.

Forestry Research in Great Britain.

I SHOULD like to support the plea put forward in the recent article on forestry research in Great Britain (NATURE, May 16, p. 729) that the Forestry Commissioners should in future take greater cognisance of research on the basal problems of pure science that underlie successful afforestation. As chairman of the Research Committee of the British Association which has been the means of providing Dr. M. C. Rayner with a small measure of assistance for her researches on tree mycorrhiza, I have been brought into intimate contact with one of the fundamental problems that concerns the establishment of forests on land hitherto devoid of trees. I have been greatly impressed with the urgent need for more adequate facilities for this work than can be provided by the very limited funds of the British Association, and I venture to express the hope that the Forestry Commissioners will give sympathetic consideration to the desirability of assisting these investigations.

F. T. BROOKS.

Botany School, Cambridge,
May 18.

The Form of Fæcal Pellets and Specific Identification.

IN the differentiation of closely allied species, any additional character which may help to separate them will be of value. In the case of ascidians, for example,

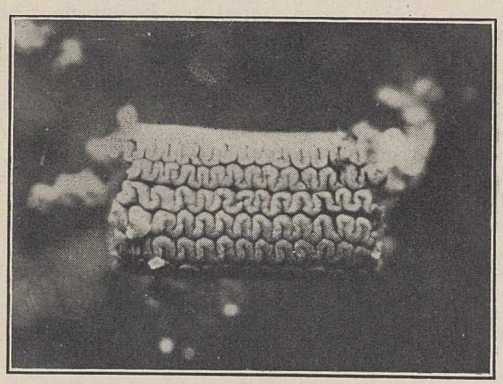

FIG. 1.—Fæcal pellet of *Gibbula magus*.

much help is obtained from the nature of the eggs. A character, however, which has not previously been made use of is the nature of the fæces. While in many cases these are either shapeless or else of very vari-e shape, a large number of animals have fæces of a te distinctive type. The specific character of the al pellets may lie either in differences of their eral shape or else in details of surface sculpture, latter often being exceedingly elaborate, as in the mple shown in Fig. 1.

While we have as yet investigated the fæces of y a limited number of species, the following exples of some of the animals which may be thus erentiated is suggestive of the value of the method: *cula nitida*, *N. nucleus*, *N. sulcata*, *N. tenuis*; *idosmya alba*, *S. nitida*; *Gibbula cineraria*, *G. gus*; *Calliostoma zizyphinus*, *Cantharides clelandi*; *nœa virginea*, *A. testudinalis*; *Ascidea venosa*, *idiella scabra*.

We hope to give an account of some of these fæcal jets in the near future, but meanwhile we suggest t value of examination of fæces, to those requiring ditional characters for the definition of species.

HILARY B. MOORE.

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Port Erin, I.O.M.

Flint Implements of Lower Palæolithic Types from Northern Ireland.

DURING a recent visit to Northern Ireland, one of us (J. P. T. B.) found in gravel lying between two Older Clays exposed in the valley of the River Carey, and in glacial gravel in the Dun valley, in Co. Antrim, series of flint implements of Lower Palæolithic types. Other examples of these specimens, easily distinguished by their forms, condition, and flaking from later artefacts, as well as from naturally flaked stones, were also discovered in certain post-glacial gravel-spreads of these two rivers.

The ancient implements referred to are derivatives both series of deposits, and their true antiquity is, from a geological point of view, therefore, unknown. Examination of the specimens, however, demonstrates that they comprise forms which at other sites, as East Anglia for example, are recognised to be of Early Pleistocene date. As is known,[1] at this epoch, over very wide areas of the earth's surface,[2] the evidence is clear that ancient man was engaged in making finely flaked hand-axes by means of a skilful development of the earlier rostro-carinate implements. It is, therefore, of considerable interest and importance to observe that these newly discovered specimens from Northern Ireland comprise coarsely flaked hand-axes of rostroid forms, and rostro-carinates.

The manner in which these implements were made in Ireland is precisely similar to that in which others were formed during the epoch of the Cromer Forest Bed of East Anglia, in Palestine, in South Africa, and in India. In view of this significant fact, we feel justified in claiming that flint implements of Lower Palæolithic (Early Chellean) types have now been discovered in Northern Ireland, and we propose in the near future to publish a detailed account of this discovery. It is well also to recall that, many years ago, the late Mr. W. J. Knowles claimed to have found Palæolithic implements in the so-called 25 ft. raised-beach of Northern Ireland. The majority of these specimens, of Palæolithic forms, one of us (J. P. T. B.) would, however, not accept as of this antiquity, though we consider it probable that a few of them are to be relegated to Palæolithic times.

J. REID MOIR.
J. P. T. BURCHELL.

May 9.

[1] *Jour. Roy. Anthrop. Inst.*, vol. 41, 1921, and vol. 55, 1925.
[2] *Jour. Roy. Anthrop. Inst.*, vol. 60, 1930.

The Peking Skull.*

By Prof. G. ELLIOT SMITH, F.R.S.

WITH characteristic promptitude, Prof. Davidson Black has now provided us with a full report upon the features of the Peking skull, giving a detailed description of its external form, illustrated by 16 photographic plates (each photograph provided with a transparent explanatory drawing) and 37 text-figures. The drawings represent exact orthogonal projections not only of the type skull but also of the second skull of *Sinanthropus*, the finding of which was discussed in NATURE of Aug. 9, 1930 (p. 210), and of a series of other fossil human skulls. The purpose of this comparison is to define the distinctive characters of *Sinanthropus* and to emphasise the contrasts in size and proportions that differentiate it from *Pithecanthropus* and the series of Neanderthal skulls. An elaborate series of measurements is provided, together with a statistical analysis of the significance of the figures, in comparison with those of other fossil human types, as well as of representatives of modern races of men. Hence complete data are now available to enable the anthropologist to realise the distinctive features of the Peking skull and the reasons which induced Prof. Davidson Black to differentiate it from all other known human types and assign it a distinctive generic rank.

The history of the finding of the skull by Mr. W. C. Pei on Dec. 2, 1929, has already been told in NATURE (Mar. 22, 1930, p. 448). It was not until four months later that Dr. Black completed the process of removing from the surface of the skull the hard mass of travertine in which it was embedded. He then began to make casts and photographs of the specimen and to prepare the preliminary reports. After this was accomplished, he set to work to expose the interior of the skull, and in this he was inspired by the motive of preserving if possible the natural endocranial cast. Fortunately, this was possible because the braincase was fractured, enabling the bones to be removed piecemeal. Moreover, the skull is that of a young adolescent, whose age, in Dr. Black's opinion, corresponds to that of a modern child between the time of eruption of the second permanent molar teeth and the attainment of adolescence, say 15 ± 2 years. Thus it was possible easily to disarticulate the constituent bones. This work lasted until well into the summer of 1930, when Dr. Black succeeded in removing the cranial bones from the surface of the endocranial cast and then reconstituted each individual bone, and eventually rearticulated the skull with more precision than it had at the time when it was found. Before doing so, however, he made photographs and models of each separate bone, and took X-ray photographs to display the sinuses and other details in the texture of the bones, such, for example, as the labyrinth in the temporal bone. Then the skull was rearticulated and an artificial cast made of the cranial cavity.

The present monograph describes the external surface of the skull and each individual bone. The description of the endocranial cavity and cast which Prof. Davidson Black has obtained of it will be discussed in a second monograph that is now in course of preparation.

In July 1930 a large part of a second braincase was obtained from certain blocks of limestone which had been brought into the laboratory in October 1930. In his monograph Dr. Black gives full details of the comparison of the two skulls and the evidence upon which he relied to interpret the sexual characters and ages of the two individuals. The skull obtained in December 1929 he now regards (for reasons set forth in full in this report) as that of a youth in a stage of development between puberty and adolescence, and the second skull that of a woman. Partial obliteration of the left side of the coronal suture suggests that the latter was an adult, possibly more than ten years older than her companion. In the accompanying diagram (Fig. 1) Prof. Davidson Black's drawings of median longitudinal projections of the young skull (shaded) and of the adult (female) skull have been superimposed. The female skull is slightly thinner than that of the youth and is also larger, being somewhat higher and longer than the male skull (Fig. 1) and presenting other differences which are probably expressions of the difference in sex.

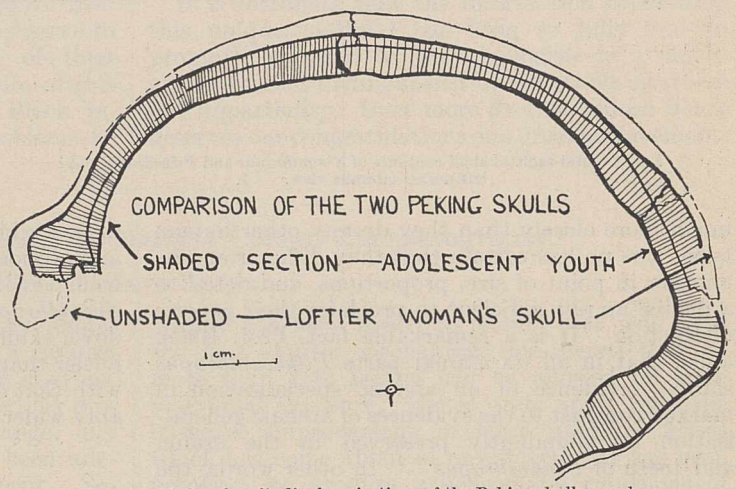

FIG. 1.—Median longitudinal projections of the Peking skulls. ×½.

In view of the claims put forward by certain writers that the Peking skull should be included in the genus *Pithecanthropus* or, alternately, in the species *H. neanderthalensis*, Prof. Black has devoted a large amount of attention to the comparison of

* Davidson Black, "On an Adolescent Skull of *Sinanthropus Pekinensis* in Comparison with an Adult Skull of the same Species and with other Hominid Skulls, Recent and Fossil", *Palæontologia Sinica*, Series D, vol. 7, Fascicle 2. (Peiping: Geological Survey of China, Peiping, April 28, 1931.)

the projections of the skulls of *Pithecanthropus* and the various representatives of the Neanderthal species. By means of statistical comparisons he has made out a conclusive case in justification of the necessity of making a new genus and species for the reception of the Peking skulls.

While it is evident that the crania of *Sinanthropus* and *Pithecanthropus* resemble one another (Fig. 2)

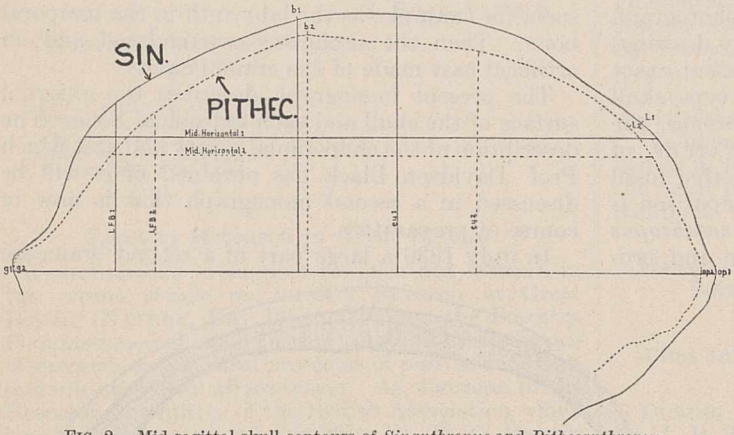

FIG. 2.—Mid-sagittal skull contours of *Sinanthropus* and *Pithecanthropus*; left norma lateralis view. × ½.

much more closely than they do any other human type, it is no less certain that they differ from one another in point of size, proportions, and detail to a degree amply sufficient to proclaim their generic distinction. It is a remarkable fact, Prof. Black adds, that in all its cranial parts *Pithecanthropus* shows "evidence of an archaic specialisation in marked contrast to the evidences of archaic generalisation so abundantly preserved in the crania and teeth of *Sinanthropus*". In other words, the apparent primitiveness of the Java fossil is in part probably due to degenerative changes responsible for the uncouth shape of the skull, which presents so striking a contrast to the elegant and undistorted braincase of the Peking man. Apart from its massive supraorbital torus and reduced third molar tooth, the Peking skull presents no highly specialised features. On the contrary, its general proportions, the morphology of the teeth, and the features of the tympanic and other individual elements of the skull, all provide evidence that *Sinanthropus* was a generalised and progressive type.

Prof. Black does not devote much attention to the comparison with the Piltdown skull. The purpose of the present work is to provide anthropologists with a detailed description of his specimen and an exact comparison with other specimens of unquestioned and generally recognised authenticity. For this reason, as well as to avoid partiality, he uses the data collected by Dr. H. Weinert in the case of *Pithecanthropus*, based upon the study of the actual fossil, with information provided by Prof. Dubois in amplification. Similarly, for the Neanderthal skulls Dr. Black relies on the data and figures provided by Dr. G. M. Morant. As, unfortunately, there is still considerable doubt in the minds of many anthropologists concerning the Piltdown skull and the mode of its reconstruction, Dr. Black does not make much use of it for comparison. He does, however, emphasise the fact that the peculiarly developed postero-inferior parietal boss in the Peking skull resembles in certain important features the similar, if less obtrusive, development of the Piltdown parietal. He also directs attention to the similar thickness of the skull in the genera *Sinanthropus* and *Eoanthropus*, but points out that the range of unevenness in thickness of the Peking skull presents a marked contrast to the more uniform Piltdown fragments.

Although Dr. Black himself has refrained from instituting detailed comparisons with the Piltdown skull, it is interesting to compare (Fig. 3) the transverse section he provides of the skull of *Sinanthropus* (the thick lines) with a section made in the corresponding plane (auditory meatus) of the reconstruction of the Piltdown skull (the larger shaded area) made by the late Prof. John Hunter. This section, like the view of the two skulls from the posterior aspect, brings out the essential identity of their architectural plan in a most striking way, and reveals a similarity of form and proportions which is unexpectedly close. Apart from the difference in thickness, the adult skull of *Sinanthropus* approaches even nearer to the Piltdown skull in some respects. Thus (see Fig. 1) it is loftier than the type skull and its height is identical with that of *Eoanthropus*, but the latter is considerably wider and correspondingly more capacious.

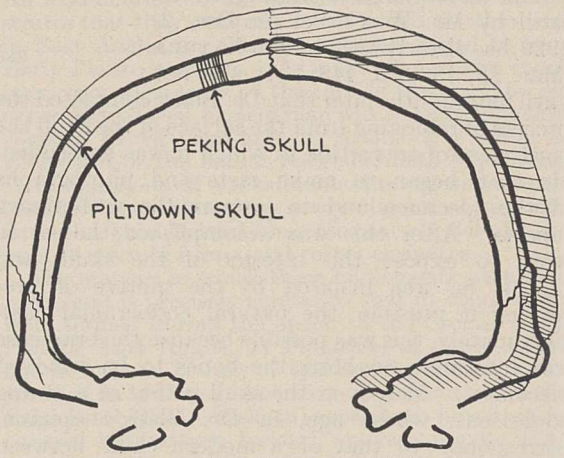

FIG. 3.—Transverse sections of Peking and Piltdown skulls. × ½.

The general form and proportions of the Peking skull, as well as the details of many of its constituent parts, are surprisingly modern in character. The man of China was clearly a very primitive and generalised member of the human family close to the main line of descent of *Homo sapiens*.

