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How Should an Engineer be Trained?

A VERY interesting discussion followed the paper on the training of engineers given by Sir Theodore Morison on Oct. 29 before the North-East Coast Institution of Engineers and Shipbuilders; and a report of it has now been published by the Institution. Those engaging in the discussion were representative of every branch of the profession, and while on some questions differences of opinion were manifest, there was a number of interesting points on which opinion appeared to be practically unanimous. Among these was the general agreement that all university students of engineering should have at least one year's works experience before beginning their university training, and that during this period evening classes should be taken in mathematics and physics with the view of conserving the habit of study engendered at school.

This plan has been advocated for many years by a number of those engaged in university teaching, and it is of interest to know that such procedure now appears to be so generally approved among practising engineers who have studied the question of engineering training. Its advantages are many. It brings a student to his university course with a realisation of the bearing of its scientific training on his future career, such as, in the majority of cases, increases notably his keenness in the work. It gives him, at the most plastic stage of his life, intimate contact with the working man whom in future years he will probably have to control, while the routine work and drudgery which is usually connected with this first period of training is likely to weed out any one whose real interests are not in engineering, and to give him the opportunity of withdrawing before much time has been wasted.

The discussion would have been important if this were the only point on which it has given a definite lead. The chief difficulty in applying it is that at present scarcely any engineering firm in Great Britain is prepared to take a youth for one year preliminary to his university training. If the North-East Coast Institution can persuade its members to adopt this course, arranging to take the youth back to complete his practical training after his graduation, it will have done a very important piece of work and made a real advance in the training of engineers.

Another point emphasised in the discussion was the somewhat haphazard method adopted by the majority of firms in the shop training of their special apprentices. In this connexion matters

have improved during the past fifteen years or so, but even now the number of firms which has arranged for the apprentices carefully graded courses of shop training, and see that this training is adhered to, is almost negligibly small.

The sandwich system, in which a youth spends alternate periods of six months in works and at the university, received some support. It is, however, becoming more generally acknowledged that the value to a young engineer of a university course lies almost as much in the facilities which are afforded him for intercourse with fellow students in his own and especially in other branches of study, and in the general activities of student life, as in the technical training which he receives; and that the necessity for keeping terms different from those of the remainder of the university, which is necessary where the sandwich system is adopted, is, from this point of view, a serious objection to the system.

Another point on which opinion was almost unanimous has reference to the requirements for entry to a university course. It was generally felt that the present matriculation regulations operate adversely in the case of many excellent students whose education prior to a shop apprenticeship has been obtained at an elementary school, and whose later work at evening technical schools has shown them to be excellent engineering material.

While one or two universities have recognised the difficulty and have made special provision for such students, the majority of British universities still insist on the normal matriculation, except indeed for mature candidates, and there is little doubt that this insistence is barring each year from the universities a number of young engineers who would richly repay their training.

As Sir Theodore Morison pointed out, engineering is becoming more and more dependent yearly on scientific developments, and its future in Great Britain will depend largely on the type of mind that can be recruited into the profession, and on the methods adopted in the training of engineers. These methods will be investigated by a committee of the North-East Coast Institution of Engineers and Shipbuilders, as suggested by Sir Theodore. It is now more than fifteen years since engineering education was discussed fully at a conference arranged by the Institution of Civil Engineers, and changing conditions have made desirable the re-examination of its many aspects. The recommendations of the committee set up by the North-East Coast Institution will be awaited, therefore, with much interest.

Archæology in South Africa.

The Stone Age in Rhodesia. By Neville Jones. Pp. xiv + 120 + 22 plates. (London: Oxford University Press, 1926.) 12*s.* 6*d.* net.

MR. NEVILLE JONES has earned our thanks for having brought together the evidence of various stone age cultures as derived from Rhodesia, together with some of the data culled from a wider South African area. He has produced a very readable book which contains some valuable information. The whole problem of the South African stone age cultures is every day becoming more interesting and suggestive; and now that search for relics is being conducted upon more scientific lines, we can see the opening of an archæological chapter of high importance. The author's own researches at Sawmills (South Rhodesia) and at Tiger Kloof and Taungs (Cape Province) are valuable as evidencing culture-levels of lower- and mid-Palæolithic *facies*, which can be clearly distinguished and placed in sequence order. He very rightly urges the paramount necessity of attacking the archæological problems from the viewpoint of geological evidence. The numberless stone implements which may be picked up on the surface can teach us little unless we can identify the geological horizons to which they originally belonged. The spade alone can provide a clear idea as to the several cultures which may be distinguished, and their relative positions in the time-sequence. Mr. Jones has worked conscientiously and thoughtfully, and his results help to advance the subject.

The value of the book is somewhat marred by unduly positive statements, which lack the support of evidence. To quote examples, which I hope may be modified in a future edition: On p. 12 (and cf. p. 19), in referring to mid-Palæolithic times, Mr. Jones says, "the core implement was thus gradually superseded by the flake implement, and finally disappeared altogether." In actual fact, core implements persisted in great abundance all through the Neolithic period, while within the Palæolithic period they form one of the most striking features of the Solutréan culture-phase. On p. 23 he says, "In Europe the stone implement, in Palæolithic times at any rate, was invariably made of flint," a statement which is quite untrue, since chert, quartzite, and other materials were frequently employed. On p. 19, in his diagram (adapted from Osborn), he asserts that the "bone industry begins" in Solutréan times. Why does he ignore the bone implements so char-

acteristic of the Aurignacian culture? On p. 44 he states that "in the Maramba . . . the only large palæoliths found in its bed are of diorite." This is not my own experience, for I have picked up in the bed of this tributary of the Zambezi typical large palæoliths of chalcedony and other materials, in addition to those of diorite. It is rather unduly committal at the present stage of our knowledge to assert (p. 21) that "we know for a fact that South Africa was Aurignacian in culture until the Bantu immigrants introduced the use of iron." So positive a dogma is rather premature and may tend to hamper unbiassed research in a field which is essentially complex.

I find it sometimes difficult to follow the author in his descriptions of stone-working technique and in some of his diagnoses of implement types. The 'tortoise-core' figured on p. 53 appears to be quite aberrant and to lack the main characteristics of this specialised core-type. Mr. Jones remarks (p. 26) that "the Mousterian culture has not yet been demonstrated in Rhodesia," but if the 'tortoise-core' industry is mainly suggestive of that culture, as many maintain, it may interest him to know that I have found on the Zambezi banks excellent examples of the 'Levallois' flakes struck from such prepared cores.

The author's description of the probable process whereby the leaf-shaped blades from the Cape Flats were made can scarcely carry conviction. Has he ever tried to effect the "removal, probably *by pressure* [italics mine], of minute chips over the entire surface" of a large piece of quartzite? If so, has he ever produced an effect similar to the surface-flaking of this type of implement? I venture to doubt it. He compares (pp. 56 and 113) the finest of the Cape Flats implements with the best examples of Solutréan technique; but this seems to do scant justice to the marvellous skill exhibited by Solutréan man. Surely no blades in any way comparable with those of Volgu have as yet been found in South Africa, and the Cape Flats examples, for all their high quality, exhibit, to my mind, a far easier technique.

Mr. Jones (p. 12) defines a 'burin' as a 'boring instrument,' but its proper function was engraving, not drilling, and its archæological interest lies in its association with engraved designs. He has adopted the unsatisfactory term '*boucher*' for the '*coup-de-poing*' or 'hand-axe' series of lower palæoliths, and urges that this name "has the special virtue of being non-