Prof. Black devotes particular attention to the unique character of the temporal bone, which presents a marked contrast to that of all other known men and apes. Of special interest are the distinctive features of the tympanic and mastoid portions,

showing, not only in the case of the mastoid but also in the form of the auditory meatus and middle ear, characters which in modern man occur only in newborn infants and very young children—a widely open meatus terminating at an ear drum the inclination of which closely approaches the horizontal. This state of affairs is lost in *Homo sapiens* long before the age of puberty is attained. As Dr. Black remarks, the features of the tympanic region of *Sinanthropus* are admirably suited to serve as a starting-point for phylogenetic speculation. "With this generalised type before us it is not difficult to imagine developmental stages through which such an element in a stem-form may well have passed, leading to the modifications such as are characteristic of the Piltdown, Neanderthal, and modern men". On the other hand, since all the essentials of the tympanic morphology of the great anthropoid apes may be recognised in these elements of *Sinanthropus*, a comparison of the latter may serve to indicate in some measure the degree of their divergence from a common type. In spite of this provocative comment, Prof. Davidson Black refrains from discussing the intriguing problems he mentions. He does not depart from the admirable restraint that characterises all he has written upon this subject, which makes his monograph a reliable guide to those who want the data and prefer to form their own opinions as to their meaning.

The great importance of the discoveries in China lies in the fact, not only that the material is more abundant than the remains found at Trinil and Piltdown, and their geological age is unquestionable, but also that, while *Sinanthropus* is differentiated from the genera *Pithecanthropus* and *Eoanthropus*, it is much more generalised than either, yet definitely linked to both. While it is the most primitive type of human being so far discovered, its structural affinities with both the Javanese and the British genera link together all the known types of Pleistocene men and give cohesion to our knowledge.

It is fortunate that the information concerning this unique material has been so fully and so promptly supplied to anthropologists in a monograph which is distinguished by admirable clearness and impartiality. Once more Prof. Davidson Black deserves our congratulations on a great achievement.

The Spicer-Dufay Process of Natural Colour Kinematography.

By T. THORNE BAKER.

ALL modern attempts to reproduce by photography the natural colours of a subject depend upon some method of three-colour analysis. The theory that by the admixture, in various proportions, of blue-violet, green, and orange, any colour in Nature can be imitated, has been adequately borne out by practical experiment. So-called 'two-colour' processes must at the best be regarded as crude attempts to saddle each of two of the primaries with one-half of the third.

Methods of photography in which a glass support is coated with a mosaic or matrix of tiny coloured areas of the three primary colours, and then with a photographic emulsion, are well-known. Such material is exposed through the coloured mosaic, so that the light rays are microscopically analysed before reaching the sensitive emulsion. It is then developed, and after the black developed image has been dissolved away, the previously unexposed silver salts are exposed to light and themselves developed and blackened in turn. This procedure gives a positive transparency image, and if it be viewed by transmitted light—that is, through the coloured matrix on which it lies—the original picture will be seen in its original colours. To A. and L. Lumière belongs the credit of having first issued such a material (1907); it is still known as the Autochrome plate, and is still largely used.

Motion picture photography based on the same fundamental idea has proved vastly more complicated. The coloured mosaic necessarily absorbs a very high proportion of the incident light, and corresponding increase in exposure is required. With the advent of 'talking pictures', the old speed of sixteen pictures per second in kinematography has been raised to twenty-four, and with the best shutter mechanism this means that no more than 1/40 second can be allowed for each individual exposure. Hence quite apart from the immense improvement in large aperture lenses which has come about in recent years, it has been necessary to produce panchromatic emulsions of extremely high sensitivity.

The films exhibited on May 20 at the conversazione of the Royal Society at Burlington House were procured on a new film which has been developed during the past four years in the research factory of Messrs. Spicers, Ltd., at Sawston, Cambridgeshire. The film base itself, which is made at Sawston, is of the acetate type, and is non-inflammable in the strictest sense. By a combination of new plasticisers with a novel method of maturation, a film has been produced which retains its suppleness and whiteness indefinitely. So rapid is the maturing that the base can be used for photographic purposes a few hours after it has been cast.

The base is coated with a very thin layer of collodion containing a green dye of the necessary concentration to act as a primary green filter. It is then passed through a rotary printing-press of special design which impresses upon it 375 parallel ink lines to the inch, with the same number of intervening clear spaces. It is next passed over rollers through a bleaching bath, which decolorises the green dye where it is unprotected by the greasy lines of printing-ink. It then passes through an orange dye, when the bleached spaces become dyed the primary orange. Finally, passage through a series of benzole tanks against revolving brushes removes the printing-ink, and a material is left

stained with alternate green and orange lines, 375 of each to the inch. A second, similar, procedure, with the greasy lines printed at right angles, provides the third primary, blue-violet, and in this way a mosaic of more than half a million blue-violet, green, and orange rectangular areas is formed on the surface of the film base.

The colour mosaic is next coated with two protective layers, in order to prevent any desensitising effect of the matrix colours upon the sensitive emulsion. A panchromatic emulsion of very high speed is finally applied. The whole procedure is carried out on 1000-ft. lengths of film 21 inches wide, which are slit up into fifteen 'cuts' of standard kinematograph width, 35 mm. A very simple protective device makes it possible to leave a colourless sound track, one-tenth of an inch wide, in each cut, so that the recording of sound with colour can be readily achieved.

Careful control of the coating of the first layer of green collodion has resulted in the production of a matrix of very uniform balance, which has been found indispensable in order that, in the subsequent dyeing processes, a correct balance of spectral distribution is maintained. It is interesting to note that the theoretical primaries have been largely departed from, and that the overlaps in the spectra of the blue, green, and orange regions greatly exceed those usually agreed upon amongst three-colour workers. That this has been justified is shown by the extraordinary faithfulness of the colour rendering.

The negative film, after reversal and redevelopment, becomes converted, as already stated, into a positive picture, which can be immediately thrown upon the screen. Such an original or 'master' positive would be of little value were it not possible to make an unlimited number of copies. The copying of any form of geometrical pattern has hitherto involved the appearance in the print of diffraction patterns or moiré, and this has greatly militated against attempts at the commercial application of matrix processes.

Satisfactory duplication of the Spicer-Dufay pictures has been effected by a comparatively simple expedient. The coloured original is passed through the gate of the printing-machine, and an image of it is thrown by projection upon the copying film, which is synchronously moved forward. The lens has been so designed that it will focus critically the black silver image of the master copy upon the sensitive film of the copying material, while the coloured matrix, which is separated from the image by about 10μ, is slightly blurred or diffused. In this way very exact natural colour copies can be obtained, which are printed at the standard rate of 800 pictures a minute. The ease of duplication at once places the process on a practical basis, for which there will doubtless be many scientific uses, apart from popular entertainment.

Centenary of David Edward Hughes.

TO commemorate the centenary of the birth of David Edward Hughes, whom Sir Joseph Larmor, in 1900, described as "one of the great scientific inventors of the age", an address on his life and work was given by Mr. Sydney Evershed, on May 14, to the Institution of Electrical Engineers, a society of which Hughes was president in 1886.

Born in London on May 16, 1831, Hughes was the son of a Welsh bootmaker, who in 1838 emigrated to the United States and settled in Virginia. At the age of nineteen he was appointed professor of music in St. Joseph's College, Bardstown, Kentucky, and while there gave lectures on natural philosophy. Like many others, he became interested in the rapidly spreading electric telegraphs and in 1854 made a practical type-printing telegraph. Resigning his professorship, in 1857 he returned to Europe to exploit his invention.

In the course of the next twenty years, Hughes made a fortune and, taking up his residence in London, devoted himself to scientific research, the first fruits of which was the invention of the microphone. He retained all his life the title of professor and his American citizenship. In 1880 he was elected a fellow of the Royal Society, in 1885 he was awarded a Royal Medal, in 1891 he became a vice-president of the Royal Institution, and in 1896, four years after Edison, was awarded the Albert Medal of the Royal Society of Arts. He died from influenza, at his house, 40 Langham Street, on Jan. 22, 1900, and was buried in Highgate Cemetery. After his death his widow returned to the United States, where she died about ten years ago. She had given his note-books to the British Museum, but much of his apparatus was left in a furniture store near the Tottenham Court Road, where it lay unheeded until 1922. Through the action of the late Mr. Campbell Swinton, much of the apparatus was secured for the Science Museum, where it can be seen. Hughes left a fortune of some £470,000. Of this he bequeathed about £13,000 to the Institution of Electrical Engineers, the Royal Society, the Paris Academy of Sciences, and other bodies, but the greater part went to the Middlesex, London, King's College, and Charing Cross Hospitals.

Many of these facts were referred to by Mr. Evershed in the course of his interesting address, the main part of which, however, was devoted to a consideration of the two outstanding achievements of Hughes's life; the invention in his early years of the synchronous type-printing telegraph, and then, in later life, the discovery of the microphone. "In these his genius was at its height, and, to use an engineering metaphor, it is the peak values that count when we attempt to estimate genius."

In the middle of the last century, said Mr. Evershed, electric telegraphy was undergoing rapid development. In England we were using Wheatstone's needle instruments; in America, Morse had produced his ink writer and efforts were being made to make instruments print messages in plain type.

At the age of twenty-one, and possibly a little earlier, Hughes invented a printing telegraph with features of great ingenuity, devising a method of synchronous working between a revolving arm at the sending end of the line and a revolving type wheel at the receiving end. At the receiving end the message was printed on a paper ribbon by the action of an electromagnet in circuit with the line. Only one impulse was needed to print a letter.

Inventions which come from outside an industry often display originality of thought, and that was true of the Hughes printer. But it was something more than original. It was what all great inventions are, a complete and practical adaptation of means to an end. It worked, and it worked well. It deserved to succeed, and it did succeed. It was so good that Hughes was not long in getting the invention into use in America, and in 1856 it was adopted by the American Telegraph Company. In the land of his birth, however, he discovered he was not a prophet, and so went on to France, where his instrument was widely applied. From France he proceeded to Italy, Russia, Turkey, Holland, and other countries, where his ideas were also fully appreciated.

With the coming of the submarine cables, Hughes's instruments were installed at the London end of the Continental lines, not on account of the merit of the apparatus, but solely as a concession to foreign idiosyncrasies. Yet it is one thing to make a successful invention and quite another to get paid for it. Too often the inventor is left to pick up the crumbs from the rich man's table. But that was not to be the fate of Hughes. He saw to it that he was well paid, and when he returned to England in 1875, from which time onwards London became his home, he was well on the way to making a large fortune out of his printing telegraph.

Hughes now entered on the second period of his life, and at the age of forty-four, with ample means, he found leisure for the work he loved best, experimental research. The opportunity for making a discovery was to come almost immediately.

Hughes's first invention was connected with the telegraph : his second was connected with the telephone. Bell's telephone was exhibited at Philadelphia in 1876, and the world soon realised that the problem of the transmission and reproduction of articulate speech had been solved. But the telephone was capable of serving another purpose. It was an extremely sensitive detector of minute variation in the strength of electric currents, and so a valuable weapon of research. Hughes was one of the first to use the telephone for research, and his experiments led him to the microphone. In this direction he was working in an entirely new field with nothing but mother-wit to guide him. Hughes was no theorist, and by what mental process he stepped from one experiment to the next will never be known. Sir Oliver Lodge has said that " Hughes thought with his hands ". The truth is that Hughes was born to make experiments and to find his way in the dark.

Hughes's experiments are referred to in his paper on " The Action of Sonorous Vibrations on Varying the Force of an Electric Current ", read to the Royal Society on May 8, 1878. In this paper he says that, being aware of the effect of light on the electrical resistance of selenium, he had an idea that sound might possibly have a similar effect on electrical conductors. Many of his experiments gave negative results, but sounds impinging on the bad contact between the ends of a broken wire were accompanied by sounds in the telephone, and this afforded the clue. Carrying on his experiments with loosely touching nails, metallic powders, bits of carbon, and other very simple apparatus, he was in the end able to hear a fly " walking with a peculiar tramp of his own ", and to the simple form of contact, sensitive to sound, he gave the name of ' microphone '.

As soon as Hughes had published his account of the microphone, there followed the usual crop of anticipations. But when we have awarded whatever credit attaches to a sporadic disclosure of uncorrelated facts, the honour must go to the man who begins at the beginning and perseveres to the end ; the man who feels his way from experiment to experiment, gathering the facts as he goes, and continuing his efforts until the full scope of the inquiry has been brought to light. That was the way of Hughes, and when his experiments had disclosed the main body of facts relating to the action of sound on electrical contacts, he gave his knowledge freely to the world.

The next thing which engaged Hughes's attention was the induction balance, an ingenious instrument which excited much interest but, contrary to expectation, proved to have a very limited field of utility as a measuring instrument. But it led Hughes to other experiments which made him acquainted with strange and bewildering phenomena. From the note-books preserved in the British Museum, which make interesting but difficult reading, Mr. Evershed was able to throw much light on Hughes's experiments on transmitting signals over a considerable distance without conducting wires ; which were once witnessed by Spottiswoode, Huxley, Stokes, and others. In these experiments, the breaking of the circuit of the primary coil was done under conditions which, as we now know, must have resulted in high frequency oscillations. Hughes did not know this ; and he was not aware that his extra current was oscillating and that his primary circuit was radiating energy in the form of electromagnetic waves.

Hughes, like others, was working at the fringe of a vast field for discovery—the wireless field. And even after Clerk Maxwell, in his electromagnetic theory of light, had forged the key to the gate, a good many years went by before Hertz, who knew about Maxwell's theory, took the key and began the work of exploration that led to wireless communication. Unfortunately, Hughes was not in possession of the key.

In the conclusion of his tribute to Hughes, Mr. Evershed remarked : " Friendly speech brings

men together as nothing else can, and Graham Bell and David Hughes who gave us the telephone and the microphone deserve to be honoured every day of our lives. It would be too much to suggest that you should think of these benefactors of mankind whenever you use the telephone, but the next time you are rung up for some far-distant friend, and hear his well-known voice speaking to you when you lift the telephone to your ear—give a passing thought to Graham Bell. And then, when you speak into the mouthpiece of the transmitter—knowing that the microphone inside it will respond and that the current ripples which faithfully represent your voice will be carried far away to your friend—remember what you owe to David Hughes."

Obituary.

THE VEN. DR. J. M. WILSON.

JAMES MAURICE WILSON was born in 1836; was senior wrangler in 1859; an assistant master at Rugby from 1860 to 1879; headmaster of Clifton College from 1879 to 1890; vicar of Rochdale and archdeacon of Manchester from 1890 to 1905; canon of Worcester from 1905 to 1926. The last five years of his life he spent in quiet but not idle retirement near Petersfield, Hants, where he died on April 15.

This bare statement does not seem to suggest many opportunities for adventure, yet it was adventure in the very best sense that was the breath of his nostrils. It was typical of Wilson that in extreme old age, when death was beckoning to him, he told one nearest to him that, though he did not know what happens to us after death, he was very keen to find out. Yes, he was always very keen to find out the truth, and always brave to face it with all its consequences. It was not his wont to abide comfortably in the old ways along which habit leads most men to slothful acquiescence. Throughout his long life, in action and in thought, he was continually breaking with his past, and gloriously happy in the difficulties that the new work and the new problems presented. The changes must have often seemed rash to the onlookers. How the wise heads must have shaken when on going up to Cambridge as a classical scholar he turned aside to mathematics, and when as a mathematical master, he allowed himself to be diverted to the teaching of science.

Before his Rugby career was over, Wilson contemplated giving up his comfortable house mastership for parochial work, and would have done so had not the headmastership of Clifton been offered him. After a few years there, he left his successful work as a headmaster to be a northern archdeacon. To many it was a matter of deep regret that no Prime Minister was ever adventurous enough to set him on the bench of bishops. The one offer that was made to him was ludicrous. It is possible that he might have been an admirable diocesan bishop; it is quite certain that he would have been leaven in the episcopal lump. As it was, he had a great influence on religious thought, and must have been a magnet which attracted many to the Church of England and kept many in it. The writer of this notice heard his first as well as his last sermon as a schoolmaster. Only a few years separated the one from the other. Both were instinct with the same buoyant and adventurous but steady faith. In all his sermons there was a certain spiritual liveliness, which kept his congregation awake even on a hot Sunday afternoon. The events of the day were seized upon to help the understanding and to show the importance of spiritual issues. He paid even his youthful congregations the compliment of recognising that they had difficulties in belief, that faith could not be easy to them any more than it had been to him.

Stress has been rightly laid on Wilson's ceaseless efforts to harmonise a spiritual faith with the claims of natural science. As a young schoolmaster it was his task to assert these latter claims. Though the teaching of science had been started in Rugby by Dr. Tait in 1849, it was looked upon as an extra, and Wilson taught it as an extra to about fifty boys from all parts of the school, even as late as 1863. Then came the report of the Royal Commission on the nine public schools, including Rugby. One of the recommendations of the Commission was that every boy should, at some stage or other of his school career, receive some education in science. Dr. Temple introduced it at once into the whole middle school; but how could one master, and that a mathematical master, cope with the work? A second mathematical master—F. E. Kitchener—was enticed to co-operate with Wilson. They insisted on only one subject being taught in all the science classes for the first few terms, so that they might cope with the difficulty. What was the subject to be? Temple suggested botany, and botany it was, even though neither of the teachers knew the subject. Wilson has himself told how the help of Sir J. D. Hooker, the great curator of Kew, was enlisted. He planned out a course of study for the two masters for the summer term. They spent the greater part of the summer holidays at Barmouth with a party headed by Prof. George Henslow and many enthusiastic collectors and diagram makers, and started teaching botany to 350 boys in September 1864. From that day until Wilson left Rugby he was the inspirer of the science teaching, which was, of course, rapidly extended, and no doubt botany was soon elbowed out by its more robust brothers, physics and chemistry. It was not only in the work in school that Wilson was an initiator. He was one of the founders of the Rugby School Natural History Society, which supplemented in almost ideal fashion the work done more formally. It aroused interest in geology, zoology, entomology, and other subjects which were

not taught in the school and yet gave life and unity to the class-room work and a common social bond to teachers and to taught.

When Wilson went to Clifton, his experience of teaching science and his enthusiasm for it were invaluable. He did not himself take a big part in the actual class work, but he collected a band of teachers and gave them the right opportunities. Of these they made splendid use. Their teaching owed a great deal of its inspiration to the way in which their headmaster encouraged them to do original work. Scientific knowledge, the Royal Society itself, would have been poorer had it not been for the opportunities that Clifton gave its masters and its boys during the period of his headmastership.

Of Wilson's work at Clifton as a whole there is much to be said. Percival had laid solid and noble foundations; Wilson gave the school just the touch of inspiration, intellectual and spiritual, that carried it through the difficult second chapter of its life. Men of ability still remember him as a teacher who made Plato a living power in their lives. To all, his versatility and enthusiasm meant much. He cared little for the solemn pomposities of life; he cared a great deal for the mortal things that touch the human mind. When sorrow or shame, success or failure, visited the community—and these are from time to time inevitable visitors in any great school—he never failed in the power to show how he longed to sympathise and restore. Now and then, no doubt, he bewildered his subordinates by improvised devices, or by a hurried change of opinion. But bewilderment is good for all men, especially for schoolmasters. He took a simple and disarming pleasure in his own feats, but was ever the first to proclaim the merits of others. Thanks to this generous quality of appreciation, masters of very different and some of very great talents found happy work at Clifton. In his northern parish these same qualities shone out for the encouragement of many clergymen and for the spiritual benefit of those laymen who, living among the dark satanic mills, are tempted to cease from mental strife.

At Worcester, Wilson mastered a new craft: that of deciphering and editing the archives in the Cathedral Library. But he did not confine himself to the Library; he spoke his mind in sermons and in lectures on the urgent social problems that affected the city's life, and he imparted his own new-won love of the ancient Cathedral to countless groups of visitors, who followed him spellbound on his courteous and enthusiastic pilgrimages from end to end of the building.

It is not fanciful to suppose that in his school-days Wilson heard the two voices that speak to men of liberty. At King William's College the ocean bellowed from his rocky shore; at Sedbergh the mountain floods brought him the same message: and all through life he had this music in his ears and rejoiced in it. To these voices others deep and vibrant were added as life brought him happiness and sorrow and quickened his imagination. So it is for a very rich and venturesome nature that all who knew him are grateful and that all the trumpets surely sounded on the other side. W. W. V.

PROF. A. A. MICHELSON, FOR.MEM.R.S.

IT is just fifty years since Michelson made his first attempt to measure the velocity of the earth through the ether. Shortly before his death he was still at work on the same problem. The memorable result was in 1887 when, in conjunction with Morley, he performed the famous experiment that ultimately led to the theory of relativity and changed our whole conception of the physical world. There was a combination of grandeur and delicacy in the apparatus which strikes the imagination—the massive pier floating in mercury and moving almost imperceptibly in slow revolution, the delicate interferometer capable of detecting a lag of one ten-thousand-billionth of a second in the arrival of the light wave; and, as a climax for the theorist, the subtle escape of Nature from the trap that Michelson had set for her.

I am not sure that Michelson himself was ever really convinced that this epoch-making work was not a 'failure'; for he was disinclined to the new theories. But he must have felt the thrill of success when in more recent times his interferometer, now magnified to colossal dimensions, gave the first measurement of the angular diameter of a star. His last work reverted to one of his earliest problems, the determination of the velocity of light; I think it is not yet known whether it has realised his most cherished ambition, to determine this constant to within one kilometre per second. He stands out as a man who could bring big ideas to fruition.

A. S. EDDINGTON.

IN 1899 I chanced to read in the *Journal de Physique* for that year two articles which provided no small part of my interest in life for several years, and the reading of which perhaps determined my career. They contained Pellin and Broca's description of the constant deviation prism, and Michelson's of his echelon diffraction grating. Michelson's first complete description is in the *Astrophysical Journal* for June 1898.

The resolving power of a diffraction grating is proportional to the product of the total number of lines by the order of spectrum observed. Consideration of how to increase resolving power by increase of the order of spectrum led Michelson to the idea of replacing the closely ruled reflecting lines of the ruled grating (with its spectra of the first, second, and other small orders) by the reflecting surfaces presented by the steps of a number of glass plates of equal thickness laid on each other *en echelon*, and yielding a spectrum of, say, the 20,000th order. He dismissed the idea of a reflection echelon at once as impracticable, saying: "The difficulty, even supposing the optical work to be practically perfect, would be the joining of the separate plates in such a way as to have always the same distance between them". But by using the same arrangement for transmission instead of reflection, he avoided these difficulties (though with some sacrifice of resolving power), and the paper describes the use of a transmission instrument to investigate the Zeeman effect.

The Michelson echelon came very opportunely for the study of this (the Zeeman) effect announced by Zeeman in 1897, and was very much used during the next ten years for that and for measurements of fine structure by many observers (Galitzin, Koch, Janiki, Nagaoka, Merton, McLennan, and Zeeman himself). Latterly, the quartz Lummer-Gehrcke plate has to some extent supplanted the echelon, chiefly on account of the fact that the lines of greatest interest lie in the ultra-violet, which is beyond the range of the transmission instrument. Together with the Fabry-Perot interferometer, these instruments have contributed in no small degree to the development of modern physics.

Quite recently, Michelson's original idea of using the grating as a *reflection* instrument has been successfully realised. This is more powerful than the transmission form, and can be used not only for fine structure work in the ultra-violet and Schumann regions, but also for substandard wave-length measurements in these regions, to an accuracy very much greater than that hitherto available. If the study of hyperfine structure, which is now just developing, fulfils the expectation of contributing to our knowledge of nuclear physics, it would seem that it is to Michelson's reflection echelon that we shall have to look for the greater share of the work. F. T.

WE regret to announce the following deaths:

Dr. Alwin Berger, an authority on succulent plants and cacti, who contributed a monograph on the Crassulaceæ to Engler-Prantl's "Natürliche Pflanzenfamilien", on April 20, aged fifty-nine years.

Prof. J. H. Comstock, emeritus professor of entomology in Cornell University, and an honorary fellow of the Entomological Society of London, on Mar. 20, aged eighty-two years.

Commander Sir Trevor Dawson, Bart., R.N., a past president of the Junior Institution of Engineers and an authority on armaments, on May 19, aged sixty-five years.

Prof. W. D. Halliburton, F.R.S., emeritus professor of physiology at King's College, London, and president of Section I (Physiology) of the British Association at the Belfast meeting in 1902, on May 21, aged seventy years.

Dr. Rudolf Marloth, who was president of the South African Association for the Advancement of Science in 1914 and author of works on the flora of South Africa.

Dr. Frederick Muir, known for his entomological work, especially in the Hawaiian Islands, formerly president of the Hawaiian Entomological Society and vice-president of the Entomological Society of London, on May 13, aged fifty-nine years.

Prof. Louis H. Pammel, professor of botany in the University of Iowa, who was a vice-president (Section G) of the American Association in 1919, on Mar. 23, aged sixty-eight years.

News and Views.

ON May 20, Lord Rutherford, as chairman of the Advisory Council of the Department of Scientific and Industrial Research, delivered an able and informative speech in the House of Lords on the problem and prospects of obtaining liquid fuel from coal. We import, he said, liquid fuel of various kinds to the value of £40,000,000 annually, and failure of this supply would have disastrous consequences to national life. So far as can be foreseen, coal is the only possible source of oil in Great Britain. Two methods are known for obtaining oil from coal, carbonisation at low or high temperatures, and hydrogenation. Lord Rutherford discussed the technical problems associated with low-temperature carbonisation and the steps taken by the Fuel Research Board to encourage the development of new retorting systems and to modify and improve low temperature tars, so as to enable them to replace natural products. Hydrogenation of tars offers promise of giving good yields of serviceable oils for various purposes, and large-scale tests are to be made. Much greater yields of oil per ton of coal can be obtained by direct hydrogenation of the coal, which has been shown to be technically possible. The development of carbonisation and hydrogenation offer great advantages, but the main problems are economic, for natural oils are available to-day in abundance and at very low prices. Progress in carbonisation depends on how far the nation is prepared to pay for a purer atmosphere by using cokes instead of coal. The hydrogenation process is limited by the degree of willingness of the nation to pay for independence in this matter of liquid fuels. Lord Rutherford ended by saying that a full scientific understanding of this problem is more essential to Great Britain than to any other country.

LORD PARMOOR, as a Government spokesman, spoke appreciatively of the importance of having in the House men like Lord Rutherford, who are able to deal authoritatively with scientific matters and expound them clearly and adequately to laymen. In contrast, on the same day, the House of Commons debated the representation of the universities in Parliament. Arguments in favour of ensuring representation of science and scholarship in the House of Commons were resisted in favour of the counting of heads. Unfortunately, the case of the universities has been weakened by their own action in selecting members according to their political complexion rather than for their intellectual stature. The debate in the House of Lords provides a good argument for the presence of scientific members in the legislature.

ON May 24, Prof. Einstein, after having had the degree of D.Sc. conferred upon him by the University of Oxford, delivered at Rhodes House his third and last lecture on the latest developments of the theory of relativity. The general theory of relativity, in its original form, was defective, inasmuch as the electromagnetic field was not expressed by means of the metric of the space-time continuum as was gravitation. A physical basis for such a unified structure was lacking, and one could only be guided by considerations of mathematical simplicity and logical form. Prof. Einstein's new development depends on a modified form of the Riemann geometry, which admitted distant parallelism (integrability of the law of displacement).

The spatial structure is described by sixteen functions, and the fundamental problem consists in deducing the differential equations of the field for the sixteen vector components. Actually, four types of field equations are evolved, of which two contain the old gravitational equations as special cases. The other two types may be discarded. Of the first two, the one which does not involve Hamilton's principle is the simpler, and Prof. Einstein proposes to adopt it. He also suggested that the results of quantum mechanics may follow from his new theory; whether his own speculations on the nature of space-time are in accord with reality can only be settled by the very difficult integration of the equations.

ACCORDING to a dispatch from the Peking correspondent of the *Times*, dated May 24, Sir Aurel Stein has left Kashgar for India, having been compelled to abandon his work in Chinese Turkestan owing to the obstruction of the local authorities. He had received permission from the Nanking Government to remain in the province for a period of three years in order to explore the ancient caravan routes. It would, therefore, appear that the efforts of the Chinese Society for the Preservation of Ancient Relics to secure his expulsion have been successful. It will be remembered that we referred in NATURE of April 11, p. 565, to the activities of this body in placing difficulties in the way of expeditions from abroad. In spite of the difficulties which beset relations with China, it would be unfortunate if the matter were allowed to rest here. It is not a matter which affects archæologists alone. China, as events in the last few years have shown, is becoming increasingly important in several branches of scientific research; and if international co-operation has been successful in one science, a *modus vivendi* should be capable of arrangement in other fields. Assuming that the Chinese Society for the Preservation of Ancient Relics is not entirely dominated by political motives, and that there is a genuine desire to preserve Chinese antiquities for China, it should be possible to arrive at an international agreement similar to those which have been framed for other countries in which the circumstances are, or were at one time, not dissimilar. Such an arrangement would make possible co-operation in the scientific development of the country, while preventing its exploitation. When a man of science of the standing and reputation of Sir Aurel Stein is prevented from carrying on, in a perfectly legitimate manner, work which is of world-wide interest and not merely of local import, the present position is obviously unsatisfactory and calls urgently for action.

THE Royal Dublin Society will celebrate its bicentenary during June, as it was founded on June 25, 1731, at a meeting held in the rooms of the Philosophical Society in Trinity College, Dublin. The Society at its foundation was known as "The Dublin Society for improving Husbandry, Manufactures, and other useful Arts and Sciences", and during the two centuries of its existence its activities have ranged over all the subjects included in the original title, and have been extended to include pure science, the fine arts, and music. They include to-day such diverse functions as the Dublin Horse Show, recitals of classical music, and the provision of radon for therapeutic purposes throughout Ireland. The bicentenary celebrations will be held at the Society's headquarters at Ball's Bridge, where ample accommodation is available for the large gatherings that a membership roll of nine thousand is likely to entail, during the period June 23–27. The functions will include an opening conversazione, special scientific and general meetings (the latter on the bicentenary date, Thursday, June 25), a garden party, and a period ball. In addition to these functions at Ball's Bridge, their Excellencies the Governor-General of the Irish Free State and Mrs. McNeill have kindly promised to invite the special guests of the Society to a garden party which will be held in the grounds of the Viceregal Lodge on Wednesday, June 24. An exhibition will be staged in some of the halls and grounds illustrating the advances made in agriculture, industry, science, and art in Ireland during the past two centuries. An interesting feature of the bicentenary week will be the presentation to Sir John Purser Griffith of the Society's Boyle Medal, which has recently been conferred on him in recognition of his work in engineering science.

Two lecture-demonstrations formed a noteworthy feature of the Royal Society conversazione held on May 20. Dr. William B. Brierley gave a lecture on a kinematograph film illustrating the formation of an intracellular inclusion in a plant cell infected with a virus disease. The preparation was made by Dr. F. M. L. Sheffield, Rothamsted Experimental Station. The film showed a normal cell with its flowing cytoplasm containing the nucleus. After infection the protoplasmic streaming becomes more rapid, and numerous small protein particles appear in the cytoplasm, which carries them passively around the cell. The particles increase in size and fuse, forming a few large aggregations, the motion of which becomes relatively slower, and after a considerable period the inclusions tend to break down, giving a number of protein crystals. The second lecturette was given by Mr. S. R. Wycherley, who showed natural colour kinematograph films made by Messrs. Spicers, Ltd., of Sawston, Cambridge, the preparation of which is described on p. 821 of this issue of NATURE. The subjects shown included indoor and outdoor scenes, photographed in the studio and out of doors, and also a film of Sir Gowland Hopkins demonstrating biochemical colour tests. The tendency in these films is towards a heightening of the colours, particularly of the blue-green, but the colour reproduction is, on the whole, very good, and the technical staff of Messrs. Spicers, Ltd., are to be congratulated on the results achieved. The fact that the films are used in an ordinary kinematograph camera and projector and are non-inflammable should ensure their speedy introduction in the kinematograph industry.

THE subject of Sir William Bragg's Friday evening discourse at the Royal Institution, on May 22, was "X-Ray Investigation of the Structure of Liquids".

Sir William pointed out that when a pencil of X-rays is sent through a liquid behind which a photographic plate is placed, the image when developed shows not only a spot where the pencil has struck, but also in general one or more circular rings surrounding the spot. Of these optical haloes there are at least three kinds. The rainbow may be set down as one of them. Rainbow colours are due to refraction in the spherical drops, and are seen when the observer has his back to the sun. The strangely shaped haloes of the Arctic regions are due to floating crystals of ice. The third kind is represented by the corona so often seen round the moon at night. In the latter case the sizes of the coloured rings depend on the sizes of the drops of water in the cloud or mist. The smaller the ring the larger the drop must be. The result is readily explained on the principle of the interference of light, due to Thomas Young. Particularly good colour effects can be produced in the laboratory by means of artificial fogs. The wave-length of the X-ray bears approximately the same proportion to the size of the molecule as the wave-length of light to the size of the water-drop; and some of the rings on the photographic plate can be explained in the same way that the coronæ are explained. But there is undoubtedly more than that in the phenomenon. It appears that sometimes the rings are due to arrangements of the molecules of the liquid in ordered array, as in a crystal, but the arrangements are only fleeting and irregular, so that the sharp pictures obtained with X-rays when crystals are used are blurred when the crystal is melted and becomes liquid. It has not been possible, until the X-rays provided the means, to demonstrate in a direct manner this tendency to arrangement; it may now be possible to examine its nature and extent in various liquids. It is probably an effective factor in determining liquid properties.

WE recently described a successful demonstration of the micro-ray system of wireless telephony between Dover and Calais. A new system of telephony called the single side-band system was demonstrated on May 21, between the wireless station at Trappes, near Paris, and the station of the Spanish National Telephone Company at Madrid. Both demonstrations were given by the engineers of the International Standard Electric Corporation. The single side-band system of telephony was first used some years ago in carrier communication on wire lines. In this connexion, its main advantage is that it doubles the number of speech channels available for the same total band width as compared with ordinary modulation with both side-bands. It has also been successfully used on the long-wave wireless telephonic circuit between New York and London. Difficulties had to be overcome in applying the side-band system to short-wave work. During last year, single side-band tests were carried out on the radio link between Buenos Aires and Madrid and the one connecting Madrid and Paris. It was found that the received quality was always as good as that obtained when using the double side-band and very definitely better during bad selective and fading conditions. With average fading, the improvement with the new system was at least twice as good as in normal working with both side-bands. Rough tests on the improvement of intelligibility showed that it was about four times as high with the single side-band system. It appears that a new system applicable to commercial working has been evolved. Mr. A. H. Reeves, the English engineer who devised the new side-band system, is to be congratulated. In time, without doubt, his method will be applied to those systems of wireless communication for which narrow limits of synchronisation are essential.

WE learn from a *Daily Science News Bulletin*, dated April 2, issued by Science Service, Washington, D.C., that Dr. Bruno Lange, of the Kaiser Wilhelm Institute, Berlin, has invented a new light cell, the sensitivity of which is many times greater than any at present in use. He deposits a thin layer of copper or other metal on the sensitive substance by cathodic sputtering. A wide mesh grid of metal is placed on this. By this means he is able to obtain much larger currents from the copper oxide 'sandwich' for a beam of light of given strength. Siemens and Halske are developing the new photocells, which are stated to have an efficiency at least fifty times greater than those now employed. A small experimental apparatus worked by sunlight has been driving a minute electric motor in dull daylight for some months in Berlin. It is stated that a square yard of copper oxide 'sandwich' can produce several watts of electric power when subjected to full sunlight. The efficiency of this invention will probably have to be improved many hundreds of times before it can be used to provide electric lighting and power on an economic scale. The solar generators will have to be placed in tropical regions where there is little rainfall. Like the alkali photocell, the new invention should find a large number of uses in scientific investigations and in applied science. For sound films and television it should prove very useful. It also makes telephony with infra-red rays a possibility. It may lead to devices which will enable ships to signal through fogs, and aeroplanes to determine the position of the sun through thick clouds.

IT is known to motorists that up to a certain limit of speed the number of cars that can be accommodated in a given length of street continually increases, but above this limit the number diminishes owing to the greater distance that has to be kept between consecutive cars. This question has recently been investigated by the traffic committee of the American Road Builders' Association. Making average assumptions, they find that at 23½ miles an hour the number of moving vehicles that can pass over a given line drawn across the street per hour is a maximum. Above or below this speed the number of cars that pass the line per hour is less. If the cars have an average length of fourteen feet and travel at only five miles an hour, they need only keep five feet apart, and thus 1380 will pass the line in single file. If they run at ten miles an hour and are fitted with four wheel brakes the distance between them must be increased to eleven feet. In this case 2100 cars cross the line.

Proceeding in this way it is found that the maximum number of 2600 cars an hour is attained when the speed is 23½ miles an hour. At a speed of 45 miles an hour only 1760 cars pass the line every hour, which is practically the same as the number that would pass at a speed of seven miles an hour, which with the modern type of car would be an uneconomical speed.

THE issue of the first numbers of the *Indian Journal of Agricultural Science* and *Agriculture and Live-stock in India* inaugurates the new series of publications in agricultural and veterinary science issued by the Imperial Council of Agricultural Research, which will take the place of the *Agricultural Journal of India*, the *Journal* of the Central Bureau for Animal Husbandry and Dairying and the Memoirs and Bulletins of the Imperial Department of Agriculture in India. The *Indian Journal of Agricultural Science* will be a scientific journal, issued in alternate months, and will largely replace the bulletins and memoirs, and at the same time afford a medium for material which has not been suitably provided for in the past. The original articles in the first number include an account of breeding investigations on *Toria*, and papers dealing with the inheritance of characters in Indian linseed and studies in Indian barleys respectively. *Agriculture and Live-stock in India* is intended to be a general journal appealing to a large circle of readers. During 1931 it will appear in alternate months, but it is hoped to issue it monthly in future years. The original articles in this first number cover a wide range of interest and include a report on the All-Burma tractor trials, a discussion on cattle-breeding policy, and papers dealing with various plant diseases. In addition, there are in both journals selected articles written by well-known authorities on subjects likely to be of special interest and help to those engaged on Indian problems. A new feature of these publications will be the abstract sections, whereby it is hoped to keep agricultural research workers in India more fully in touch with other investigators in the country, and permission has been obtained from the newly established Imperial Agricultural Bureaux to reproduce certain of their technical communications and abstracts. Attention is directed to the " instructions to authors " contained in these numbers, for only with the co-operation of all contributors in the manner prescribed can the Council achieve its aim of prompt publication of scientific work.

THAT India has set an example to other parts of the British Empire in forest research is well known. So far as research in connexion with tropical forestry is concerned, she has given a lead to the tropical world. In some of our colonies and dependencies the Indian example is being followed, and we welcome the first number of the " Record of Forest Research in 1928 " of the Nigerian Forest Department (*Bulletin* No. 1, 1930). A commencement was made with the inauguration of an Investigation Branch in 1913. This branch started certain investigations into the composition of the growing stock in some of the better known Nigerian forests, and also into the technical and physical qualities of the common timbers. The War put an end to these inquiries. The first of the new research officers, who are responsible for the present bulletin, are Messrs. J. D. Kennedy and W. D. Macgregor—both of whom received their forestry training at Edinburgh and, after a few years' work in Nigeria, were given a year's special course, partly at Oxford, on the Continent, and, more important, in India and Burma. It was a wise step to send the future research officers to study the progress made in India, for the Indian lines of advance more nearly approach those which many of the forest services of the Empire will follow than the more stereotyped European practices, once these have been correctly assimilated. The two officers returned to Nigeria in 1927, and the present report records their work during 1928. Mr. Kennedy was stationed at Sapoba, in North Nigeria, and Mr. Macgregor at Olokemeji. The latter place was at one time the Southern Nigeria Forestry Headquarters Station, and contains much of value and interest. The report gives evidence that the lines upon which sylvicultural investigations have been commenced are sound, and some interesting results may be confidently looked for. It may be noted that a forest utilisation officer and a wood-seasoning officer have also been added to the research staff. Whilst much forestry administration and executive work remains to be accomplished in Nigeria, the Department may be congratulated on this important departure in the matter of research.

AT the fifty-sixth annual general meeting of the Linnean Society of New South Wales, held on Mar. 25, Mr. E. Cheel delivered his presidential address. After a review of the Society's activities, he gave a general summary of the myrtle family. Upwards of 3000 species are known of the plants commonly called 'myrtles' and these are classified into 74 genera in the family Myrtaceæ. The Australian myrtles are widely different from those of other countries, and they form a very important group of the Australian flora on account of the value of their timber, the medicinal and industrial properties of the species, and the utility of the berried fruits. The Australian eucalypts play a prominent part in the sylvan culture of millions of acres of land in various parts of the warmer zones of the globe. Some eucalypts produce tannin; practically all of the Myrtaceæ are useful bee-plants; a number of species of eucalypts has given fairly satisfactory results in tests for wood pulping qualities; *Eucalyptus macrorrhyncha* has yielded a valuable dye-material, myrticolorin. Many species of the myrtle family produce timbers suitable for a variety of purposes. Forests of these have been exploited, without provision being made for rehabilitation, and re-afforestation is now perhaps the most important forestry problem. Different groups of the Australian myrtles yield a variety of essential oils, some of which have a considerable commercial value. Following the address, Prof. T. G. B. Osborn, professor of botany in the University of Adelaide, was elected president for the ensuing session.

CAPT. T. E. JOYCE, leader of the British Museum's expedition of archæological exploration in British

Honduras, returned to London on May 23. This year's expedition, which is the fifth in succession, left England at the end of last January. Ten weeks were spent in the bush. One of the objects of the expedition was to retrieve the stone stela from Pusilhà, containing the longest and most important of known Maya inscriptions, which had to be abandoned on the return journey last year owing to difficulties of transport and weather. Two large plazas on a recently reported site, thirty miles from the coast on South Stann Creek, were explored. On the south side of the central dividing mound a collapsed staircase was found; but the buildings were in a bad state owing to the perishable nature of the material, and it was probably owing to the friable nature of the surface afforded by the granite of which they were made that the numerous stelæ showed no signs of inscription. On the return journey another site yielded two stone coffins made of slate slabs. No bones were found in these. Probably they had perished owing to the damp. The pottery which had survived was of the consistency of putty owing to this cause. Other finds were a finely worked and slender spear-head eighteen inches long, an incense burner, jadeite ornaments, greenish stone axes, and a stone knife. They are tentatively dated at about A.D. 500. According to a report in the *Times* of May 25, the objects found will be added to the British Museum, on the understanding that some of them will be returned to Belize should an archæological museum be established in British Honduras.

THE Report of the National Physical Laboratory for the year 1930 is a quarto volume of nearly 300 pages, published by the Stationery Office for the Department of Scientific and Industrial Research at 12*s*. 6*d*. net. As in past years, it consists of a general report of the Executive Committee and of more detailed reports from the heads of the various departments. The latter give sufficient information as to the methods in use for the solution of the problems in hand, and as to the results which have so far been obtained, to allow the reader to judge for himself the importance of the work being done, whether it is of the scientific or of the industrial type. In most cases these reports are provided with illustrations, which add much to their interest. So far as the routine tests of instruments and apparatus are concerned, the work for the year does not differ materially in quantity from that of the previous two years, except that many more radium preparations have been examined.

VARIOUS government departments continue to call on the National Physical Laboratory for information which involves new experimental work, amongst them the Air Ministry in connexion with the *R101* disaster, and the Home Office with regard to the strength of chains. A large proportion of the research on scientific problems is directed by the various research associations which have been formed under the Department of Scientific and Industrial Research or by the Research Committees of the Laboratory. During the year, the Laboratory has lost the services of Lord Rutherford and Sir Thomas Stanton by retirement, and of Sir William Smith and Mr. Campbell Swinton by death. The new physics building and the compressed air tunnel have been completed, and a new ship tank is in course of construction to meet the great demand for tests. There is a strong feeling on the part of the Executive Committee of the Laboratory that the demand for work for industry should not be allowed to crowd out research of a more fundamental character which will extend our knowledge and provide a basis for future advances in both pure and applied science.

THE March issue of the *Decimal Educator* reproduces the section of the *Chinese Economic Bulletin* for Oct. 25, 1930, which deals with the new standards of weights and measures adopted by the National Government on Feb. 6, 1929, for the whole of China. The ultimate standards are the metre and the kilogram, and, during the transition period, the old weights and measures, which vary considerably throughout China, are to be unified and defined in terms of the metric standards. The Sheng is in future to be the Shih Sheng of one litre, the Ch'ih is to be the Shih Ch'ih, one-third of a kilogram. The British quart, pound, and yard are stated to have the approximate values, a litre, half a kilogram, and a metre respectively. It is noteworthy that these approximate values given in the Chinese document should be those which the Decimal Association in Britain and the Metric Association in the United States advocate for the transition periods in those countries.

SIR CHARLES CLOSE, president of the Hampshire Field Club and Archæological Society, recently addressed the Society on "On the Deadliness of Museums", and if his criticisms of the provincial museums of Great Britain were of the obvious and usual type, his suggestions, though not startlingly novel, were based on sound common sense. If a provincial or local museum is to be wholly or primarily an instrument of popular education, then the ideal which Sir Charles held up to the curator in his picture of the Neolithic Room was admirably conceived. He pointed out that it remains an ideal unachieved as yet in Great Britain, though he finds steps towards it in a few museums, among which, with due regard to his audience, he placed the Cloth Hall at Newbury and the new museum at Basingstoke. His final suggestion is that the caretaker (presumably in such a smaller museum) might act as guide; the value of the suggestion depends on the caretaker. In general, we believe that the defects of which Sir Charles complains are due not to lack of goodwill or brains in the curators, but to want of means.

THE Czechoslovak National Research Council, which is incorporated in the International Research Council, and is an offshoot of the Czech Academy of Sciences, completed the seventh year of its activities at a general meeting held in Prague on Mar. 21. Succeeding Prof. F. L. Syllaba, who died on Dec. 30, 1930, Prof. B. Němec was elected president. Dr. J. Bašta delivered a lecture on "The Spirit of Opposition in Scientific Research", in which he emphasised that

the principle of opposition is a fundamental one both in the reactions of matter as well as in the investigator's mind.

MESSRS. Adam Hilger, Ltd., have issued, under the title of "Spectrum Analysis in Mineralogy", a valuable review by Dr. A. A. Fitch of the technique of mineralogical spectrum analysis and the results that the method has so far yielded. The topics dealt with include preliminary treatment of the mineral; optical apparatus; excitation of the spectrum; spectroscopic and spectrographic technique; and methods of qualitative and quantitative analysis of minerals, concentrates, rocks, meteorites, and mineral waters. Reference is also made to X-ray spectrum analysis of minerals and to mineral determination by means of absorption spectra. A long list of examples of the elements found in various minerals by spectroscopic analysis has been compiled, with references to a bibliography of 91 items. This alone makes the pamphlet indispensable to all workers in this rapidly advancing field of research. Scientific workers will be grateful to Messrs. Hilger for providing them with this convenient summary of technical methods and published results, particularly as the latter are scattered through a very wide range of periodicals.

THE great advances made in our knowledge of the elements in recent years has led to a desire on the part of many teachers for modern periodic law charts in which this new information has been included. Mr. John Murray, Albemarle Street, W.1, has just published such a chart, prepared by Mr. W. H. Barrett, of Harrow School, which should meet the requirements of teachers in schools. It comprises four separate charts, one of the Periodic Table and Atomic Numbers (after Bohr), one of the Periodic Table and Atomic Weights (after Mendeléeff), one of the Periodicity of Atomic Volumes (after Lothar Meyer), and one of Melting Points and Atomic Numbers. It will be seen that these new charts (which together cover an area of 6 ft. by 2 ft. 2 in.) will serve to illustrate the main features of the modern Periodic System, and they will be found most useful in senior courses in chemistry. The printing is very clear and the charts are free from unnecessary complications. The price of the set, unmounted, is 5s. 6d. net, or mounted on linen, 9*s*. 6*d*. The chart is also available mounted on linen, varnished, and on rollers, for the price of 15*s*. 6*d*. net. When the great advantage of such a modern set of charts is kept in mind, these prices must be considered very reasonable. The diagrams are sufficiently large to be suitable for classroom teaching, and their use should considerably simplify the teacher's work.

AT the annual general meeting of the Institute of Physics, held on May 19, Lord Rutherford was elected president for the year 1931–32.

SIR ARTHUR EDDINGTON, Plumian professor of astronomy and experimental philosophy in the University of Cambridge, has been elected a foreign member of the American Philosophical Society, Philadelphia.

A LARGE earthquake was recorded at Kew Observatory at 2 hr. 27 min. 0 sec. G.M.T. on May 20. It is estimated that the disturbance originated 1200 miles away, the epicentre being under the Atlantic about 300 miles west of Cape St. Vincent.

THROUGH the generosity of Lady and Miss Darwin, who have founded a Darwin Trust of about £275 a year, augmented by a contribution from the Medical Research Council, a study of the cause of amentia (feeble-mindedness) is to be undertaken at the Royal Eastern Counties Institution for the Mentally Defective at Colchester. Dr. Lionel Penrose has been appointed research medical officer, and Miss Newlyn social investigator, for this investigation.

AT the annual meeting of the Optical Society held on May 14, at the Imperial College of Science and Technology, the following officers were elected for the session 1931–32: *President*: Prof. A. O. Rankine; *Hon. Treasurer*: Major E. O. Henrici; *Hon. Secretaries*: W. B. Coutts (Business), E. T. Hanson (Papers); *Hon. Librarian*: Dr. J. J. Hedges; *Editor of Transactions and Assistant Secretary*: Dr. J. J. Hedges.

PROF. ABDUL HAMID BEG, Islamia College, Lahore, sends us a short description of an experiment on the recomposition of white light by the use of a rotating mirror. Recomposition by a rotating colour disc is not very satisfactory, as an impure white or grey is seen. A better method is to use a lens, or an oscillating mirror, to recombine the colours of the spectrum of white light. Prof. Beg substitutes for an oscillating mirror a rotating cube having plane mirrors on its vertical sides, and his device may interest some teachers of physics.

IN memory of its late editor, Prof. Eugenio Rignano, who died on Feb. 9, 1930, *Scientia* has founded a Eugenio Rignano Prize of the value of 10,000 Italian lire. The prize will be awarded as a result of international competition to the author of the best essay on "The Evolution of the Notion of Time". The works submitted should either be unpublished, or published since 1930, and should be sent for examination not later than Dec. 31, 1932. Further information may be obtained from the Editor of *Scientia*, 12, Via A. De Togni, Milano (116), Italy.

IN a note in NATURE of May 9 (p. 714) on the Manchester earth-shake of May 3, it was stated, on the authority of the local press, that the shock was not recorded at the Godlee observatory at Manchester. We have received a letter from the Rev. J. P. Rowland, *S.J.*, pointing out that no seismograph has yet been installed at this observatory. He also gives a revised estimate for the time of the initial movement recorded at Stonyhurst, namely, 8 h. 26 m. 0·5 s. (G.M.T.), and the time at the origin as 5 seconds earlier. The tremors were exceedingly small, the amplitude being not more than 6·7 μ.

A USEFUL and well illustrated guide to the larger moths of Eastbourne appears as a supplement to *Trans. Eastbourne Nat. Hist. Photog. and Lit. Soc.*, vol. 10. The author, Mr. Robert Adkin, has already

described the butterflies of the district, and this account of the sphingids, bombycids, noctuids, and geometrids forms the second of three instalments.

WE have received from the Zenith Electric Co., of Willesden Green, London, N.W.2, a copy of its latest catalogue of regulating resistances. These devices are well known in laboratories, and are now often used in electrical works. The latest sliding type of resistance gives very fine adjustment and is cheap. As they are flash-tested at 2000 volts alternating, they are safe to use in electrical testing rooms.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A professor of education in the University of Bristol—The Secretary and Acting Registrar, University, Bristol (June 6). A visiting teacher at the Hackney Technical Institute, for instruction to junior workers in the chemical manufacturing trades—The Education Officer (T.1), County Hall, S.E.1 (June 6). An assistant veterinary inspector under the Surrey County Council to carry out duties under the several Acts and Orders relating to milk and dairies ; diseases of animals ; and such other veterinary duties as the council may require —The Chief Veterinary Officer, County Hall, Kingston-upon-Thames (June 8). An assistant marketing officer under the Ministry of Agriculture and Fisheries —The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 8). A full-time teacher of general elementary science and mathematics at the Technical College, Wolverton—The Secretary, Technical College, Wolverton (June 8). A lecturer in physics at the Birmingham Central Technical College —The Principal, Central Technical College, Birmingham (June 12). An assistant lecturer in zoology in the University of Bristol—The Secretary and Acting Registrar, University, Bristol (June 13). A library assistant at the University College of North Wales, Bangor—The Librarian, University College of North Wales, Bangor (June 13). A Thomas Wall reader in comparative education at King's College, London—The Academic Registrar, University of London, S.W.7 (June 15). A junior assistant (chemist) under the Department of Scientific and Industrial Research—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (June 16). Keepers of, respectively, ethnology and geology in the Public Museums, Liverpool—The Town Clerk, Municipal Buildings, Dale Street, Liverpool (June 19). A Clothworkers' scholar in the University of Leeds for research in the physical properties of wool and other fibres—The Clerk to the Senate, University, Leeds. A graduate assistant master for engineering science and cognate subjects at the Cambridge and County School of Arts, Crafts, and Technology—The Education Secretary, County Hall, Cambridge.

Our Astronomical Column.

The Light-Variation of Eros.—*Astr. Nach.* 5784 contains two papers on this subject. S. Taffara, of Catania Observatory, discusses the period, finding the value 0·109796 day, which agrees exactly with that announced by L. Jacchia, of Bologna. Most observers take this value as the half-period, considering that the complete cycle contains two slightly dissimilar waves. The elongation observed at Johannesburg was stated to travel round in the double period 5 h. 16 m.

The other paper is from Uccle Observatory, by E. Delporte and P. Bourgeois. They determined the magnitude photographically, both by ordinary plates and by plates with a maximum of sensitiveness between wave-length 5200 and 5800. With the latter plates a yellow screen was employed, stopping all light of wave-length less than 4860. The curves obtained by the two methods are very nearly parallel to each other. The distance between them indicates a colour index of 0·77 mag. The colour has some influence on the parallax investigation, owing to differential atmospheric refraction. One advance in the present parallax campaign over that of 1900–1 is that on this occasion the spectral types of the comparison stars have been determined, so that it will be possible to make allowance for differential refraction, or at least to exclude stars of type differing much from that of Eros.

Absolute Magnitudes of *K*-type stars.—A method was recently devised by Strömberg for determining statistically the distribution of absolute magnitudes in a group of stars. The requisite data are proper motions and radial velocities, or derived functions of these quantities, from which accurate values of the frequencies of different absolute magnitudes in the group can be determined. Some interesting results have now been obtained by the author in applying his method to *K*-type stars (*Astrophysical Journal*, vol. 73, p. 40). Amongst types *K*0 to *K*2, four distinct maxima appear in the frequency curve at absolute magnitudes −2·5, +0·3, +2·7, and +6·1 ; the largest number (78·3 per cent) being of absolute magnitude +0·3. It thus appears to be necessary to subdivide the giants into three groups of mean absolute magnitudes equal to the first three maxima ; and the designations of bright, normal, and faint giants have been provisionally applied to these groups. For stars of types *K*3 to *K*9 only three maxima appear, corresponding to super giants, normal giants, and dwarfs at absolute magnitudes −4·5, −0·1, +6·7 respectively.

New Catalogue of Comets.—Mr. I. Yamamoto has just published a new catalogue of comets in the current *Handbook* of Kwasan Observatory. Most of the book is in Japanese, but the catalogue is in English. It reproduces the orbits given in Galle's "Cometen-Bahnen", with the addition of those that have since been published, extending up to the end of the year 1930, so that it is quite up to date. The elements are given to the third decimal of a degree, which is near enough for most purposes. There is a useful separate table of the comets of short period, with the approximate date of their next apparition, and a list of the returns at which they were observed. There are a few errata. Some proper names are misspelt. Skjellerup's comet of 1927 is wrongly identified with De Vico's of 1846. Yamasaki's name is given, instead of that of Forbes, as the discoverer of 1928 IV. However, there are probably no catalogues of the kind that are quite free from mistakes. The book contains some other tables in English. They include elements of satellites and the more interesting minor planets, and a table for converting R.A. and declination into galactic longitude and latitude.

Research Items.

A Saxon Sword from Wales.—Mr. C. E. Vulliamy describes in *Man* for May the discovery of a bronze ring and sword in a hut-circle in the parish of Llowes in Radnorshire. The wall of the hut is marked by a low bank of turf and stones. The interior is filled with sandstone blocks of moderate size, probably fallen from the roof. A lining of massive blocks seems to have served as a revetment of the inside of the walls. A trench across the enclosure from east to west revealed the floor at a depth of eighteen inches to two feet. A small flint knife broken in two pieces and damaged by fire, and two pieces of burnt flint, were found. A surprising find was a small, thick, bronze ring, 1½ in. in diameter, in debris above the floor in the western sector. This was followed by the discovery of an iron sword, broken in two and thickly covered with yellow rust. It was lying on the collapsed material of the wall. The blade of the sword was badly corroded and the point was missing, but it is undoubtedly Saxon and, it may be assumed, belongs to the pagan period, dating at about A.D. 400-500. The tang and shoulders correspond with datable Saxon swords of about that time. A La Tène date seems improbable, but in the absence of the pommel exact dating is impossible. The length of the sword from tang to point was probably about thirty-four inches. It is interesting to note that the find was made fourteen or fifteen miles from Offa's Dyke and eight or nine miles south of Garth Maelwys, where the Welsh are supposed to have defeated the Mercians in 723. A Saxon dagger and spear ferrule have been recorded from one of the Worlebury hut-circles near Weston-super-Mare.

Important Foods of Wild Ducks.—North Dakota is a recognised and favourite resort for wild ducks, and as a consequence is much visited by sportsmen. Its selection by the birds is due to its maze of lakes, sloughs, and ponds, well stocked with suitable food and having plenty of cover. To determine the relative values, and the possibilities of the improvement of the marsh and aquatic areas as feeding grounds for the birds, a survey of the vegetation of about five hundred lakes was made by the late Douglas C. Mabbott and Franklin P. Metcalf in 1917 (*Technical Bull.* No. 221, U.S. Dept. Agric., March 1931). Although the full list of the plants inhabiting the lakes includes the names of about 350 species, the important food-plants for ducks are comprised in some 13 species. Of these, the most abundant is sago pondweed (*Potamogeton pectinatus*), found both in fresh and alkaline-saline lakes, and supplying food in the form of abundant underground tubers as well as seeds. Next in importance come wigeon grass (*Ruppia maritima*) and bayonet grass (*Scirpus paludosus*), while the other most useful contributors to the diet include other species of these genera, as well as species of *Sagittaria*, *Lemna*, *Polygonum*, *Ceratophyllum*, and *Chara*. It is noteworthy that almost all the lakes contain at least a small quantity of alkali.

Rabbits and Butterflies.—In a short article in the *Vasculum* (May 1931, p. 68), Prof. Heslop Harrison directs attention to a curious dependence of the numbers of small copper butterflies upon the numbers of rabbits in certain districts. The small coppers depend for food upon the sorrels (*Rumex acetosa* and *R. acetosella*). The latter favours disturbed soils; it is the first invader to appear when whins and heather have been burnt; similarly it is the plant which thrives best among the scrapings and burrows of rabbits. Were the rabbits to disappear in certain places which the author names, the vegetation would close up, sheep's sorrel would disappear, and the small copper would follow suit. It is a series of links in a Nature chain, 'small coppers'—sorrel—rabbits, and Prof. Harrison might have added that we owe our rabbits to the Normans, so that the numbers of 'small coppers' in the British Isles may be said to depend to some extent upon the Norman Conquest!

Japanese Macrura.—Dr. Zu Yokoyâ describes the Macrura of Mutsu Bay in the "Report of the Biological Survey of Mutsu Bay, 16" (*Science Reports*, Tôhoku Imperial University, **5**, 3; 1930. Contribution No. 55 from the Marine Biological Station, Asamushi, Aomori-Ken). Thirteen genera and twenty-three species are represented, one genus and four or five species being new. Our knowledge of the geographical distribution is greatly extended, especially of certain southern forms which are now found to live in Mutsu Bay. *Penœus japonicus* is one of these. The new genus *Paraspirontocaris* is closely allied to *Spirontocaris*, but differs in its peculiarly shaped, laterally compressed rostrum projecting obliquely downwards with a rib on each side and small teeth on the upper margin, in the paired carinations of the first and fifth abdominal segments, and in the branchial formula. This new genus is created for the species *Paraspirontocaris Kishinouyei*.

Furunculosis of Salmon.—In two recent papers, a definite advance has been made in the problem of eradication of furunculosis from our salmon and trout fisheries. First, a test has been found whereby *Bacillus salmonicida* can be identified for certain; and secondly, a method for the external disinfection of salmon and trout ova has been successfully tested. Isobel Blake (I. J. F. Williamson) and Eleanor J. M. Anderson (*Fisheries, Scotland, Salmon Fish.*, 1930, No. 1) by the bacteriological test known as the complement-fixation reaction have shown that *B. salmonicida* is a serologically homogeneous species. Many strains of other organisms isolated from fish and from fresh water gave consistently negative results. The general test was modified in that the immune serum was heated at 65° C. for half an hour and the complement was treated with charcoal. The first-named author has shown that acriflavine is a suitable agent for disinfecting ova which can carry the furunculosis bacilli (*Fisheries, Scotland, Salmon Fish.*, 1930, No. 2). The bacilli are only present on the outer surface of the eggs and acriflavine in a dilution of 1 in 2000 effectively kills the bacilli without causing injury to the eggs, which should be subjected to the treatment for 20-30 minutes. A method is given for the practical application of acriflavine to eggs at a hatchery on a commercial scale.

New Strains of Welsh Oats.—The Welsh Plant Breeding Station at Aberystwyth is not able to undertake the growing of new varieties of cereals on a large scale so that they may be distributed to meet a general farming demand. The Station is, however, selecting a number of pure lines from some of the commonest Welsh strains and breeding them on sufficiently to enable a comparison of growth habit and yield and behaviour from season to season. It is then prepared to bulk the produce of selected pure lines to an extent sufficient to allow a limited distribution to Welsh growers. If the new line behaves well in ordinary farming practice, then the seed supply may be increased through the farm-grown crop. Two cultivated oat varieties, commonly grown in Wales,

Ceirch Llwyd (*Avena Strigosa*) and Ceirch-du-Bach (*A. sativa*), especially the former, proved to be far from uniform when tested at the Station. A number of pure lines were therefore grown from selected heads, and from these, after rigorous elimination, a few have been chosen and grown, as on behaviour and yield they showed better performance than the aggregate. The work done in selecting these lines and their characters is described in leaflet S.2 from the Station (1931), by E. T. Jones. Supplies of seed will be available for growers for planting in 1932.

Interspecific Plant Hybrids and Backcrosses.—The first part of a paper on this subject by E. Warren (*Annals* of the Natal Museum, vol. 6, part 3) deals with the selfed hybrid generation of *Venidium* and *Arctotis* and the two backcrosses, and a comparison is made of their characters with the corresponding ones in the hybrid and in the two parents. In the second part certain aloe hybrids are discussed. The hybrids and backcrosses are described in connexion with a statistical treatment of a series of characters, the distributions of the variable in the different generations being given in comparative tables; and by means of certain ratios a comparison, on a numerical basis, is made of the general facies of the different generations of the crosses and backcrosses. The daisy hybrid exhibited greater sterility to selfing than to backcrossing, and the plants of the hybrid × hybrid generation were so sterile that no achenes capable of germination were obtained by selfing. The aloe hybrids were exceedingly sterile to selfing, and no good seeds were obtained, but backcrossing was comparatively easy. This fact is significant in relation to the taxonomy of aloes where hybridisation readily occurs in Nature, and there must be a considerable mixture of species in the population of aloes of many districts where various species are growing together.

Ice in the Arctic Sea.—The Danish Meteorological Institute has issued its report on "The State of the Ice in the Arctic Seas, 1930". In European Arctic waters there was extraordinarily little ice. In the Barents Sea and around Spitsbergen open water was more extensive than in any other year during this century. So early as February, the ice edge in the Barents Sea was in the normal position of May and June, and by August it was lying north of the western islands of Franz Josef Land instead of some three degrees to the south. Bear Island was free from ice by April, and remained free throughout the summer. From the autumn of 1929 until April 1930, the whole west coast of Spitsbergen was clear of ice. After a little ice in May and June, the coast was again completely clear, and in July and August, the ice edge lay in lat. 81° N. During August the entire archipelago was free from ice, and there was practically no ice between Spitsbergen and Franz Josef Land. The Kara Sea was clear enough to be navigable in August and September. On the east coast of Greenland the ice was fairly abundant until the autumn, when parts of the coast were easily accessible. Iceland was almost ice-free throughout the year. In Davis Strait the amount of ice was below the normal. Hudson Strait and Bay were clear of ice in July and August. In contrast with these comparatively ice-free coasts, Alaska and eastern Siberia had the pack ice up to their coasts for most of July and August. In fact, the polar ice would appear to have been driven against these coasts rather than out into the Barents and Greenland Seas.

X-Rays without Tubes.—In the March issue of the *Journal de Physique*, M. G. Reboul, of the Physics Laboratory, Montpellier, gives an account of the methods which have been developed in that laboratory for the production of X-rays by driving electric currents through solids of high electrical resistivities by high electrical pressures. In cases in which a large proportion of the fall of potential occurs in the material either at the anode or at the cathode, that portion of the material is found to emit soft X-rays of the order of 10^{-6} cm., which become harder as the potential fall increases. The electrode at which there is a large fall of potential, is given a grid form so as not to interfere with the emission of the radiation. The material is used in the form of rods, about 9 cm. long and 3 cm. diameter, surrounded by ebonite, with an arrangement for pressing the electrodes against the ends of the rod by means of an ebonite screw. Magnesia, yellow oxide of mercury, alum, and other materials have been used with differences of potential up to 30,000 volts, and X-ray photographs of the usual type obtained.

Spectra of Beryllium.—A paper by F. Paschen and P. G. Kruger in the *Annalen der Physik* (vol. 8, p. 1005), on the spectra of beryllium (Be I and Be II), closes an important gap in our knowledge of the properties of the lightest elements. These spectra are difficult to produce, for technical reasons, and had previously been described only incompletely, but Prof. Paschen has now been able to obtain good sources both in arcs and glow-discharge tubes. The spectra have the structure which would be anticipated, but it is remarkable that a number of lines appear in the spectrum of the neutral atom, which show that two of the electrons can be excited simultaneously; part of the spectrum of the solar corona has been attributed recently to a somewhat similar excitation of helium. In this case, it is found that the new lines are most prominent in the presence of some bands which have been tentatively ascribed to the molecule Be_2, and it is suggested that their production is connected with chemical action involving these or other molecules. The ionisation potential of the normal beryllium atom is 9·281 volts, and the ionisation potential of its metastable $^3P_2$ state, 6·5675 volts.

Phosphorus and Antimony Pentachlorides.—Since it is impossible to represent the central atom in the molecules PCl_5 and $SbCl_5$ as surrounded by eight electrons if the five chlorine atoms are attached by ordinary co-valent links each corresponding with a pair of electrons, polar formulæ such as $SbCl_4^+Cl^-$, or formulæ in which two of the chlorine atoms are held by single electron links, have been suggested. Simons and Jessop, in the April number of the *Journal of the American Chemical Society*, describe experiments on the dielectric properties of these two compounds which show that their molecules possess a zero or very small dipole moment. This indicates a symmetrical structure and is in favour of five co-valent linkings, with a ten-electron shell around the central atom. An arrangement with three electron pairs in a plane and two single electron bonds at right angles to this plane is regarded as improbable, since antimony pentachloride is diamagnetic, and it is difficult to see how two unpaired electrons on opposite sides of the central atom could give rise to a mutual neutralisation of magnetic fields. An interesting result was that the dielectric constant of liquid phosphorus pentachloride was smaller than that of the solid. It is considered possible that the crystal forces distort the molecule and increase the polarisation. The liquid has a lower conductivity than the crystalline material. This result is interpreted as throwing doubt on the method of finding the polarisation of a substance by making use of the dielectric constant of the solid material.

Whipsnade Zoological Park.

THE new estate of the Zoological Society of London at Whipsnade was shown to the Press on May 21. There was a private view for fellows of the Society on the following day, and on Saturday, May 23, it was opened to members of the public, who in future will each day, including Sundays, be admitted on payment of one shilling, from 10 o'clock in the morning until 'lighting-up time'.

The Zoological Park, as it is called, considered merely as a place of resort in which to spend some of one's leisure, is most attractive, and from it there is a magnificent view over some eighty miles of country, rivalling that from the Malvern Hills. Much of the five hundred acres consists of downs and woodland, and it is very pleasant to think that so large a rural area is to be kept as a beauty spot.

The charm of the English landscape depends largely upon its vegetation, and the special Act of Parliament, which allows a charge for admission to be made on Sundays, forbids the picking of wildflowers, the damaging of trees and shrubs, and the throwing down of litter. "Blue-bell Wood", where there is no bush undergrowth, is at the time of writing a magnificent sheet of colour, broken only by the trunks of the trees, and there are bluebells too in the Bird Sanctuary, into which the interesting and rare plants of the neighbourhood, which are disappearing elsewhere, will be introduced. Wild birds are protected, and those which build in holes encouraged, by the provision of nesting boxes. No birds, other than those usually found in the sanctuaries near London, have as yet been recorded as breeding there. In the enclosure are a few tiny antelopes (Reeves' muntjac) and numerous peafowl. The writer here saw several nests of Amherst's pheasant, on which the hens were sitting, and the empty egg-shells of an Impeyan pheasant which had successfully hatched out her young. Perhaps the most interesting occupants are the brush turkeys, which it is hoped will build their mounds and leave their eggs to be hatched by the heat of fermentation, as has happened in the Gardens at Regent's Park.

In the disposal of the animals generally, advantage has been very skilfully taken of the conformation of the ground and what is growing upon it. Wolves are rearing their young in a dense wood of conifers, which makes an excellent setting for them. The more scattered trees and bushes make an appropriate home for graceful Indian deer. In a more open space adjacent, and looked down upon from a causeway, is a good collection of bears.

A herd of American bison has been given a large piece of the side of a down, and little dells elsewhere have been fenced round for marmots, wood-chucks, and wombats. It is intended to isolate a tableland of grass-covered chalk to form a home for lions, and a good beginning has been made with the work. "Wallaby Wood", consisting of deciduous trees, has as its name implies, been dedicated to the kangaroos. No attempt has been made to provide houses through which the public can walk for any of the animals mentioned, but shelters have been constructed into which the creatures can retire, and which can, if necessary, be warmed in winter by electric radiators.

The orchards, meadows, and the farm-land have been made into grass enclosures for the cranes and crested screamers; the wild horses, asses, and zebras; the camels and llamas; as well as the ostriches, emus, and rheas. The area of several of them is ten acres or more, and there is one of thirty acres, in which it is hoped that there will ultimately be seen a panorama of the large mammals of Africa.

In the Home Paddocks are English 'wild white cattle' of the Chartley strain, and among the herd is a black calf, which points to an occasional crossing in the past with some domesticated breed. There are also red deer, including an albino sport, and, nearby, some lion cubs bred in the Society's Gardens at Regent's Park.

The giving of considerable space to animals, the providing of them with surroundings (and in some cases, food) which approximate to those which they would enjoy in Nature, may be looked upon as mere common sense, seeing that their health should benefit and that they should look better and live longer, for many are costly and difficult, if not, nowadays, almost impossible, to replace. There are, however, other important aspects of the matter. It is allowed that people in Great Britain, at any rate, are gradually becoming more considerate towards animals. Possibly the acceptance of the theory of evolution has helped to create a fellow-feeling, and there are now many whose sense of justice is strongly developed who, when they see a wild creature cooped up in a cage or living in a sty unable to roam about and fulfil its functions, cannot help comparing it with a felon imprisoned for life for some crime against society, and consider the animal to be suffering punishment which is undeserved and quite unwarranted.

These, and indeed every lover of animals, will welcome the new Zoological Park as a great advance, for here the animals can be given opportunities to produce their young, and this leads to further business and scientific considerations. Many animals, as has already been mentioned, are of considerable value, and this is especially the case where their export from their native country has been prohibited. The rearing of these and their subsequent sale or exchange may well help to maintain and improve the Zoological Park, for it is intended that any profits from it shall be used for its betterment. Then there are, unfortunately, animals which are dying out, and it may be that the only way to keep them from extinction will be to breed them in captivity.

Visitors to the Park should remember that it is only in its initial stage, and that a great deal of money had to be spent on making roads, although the Ministry of Labour supplied a hundred men from distressed areas and paid three-quarters of their wages.

There are at present but few ponds, though considering the accommodation there is a good series of swans and geese and duck, with some flamingoes. It is, however, part of the plan, when funds allow, to make at least one large lake.

The Park should be a great help to the Gardens at Regent's Park. Animals which need a change of food and air can be taken there to recuperate, and any that it is desired to keep but not at the moment to exhibit in London can also be sent into the country. It may not perhaps be too much to expect that those which remain in the Gardens will get a little more room as time goes on.

The moving spirit in the whole scheme has, of course, been Sir Peter Chalmers Mitchell, and he is to be congratulated upon his achievement. This should also gladden the hearts of those whose efforts to improve the conditions at Regent's Park, years ago, resulted in his appointment as secretary to the Society. Dr. G. M. Vevers, the Superintendent of the Zoological Gardens, has been staying at Whipsnade for some time, but the resident superintendent is Capt. W. P. Beal.

To follow the boundary of the estate on foot would

mean a walk of eight miles, and the Zoological Society has introduced a service of motor omnibuses of its own, inside the Park. The old farmhouse and its outbuildings have been made into excellent luncheon and tea rooms, but places have been set apart where visitors may picnic and enjoy the view, while refreshment kiosks have also been provided.

It is understood that motor omnibuses will bring visitors from Luton and Dunstable (which can be reached by train from London) and from the large towns within a convenient distance of the Park.

WILFRED MARK WEBB.

The Newfoundland Earthquake of Nov. 18, 1929.

THE Eastern Section of the Seismological Society of America (U.S. Coast and Geodetic Survey, Washington, D.C.) has issued two papers, by Dr. Arthur Keith and by Messrs. E. A. Hodgson and W. W. Doxsee, read at the 1930 meeting, at Washington, D.C., on the earthquake which broke twelve of the submarine cables to the south of Newfoundland on Nov. 18, 1929.

The preliminary position of the cable fractures was marked in a map published in NATURE, Dec. 21, 1929, and in an accompanying communication Prof. J. W. Gregory explained the earthquake as due to the subsidence of a strip of the sea floor, probably about 400 miles long, in continuation of Cabot Strait. This view is fully supported by the new papers. The violence of the earthquake may be appreciated from Dr. Keith's remark that it was of the same order of magnitude as the disastrous Charlestown earthquake of 1885. He concludes "that all the evidence is in harmony with the theory that parallel faults produced the Cabot trench in the past, the Grand Banks Earthquake in the present, and minor breaks like that of Sherbrooke as aftershocks". He also quotes a report by Thos. S. Woods attributing the boundary of the continental shelf in that region to faulting.

The paper by Messrs. Hodgson and Doxsee gives a useful collection of data as to the records of the earthquake, which was felt at all the chief observatories of the world. The authors determine the epicentre as at lat. 44° 5′ N. and long. 55° W., and the time there at $20^h\ 31^m\ 55^s$ G.M.T. They conclude that "the evidence strongly supports the hypothesis of a down-dropped section of ocean floor bounded by two fault planes roughly parallel to the axis of Cabot Strait as defined by the 100-fathom contour, and extending from 45° N. to about 39° N. as a prolongation of that strait, the northern end being the more seriously displaced". The subsidence they suggest was about 25 feet.

Messrs. Hodgson and Doxsee (p. 76) give a list of the times of the earthquake at 32 observatories. The time records are of interest in connexion with the view that the floor of the Atlantic is of different material from that under the continents. The earthquake records include those at Budapest, 5567 km. to the east, and at Berkeley in San Francisco, 5600 km. a little south of west. Budapest is 33 km. nearer the epicentre than Berkeley; it recorded the *P* waves 6 seconds earlier and the *S* waves 7 seconds earlier. As the *P* waves travelled to Budapest in 9 min 1 sec. and to Berkeley in 9 min. 7 sec., the rates of transmission under North America and under the Atlantic were practically equal—the rate to Budapest being 10·29 km. per sec., and that to Berkeley 10·24 km. per sec. The rates were: to Munich, distance 5000 km., 9·9 km. per sec.; to Strasbourg, 4589 km., 9·3 km. per sec.; to Barcelona, 4700 km., 10 km. per sec.; and to Balboa, 4506 km., to which the direct route would have been across the deeper part of the North Atlantic basin, only 9·18 km. per sec., instead of the acceleration that would be expected if that ocean floor were underlain by sima at a slight depth.

University and Educational Intelligence.

CAMBRIDGE.—The Appointments Committee of the Faculty of Economics and Politics has appointed C. G. Clark to be University lecturer in statistics.

The Appointments Committee of the Faculty of Biology 'A' has appointed Dr. O. M. B. Bulman to be University demonstrator in geology.

Mr. John Hilton, Assistant Secretary to the Ministry of Labour, has been elected to the recently founded Montague Burton professorship of industrial relations.

The Buildings Syndicate has issued a report to the University on a site for the Royal Society Mond Laboratory and on accommodation for the future development of the physical sciences. It recommends that the sites of the present engineering workshops and the University power station be assigned for new buildings to contain the Royal Society Mond Laboratory, the reconstructed power station, and new workshops for the Cavendish laboratory, and that the drawing office and adjoining rooms to be vacated by the Department of Engineering be assigned to the Department of Physics.

DURHAM.—At a meeting of Convocation on May 20, Lord Londonderry was installed as Chancellor of the University, in succession to the late Duke of Northumberland.

LONDON.—New members of the Senate elected by Convocation include—Major A. G. Church, M.P., and Prof. William Wilson (science), in place of Prof. F. G. Donnan and Sir Philip Magnus, who have retired. Those reappointed by Convocation and the Faculties include—Sir Ernest Graham-Little, M.P. (medicine), Mr. Roger Smith (engineering), and Prof. A. L. Bowley (economics).

Dr. C. H. Lander, since 1923 Director of Fuel Research, has been appointed professor of engineering (Imperial College—City and Guilds College) as from Sept. 1, 1931. Dr. E. L. Kennaway, since 1921 chemical pathologist at the Cancer Hospital, has been appointed professor of experimental pathology (Cancer Hospital—Free) as from May 1, 1931.

IT is announced by the Cape Town correspondent of the *Times* that, on May 19, the University of Cape Town conferred the honorary degree of D.Sc. on General Smuts, in recognition of his scientific achievements, and with special reference to his election as president of the 1931 meeting of the British Association.

THE Rockefeller medical fellowships for the academic year 1931–1932 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 1. Fellowships are awarded by the Council, in accordance with the desire of the Rockefeller Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university in the United States before taking up positions for higher teaching or research in the British Isles. In special circumstances, the fellowships may be tenable at centres of research not in America. Full particulars are obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S.W.1.

Birthdays and Research Centres.

May 31, 1845.—Col. R. E. CROMPTON, formerly president of the Institution of Electrical Engineers.

As I was born in the country eighty-six years ago, in that part of the Vale of Mowbray in Yorkshire where farming is at its best, although I have devoted most of my life to such subjects as mechanical haulage and the supply of electricity to town users and to the greatly increasing industrial districts of England, I have, during the last few years, become more and more impressed by the far greater importance of solving the problem of increasing the food production of our farmlands and gardens, by the use of electrical power. We now are all working on the somewhat difficult problem of the distribution of electrical energy at such a low cost that we should be able to persuade our farmers to substitute electrical trenching and aerification of the soil for the old-time ploughing; and we hope that in the not very distant future we may perfect the processes of obtaining nitrified products, such as nitrate of lime, direct from the nitrogen of the atmosphere, and at points close to where we desire to supply it to our fields, by utilising the electrical supply on the spot, instead of our farmers having to purchase the synthetic products at high cost. I, for one, believe it possible that by such means we shall persuade our farmers to increase the area of arable land, and produce from it crops almost, if not quite, equal to those now produced by our market gardeners, largely by manual labour.

June 1, 1866.—Dr. CHAS. B. DAVENPORT, director of the Department of Genetics, Carnegie Institution of Washington.

Since the study of heredity is really that of the internal control of development, studies on heredity in man, particularly on stature and body build, may usefully be concerned with the way individual children, of known families and races, grow, and especially with the changes in endocrine activity and other physiological factors that are associated with such growth. I am, accordingly, following in individual children, during a span of years, their physical, physiological, and mental changes, to learn how they are interrelated.

June 2, 1866.—Sir LEONARD E. HILL, F.R.S., honorary director of research at the London Light and Electrical Clinic.

Two years ago, working in co-operation with Mr. R. H. Davis, of Siebe Gorman, Ltd., I was able to show, with the help of the Admiralty, that it is possible for divers to go to depths of 300 ft. in the ordinary diving dress. The necessary decompression period can be greatly shortened by the breathing of oxygen in a submersible decompression chamber designed by Mr. R. H. Davis, and used from a depth of 70 feet upwards by the ascending diver. The chief investigation I have been engaged on is assisting the Admiralty Diving Committee in working out, on animals, safe times for decompression, so using oxygen, for divers working up to thirty minutes on the bottom at 300 ft.

I am also engaged in research on the penetration of the skin by infra-red, visible and ultra-violet rays, and the action of irradiation on the body in health and disease.

June 3, 1853.—Sir W. M. FLINDERS PETRIE, F.R.S., professor of Egyptology in the University of London.

The development of man's abilities and ideas has appeared to me the most interesting subject of research during the last fifty-five years. At present I am engaged in excavating one of the largest cities of the bronze age and the continuity into the Neolithic period. As it is useless to make collections if no place is provided for them, it is to be hoped that the scheme for a study-series of development in the great civilisations will be carried out in the new buildings of the University of London.

Societies and Academies.

LONDON.

Royal Anthropological Institute, April 28.—**A. Leslie Armstrong**: Excavations in the Pin Hole cave, Cresswell, Derbyshire. The Pin Hole excavations have been in progress since 1924. By a fortunate circumstance, this cave appears to be the only one of the Cresswell series which held the full story of the occupation of the ravine in Palæolithic times, and it was the only cave left practically intact by earlier excavators. Two layers of cave earth exist, an upper level ranging in time from Upper Aurignacian to a phase which is contemporary with the Magdalenian of France. This has yielded an important series of tools in flint, which reveal the gradual development of the upper Palæolithic industries of Britain, and also two examples of early art, one of which is the engraved outline, on bone, of a masked male figure. The lower cave earth is in three zones, in each of which early Mousterian tools are found and definite evidence of the cave's occupation by man. This lower level has also provided valuable evidence relative to fluctuations of climate during the last great ice age of Britain. Many animal remains were found.

Society of Public Analysts, May 6.—**E. J. Guild**: Demonstration of a new development in filter paper. The paper contains at least 99 per cent of alpha-cellulose, with about 0·04 per cent of ash. It is very strong when wet and offers great resistance to alkaline solution, such as caustic soda, etc. It is suitable for the rapid filtration on a large scale of coarse or gelatinous substances, and also for all but the most delicate analytical work.—**A. J. Amos** and **D. W. Kent-Jones**: The 'rope' spore content of flour and its significance. Far less importance must be attached to the rope spore content than to the technique adopted in the bakery as a factor in the production of ropy bread. The conditions tending to aggravate rope trouble in bread have been separately investigated.—**W. R. Schoeller** and **H. W. Webb**: The separation of tin from tantalum and niobium. For the separation of small amounts of tin from much earth acid, Giles's process (fusion with potassium carbonate, solution in citric acid, precipitation of tin as sulphide) is not suitable for earth-acid minerals. Schoeller and Powell's process (fusion with bisulphate, solution in tartaric acid, treatment with hydrogen sulphide, collection of insoluble residue and sulphide precipitate) is serviceable.—**N. L. Allport**: A new method for detecting decomposition products in anæsthetic chloroform. The decomposition of medicinal chloroform, resulting in phosgene formation, leads to the presence of free hydrochloric acid due to action on the alcohol which is added as a preservative. A new test capable of detecting one part of free hydrochloric acid in a million parts of chloroform is based upon the condensation of resorcinol and vanillin by the free hydrochloric acid, with the formation of a red acidic dye. By subsequent treatment with alkali, a pink aqueous layer is obtained, the intensity of the coloration varying with the quantity of impurity present.—**J. N. Rakshit**: Contaminations in morphine deposited in the British Pharmacopœia process for

the analysis of opium. The morphine obtained in the determination of the alkaloid by the B.P. process contains 5–6 per cent of other alkaloids consisting principally of codeine. A modified method is described in which a lime solution of the opium is extracted with benzene prior to precipitation with ammonium chloride. This yields a much purer morphine than the original process.

LEEDS.

Philosophical and Literary Society, Mar. 3.—**R. Whiddington** and **J. E. Roberts**: An accurate experimental determination of excitation energy by electron impact in helium. The following values with their probable error in volts were obtained, and a comparison is made with the values calculated from spectroscopic data:

Experimental.	Calculated.	Origin.
$21{\cdot}24 \pm 0{\cdot}03$	21·12	$1\,{}^1S_0 - 2\,{}^1P_1$
$23{\cdot}19 \pm 0{\cdot}04$	22·98	$1\,{}^1S_0 - 3\,{}^1P_1$
$23{\cdot}84 \pm 0{\cdot}10$	23·63	$1\,{}^1S_0 - 4\,{}^1P_1$

The observed values are all a little greater than the calculated ones, but by an amount more than the probable experimental error.—**E. C. Pollard**: Atomic disintegration without capture of the projectile. A discussion of energy and momentum relations is given for a process of atomic disintegration without capture of the alpha particle, and a simple picture of the detailed occurrence is put forward and tentatively considered for the elements aluminium and boron.—**K. E. Grew**: The thermoelectric power of nickel in the neighbourhood of the Curie point. Prior to an investigation of the thermoelectric properties of the copper-nickel alloys, the thermoelectric power of nickel (99·97 per cent pure) against platinum at temperatures between 250° and 450° C. has been measured. Preliminary results show that the specific heat of electricity in nickel increases at the Curie point by $4{\cdot}9 \times 10^{-24}$ cal. per electron per degree, in good agreement with the value found by Dorfman and Joanns. Some irregularities in behaviour above the Curie point were observed.—**F. Tyler**: Upper limits for stellar masses—a criticism. The investigations of Anderson and Pokrowski on the upper limit for stellar masses are discussed and criticised.—**H. M. Dawson**: Reaction velocity in relation to the concentration and activity of the reacting components. The best available data for the catalytic influence of hydrochloric acid on the hydrolysis of ethyl acetate show that the velocity is proportional to the concentration of the hydrogen ion and bears no simple relation to its activity or thermodynamic concentration. The rate of conversion of *N*- into *p*-chloroacetanilide in solutions of free hydrochloric acid is consistent with the hypothesis that the velocity is proportional to the product of the activities of the reactants (*N*-chloroacetanilide, hydrogen ion, and chlorine ion), but the results obtained in the presence of chlorides, when the concentration of the chlorine ion is greater than that of the hydrogen ion, show that this hypothesis is not generally applicable. On the other hand, the velocity is in all circumstances approximately proportional to the product of the concentrations of the hydrogen and chlorine ions.—**C. H. Douglas Clark**: A spectroscopic classification of the elements according to ground states. Earlier tables showing the electronic distributions within atoms derived from spectral evidence fail to exhibit the group relationships of the elements, which is especially important from the chemical point of view. A new table is therefore proposed showing the elements (rare earths excepted) in periods and groups, in relation to ground states and corresponding atomic quantum numbers, and also to electronic groups, here divided as ultimate, penultimate, and antepenultimate. The arrangement shows electronic levels in a more compact and convenient form than the schemes hitherto proposed, and forms a suitable basis for discussion of the relation existing between the valencies of the elements and their ground states.—**H. Richmond** and **W. H. Pearsall**: Absorption of ammonium and nitrate ions by plant tissues. Discs of potato tuber show a higher rate of nitrate absorption in more acid solutions, while ammonium ions are absorbed more rapidly in less acid solutions. Wheat seedlings show a similar type of absorption. *Eriophorum* cuttings, however, absorb more ammonia in acid solutions, and also have a much lower rate of absorption of both ions, in relation to their dry weight.—**W. Garstang**: The phyletic classification of Teleostei. The order Isospondyli is broken up, the Clupeoids being ranged with the Hyodontoids and Ostariophysi in a section termed Otophysi, characterised by a connexion, actual or vestigial, between air-bladder and auditory organ, while the Salmonoids are linked with Scopeloids, Salmopercæ, Cyprinodonts, and Synentognathi, which lack all trace of such a connexion. The adipose fin, deeply rooted in the Teleostean constitution, is regarded as a vestige of the second dorsal fin (D^2) of Elasmobranchs and Crossopterygians. Its loss is almost always due to the encroachment of D^1 upon its site, rarely to simple obsolescence. This 'opisthopterous' condition characterises fishes with semi-sedentary (for example, Osteoglossoids) or lurk-and-rush habits (for example, pikes). Accordingly the loss of the adipose fin in Clupeoids indicates the derivation of this group from opisthopterous freshwater ancestors (cf. *Pholidopleurus*), while its presence in Salmonoids indicates an unbroken pedigree of wide-roving forms, in which D^1 has preserved its mid-dorsal position throughout (pre-Cretaceous forms still unknown).

PARIS.

Academy of Sciences, April 13.—The President announced the death of Raffaello Nasini, *Correspondant* for the Section of Chemistry.—**Léon Guillet, Jean Galibourg**, and **Michel Samsoen**: The resistance of ordinary steels to high temperatures. Details of measurements with an instrument described in earlier communications. The observations lead to the view that, even for steels at the ordinary temperature, there is not, properly speaking, a true elastic limit, and that the apparent permanence of the dimensions after the application of a small load is the result of the imperfection of the measuring apparatus.—**Auguste Lumière** and **Maurice Bourgeois**: Blocking the reticulo-endothelial system and anaphylactoid shocks. Blocking and shock are two independent phenomena: they may happen together, but there does not appear to be any relation between them.—**W. Slebodzinski**: The symbolic forms of differentials.—**Henri Cartan**: The transformations of limited semi-enclosed domains.—**J. Le Roux**: The invariants of the group of relative movements.—**Mlle. Yvonne Dupont**: The invariantive theory of elasticity with finite deformations.—**A. Guillet**: The disruptive state of the plane-sphere spark gap in atmospheric air.—**V. Posejpal**: A theoretical formula for the absorption gap.—**Ch. Féry**: A positive electrode with gaseous circulation for batteries with air depolarisation. In the cases where the polarisation is produced by gases lighter than air (hydrogen, ammonia) the positive electrode is hollowed out and the heavier air is led to the bottom of this cavity. The usefulness of this simple arrangement has been proved in practice.—**Pierre Montagne**: The calculation of the equilibria and of the temperature resulting from the combustion of hydrocarbons. The graphical method described in earlier papers has been applied to the combustion of heptane in oxygen.

—André Meyer and Robert Vittenet: The azo derivatives of homophthalimide.—Mlle. Eliane Basse: The age of the interstratified basaltic coulées in the Cretacean of the sedimentary border of Madagascar.—Mme. M. L. Le Roux: Parasitic castration and secondary sexual characters in *Gammarus*.—Paul Wintrebert: The determination of the plane of bilateral symmetry in the egg of *Discoglossus pictus*.—Maurice Piettre: The influence of the phenomena of adsorption on the physico-chemical properties of organic colloids.—Mme. Z. Gruzewska, and G. Roussel: The amylase of horse serum in the course of numerous successive bleedings. Its relations with the serum proteins.

GENEVA.

Society of Physical and Natural History, Feb. 5.—Léon W. Collet: Results of the geological expedition of Harvard University in the Canadian Rockies (Jasper National Park, 1929). (2). The presence of Upper Lias and Bajocian in the Fernie formation of Fiddle Creek. Ammonites found by the author, chief of the expedition, and his collaborators show, for the first time, that the Toarcian is represented in the Jurassic formations (Fernie) of the Canadian Rockies. The complete Bajocian has also been discovered for the first time in Jasper National Park.—A. Amstutz: The existence of palæovolcanic rocks in Sardinia. In the course of his researches in Sardinia, the author has produced evidence of eruptions, probably palæovolcanic. At the northern base of the mountain of Galtelli, he has, in fact, observed quartziferous porphyries the volcanic origin of which is clearly shown by the fluidity of the mass. These rocks of effusion are prior to the Jurassic and are probably contemporary with the large Permocarboniferous eruptions of Corsica.—L. Duparc: The fluorspar deposits of Martinèche and Les Isserts near Pontgibaud, Puy de Dôme. The author gives a short outline of the deposit, with a hypothetical estimation of the reserves. The lodes consist of fluorspar of various colours, colourless, green, and violet.—L. Duparc and A. Amstutz: The diabases of Mayombé and the adjacent regions (French Congo). The authors have studied the basic rocks, the age of which, relatively to the neighbouring sedimentary formations, is determined by the fact that they penetrate the crystalline schists and more recent metamorphic formations, and that the younger limestone schist series contains pebbles of these rocks. They have recognised in it the ophitic, intersertal, and more rarely gabbro structures.—L. Duparc and A. Amstutz: The enclosure of basic rocks of Moukagni (Gabon). The authors give a brief petrographical description of rocks the dominating character of which is the presence of amphiboles and pyroxenes, enclosed in a black mica granite. By analogy with other very numerous cases they consider these rocks as products of metamorphic action of the granite in the calco-magnesium sediments of a layer now disappeared.—Ch. Cimerman and P. Wenger: A micro-chemical method for the estimation of glucose in solutions and in urine. A modification of Fehling's method, in which the cuprous oxide is removed by the centrifuge instead of by filtration. A spot test with guaiacum replaces the ferrocyanide reaction and micro-burettes are used for the volume measurements. The advantages are no filtration, rapidity, and the use of small quantities of materials and reagents. It is possible to estimate very small quantities of sugar in a fluid.

VIENNA.

Academy of Sciences, Jan. 29.—E. Ullrich: Exceptional values of algebroid functions.—E. Hofmann: The fruit of *Aspidosperma megalocarpon* and its opening mechanism.—F. Seidl, R. Enenkel, and H. Nohel: Adsorption potential and phase-boundary potential of highly resistant glasses.—I. Felber-Pisk: The growth of isolated roots. Experiments were made in the dark and in the light on the isolated roots of *Phaseolus*.—J. Scholz: Atmospheric electricity (73). Theoretical investigations on the distribution of field and ions in a gas which conducts a current and also contains heavy ions.

Feb. 5.—F. Pauer: Contributions to the preparation of acetals. Benzol-glycerin (=benz-aldehyde-glycerin-acetal) and ortho-formic-acid-mono-glycerin-ester were prepared. Both are colourless, hygroscopic, soluble fluids.—Z. Dische, W. Fleischmann, and E. Trevani: The relation between hibernation and hypoglycæmia. The blood-sugar contents of active and hibernating animals, for example, of dormice, were determined. Insulin was injected, producing in some cases convulsions, but not confirming the idea that hibernation could be produced.—H. Schober: The spectrum of rhenium (1). The arc spectrum in the photographic region.—H. Popper and O. Wozasek: The glycogen content of the diabetic liver.

Official Publications Received.

BRITISH.

Records of the Indian Museum. Vol. 23: Anthropological Observations on the Anglo-Indians of Calcutta. Part 2: Analysis of Anglo-Indian Headlength. By P. C. Mahalanobis. Pp. 97-149. 2 rupees. Vol. 32, Part 4. Pp. 357-495. 2.12 rupees; 5*s*. Vol. 33, Part 1. Pp. 69. 2.12 rupees; 5*s*. (Calcutta: Zoological Survey of India.)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1930. Pp. iv+512+129. 15*s*. net. Bulletin of Miscellaneous Information. Appendix 4, 1930: General Index to the Volumes of the Kew Bulletin for the Years 1919-1928. Pp. 73. 2*s*. 6*d*. net. (London: H.M. Stationery Office.)

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1929-30. Pp. 22. (London: H.M. Stationery Office.) 1*s*. 3*d*. net.

Journal of the Chemical Society. April. Pp. iv+673-1032+x. (London.)

Proceedings of the First Imperial Horticultural Conference, 1930. Part 1: Papers on the Economic and Administrative Side of Horticulture. Pp. 36. 1*s*. Part 2: Papers on the Application of Science to Horticulture. Pp. 58. 2*s*. Part 3: Papers on Progress in Fruit Storage Methods. Pp. 101+11 plates. 2*s*. 6*d*. (East Malling: Imperial Bureau of Fruit Production.)

Imperial Bureau of Fruit Production. Technical Communication No. 2: Field Experiments in Horticulture. By T. N. Hoblyn. Pp. 50. (East Malling.) 2*s*.

Transactions of the Institute of Marine Engineers, Incorporated. Session 1931, Vol. 43, No. 3, April. Pp. 113-156+xliv. (London.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1930. Pp. v+135+7 plates. (Hobart.) 10*s*.

The Indian Journal of Veterinary Science and Animal Husbandry. Vol. 1, Part 1, March. Pp. vi+62. (Calcutta: Government of India Central Publication Branch.) 2 rupees; 3*s*. 6*d*.

Catalogue of Indian Insects. Part 18: Carabidae. By H. E. Andrewes. Pp. xxii+389. (Calcutta: Government of India Central Publication Branch.) 8.10 rupees; 14*s*. 10*d*.

Botanical Survey of South Africa. Memoir No. 16: Forest-Succession and Ecology in the Knysna Region. By Dr. John F. V. Phillips. Pp. 327+82 plates. (Pretoria: Government Printing Office.) 5*s*.

Proceedings of the Cambridge Philosophical Society. Vol. 27, Part 2, April. Pp. 163-289. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

FOREIGN.

Proceedings of the Imperial Academy. Vol. 7, No. 3, March. Pp. vii-viii+85-127. (Tokyo.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry), Vol. 20, No. 1. Pp. 196. (Tokyo and Sendai: Maruzen Co., Ltd.)

Danmarks Naturvidenskabelige Samfund: Ingeniørvidenskabelige Skrifter. A, Nr. 24: The Jet-Wave Rectifier, an Account of its Constructional Development during the Years 1919-1929. By Jul. Hartmann. Pp. 300. (København: G. E. C. Gad.) 30·00 kr.

Journal of Science of the Hiroshima University. Series A (Mathematics, Physics, Chemistry). Vol. 1, No. 1, December. Pp. 76. 90 sen. Vol. 1, No. 2, March. Pp. 77-157. 99 sen. Series B, Div. 2 (Botany). Vol. 1, Art. 1: Chromosomenzahlen und Phylogenie bei der Gattung *Potentilla*. Von Naomasa Shimotomai. Pp. 11. 15 sen. Vol. 1, Art. 2: Studies on the Hepaticae of Japan, IV. By Yoshiwo Horikawa. Pp. 13-35+2 plates. 36 sen. Vol. 1, Art. 3: Bastardierungsversuche bei *Chrysanthemum*, I. Von Naomasa Shimotomai. Pp. 37-54+plates 3-6. 56 sen. Series B, Div. 1 (Zoology). Vol. 1, Articles 1-3: Histologische Untersuchungen des Sommer- und Winterhaarkleides, von Yoshio Abe; On the Corean and Japanese Wolves, by Yoshio Abe; Das Vorkommen von Echinoderes in den japanischen Gewässern, von Yoshio Abe. Pp. 43+17 plates. 95 sen. Vol. 1, Article 4: A Synopsis of the Leporine Mammals of Japan. By Yoshio Abe. Pp. 45-63+8 plates. 38 sen. (Tokyo: Maruzen Co., Ltd.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 72: Scientific Report of the North-western Area Committee for 1928–1929. Published by Prof. Johs. Schmidt. Pp. iii+41+24+13+8+20. 5·25 kr. Faune ichthyologique de l'Atlantique nord. Publiée sous la direction de Prof. Joubin. No. 6. 24 planches. 4·00 kr. No. 7. 24 planches. 4·00 kr. (Copenhague: Andr. Fred. Høst et fils.)

U.S. Department of Agriculture. Technical Bulletin No. 238: The Pharmacology of Thallium and its Use in Rodent Control. By James C. Munch and James Silver. Pp. 28. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 78, Art. 14: Notes on Ichneumon-Flies of the Genus Polycyrtus, with Descriptions of New Species. By R. A. Cushman. (No. 2857.) Pp. 62. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 82, No. 18: Tropisms and Sense Organs of Coleoptera. By N. E. McIndoo. (Publication 3113.) Pp. 70+2 plates. (Washington, D.C.: Smithsonian Institution.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 26, Part 6: Asiatic Pteridophyta collected by Joseph F. Rock, 1920-1924. By Carl Christensen. Pp. v+265-337+vii-xii+plates 13-29. (Washington, D.C.: Government Printing office.) 30 cents.

Diary of Societies.

FRIDAY, MAY 29.

ROYAL SANITARY INSTITUTE (at Guildhall, Exeter), at 4.30.—E. J. Silcock: The Exeter New Sewage Purification Works.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Sir William Hamer: The Crux of Epidemiology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Very Rev. Dean Inge: The Future of the Human Race.

SATURDAY, MAY 30.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (Annual General Meeting) (at Cambridge).—E. B. Parsons: The Action of Avertin on the Liver.—S. E. F. Goodling: The Action of Radon on Isolated Tissues.—E. G. Holmes and C. A. Ashford: Cerebral Metabolism.—J. Hellier: Sensitisation of the Uterus.—W. E. Dixon and J. Heller: Some New Observations on Intracranial Pressure.—N. Myers: The Treatment of Toxæmia.—J. C. Hoyle: The Action of Histamine.

MONDAY, JUNE 1.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Prof. H. Briggs: On the Relation between the Yield of Crude Oil, and the Composition of Retortable Carbonaceous Minerals.—Dr. C. H. O'Donoghue: Abnormalities of the Vascular System of the Anura.—G. L. Purser: The Early Stages of Development of the Vertebrates.—R. Elmhirst: Studies in the Scottish Marine Fauna—the Crustacea of the Sandy and Muddy Areas of the Tidal Zone.—Sir Thomas Muir: Note on Cayley's Elimination-Problem involving Superfluous Data.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

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

CHARTERED SURVEYORS' INSTITUTION, at 5.—Annual General Meeting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—E. Maclagan: Museum Planning.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Major J. H. Stafford: The British-Italian Somaliland Boundary.

WEDNESDAY, JUNE 3.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. D. H. Wiseman: A Contribution to the Petrology of the Metamorphic Rocks of Eastern Greenland.

INSTITUTION OF STRUCTURAL ENGINEERS (at 10 Upper Belgrave Street), at 6.—The Art of Making and Using Concrete (1): Types of Cements and their Peculiarities (Lecture).

THURSDAY, JUNE 4.

ROYAL SOCIETY, at 4.30.—Prof. E. D. Adrian: The Messages in Sensory Nerve Fibres and their Interpretation (Croonian Lecture).

ROYAL SOCIETY OF ARTS, at 6.—J. F. J. Malone: A New Form of Prime Mover and its Uses for Locomotives, Marine and other Engines.

CHEMICAL SOCIETY, at 8.—J. W. Baker: (*a*) Synthesis of Substances Analogous to Bile Acid Degradation Products. Part I. Preliminary Investigation of Methods of Attachment of Carboxylated Side-chains to the Cyclopentane Nucleus; (*b*) Reactions of ω-substituted Acetophenone Derivatives. Part I. The Action of Acetyl Nitrate on ω-halogeno-*m*-nitroacetophenones.—K. H. Hasan and E. Stedman: The Constitution and Synthesis of Embelic Acid (Embelin), the Active Principle of *Embelia Ribes*.—S. H. Bastow: Adsorption of Nitrogen by Condensed Atomic Platinum.—E. C. S. Jones and J. Kenner: The Direct Formation of Quinones from 2-6-disubstituted Derivatives of 4-nitrophenol.

FRIDAY, JUNE 5.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Mrs. Patrick Villiers-Stuart: The Indian Paradise Garden (Sir George Birdwood Memorial Lecture).

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5.—Dr. H. C. Hepburn: Electro-osmosis and Electrolytic Water-transport. Part 2.—J. S. Badami: Spectra of Trebly and Quadruply Ionised Antimony Sb LV and Sb V.—G. I. Finch, R. W. Sutton, and A. E. Tooke: A Time Base for the Cathode-ray Oscillography of Irregularly Occurring Electric and Magnetic Phenomena.—Dr. R. L. Smith-Rose and J. S. McPetrie: The Attenuation of Ultra-short Radio Waves due to the Resistance of the Earth.—Prof. S. Chapman: The Absorption and Dissociative Ionising Effect of Monochromatic Radiation in an Atmosphere on a Rotating Earth. Part 2. Grazing Incidence.—A Ripple-tank Demonstration of Beats as Moving Interference Fringes, by M. O. Clarke.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—R. O. Jones: The Development of the Tawe Drainage.—Dr. S. W. Wooldridge and C. J. C. Ewing: Further Observations on the Geology of the Lane End Eocene Outlier.

WEST LONDON MEDICO-CHIRURGICAL SOCIETY (at Kensington Town Hall), at 8.15.—Prof. J. S. Huxley: Development in Relation to Heredity and Evolution (Cavendish Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. W. MacBride: Habit—the Driving Force in Evolution.

ROYAL SOCIETY OF MEDICINE (Laryngology Section).—Morning and Afternoon.

PUBLIC LECTURES.

FRIDAY, MAY 29.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—N. Howard-Mummery: An Industrial Welfare Scheme.

SATURDAY, MAY 30.

UNIVERSITY COLLEGE, LONDON, at 2.30.—Sir Flinders Petrie: The City of the Shepherd Kings. (*To be repeated on June 2 at* 5.30.)

MONDAY, JUNE 1.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. F. C. Shrubsall: Mental Deficiency from the Social, Legal, and Educational Aspects.

TUESDAY, JUNE 2.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. March: La méthode statistique et ses applications à la Science des affaires (1). (Succeeding Lecture on June 4.)

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. C. J. Thomas: Physically Defective Children (1).

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Dr. A. Gratia: The Schwartzman Phenomena.

THURSDAY, JUNE 4.

CHELSEA PHYSIC GARDEN, S.W., at 5.—Dr. T. F. Chipp: Trees and Man (Chadwick Lecture).

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. C. J. Thomas: Physically Defective Children (2).

FRIDAY, JUNE 5.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—R. R. Hyde: Industrial Welfare.

CONGRESSES.

MAY 27 TO 29.

CONFERENCE ON MENTAL HEALTH (at Central Hall, Westminster).

Friday, May 29, at 3.—The Human Factor in the Social Services.
At 8.15.—The Human Factor in Education.

MAY 28 TO 30.

VEREIN DEUTSCHER CHEMIKER (at Vienna).—Symposium: The Separation of Liquids and Solids.

JUNE 1 TO 5.

INTERNATIONAL FEDERATION FOR HOUSING AND TOWN PLANNING (at Berlin).—International Housing and Town Planning Congress.

JUNE 2 TO 5.

INSTITUTION OF GAS ENGINEERS.—ANNUAL GENERAL MEETING AND INTERNATIONAL GAS CONGRESS (at Institution of Civil Engineers).

Tuesday, June 2, at 10 A.M.—Annual General Meeting.
Presidential Address.
J. S. Thorman: Intermittent Vertical Chambers and Coal and Coke-handling Plant at Southall.
At 2.30.—Dr. H. Schütte: Problems of Modern Gas Distribution.
A. L. Holton: The Semi-direct Recovery of Ammonia in Gasworks Practice and the Recovery of Tar Acids from Ammoniacal Liquor.

Wednesday, June 3, at 10 A.M.—C. E. Paige: The Gas Industry in America.

Thursday, June 4.—Dr. R. Lessing: Clean Coal in the Gas Industry.
R. N. Webb: An Experiment in Controlling Pressure Conditions within Coal Gas Retorts.
At 2.45.—J. H. Clegg: The New Oswald Street Gasworks of the Burnley Corporation.

JUNE 3 TO 5.

ELECTRICAL ASSOCIATION FOR WOMEN—INTERNATIONAL CONFERENCE (at Glasgow).

Wednesday, June 3, 7.30 to 10.30 P.M. (at Central Hotel).—Informal Reception.

Thursday, June 4, at 10.30 A.M. (at Royal Technical College).—Short Papers by representative women, including the following from Overseas:—Madame Silfverhielm, Mlle. Paulette Bernège, on Electrical Education.

Friday, June 5, at 12 noon (at Royal Technical College).—A. E. McColl: The Grid in Scotland.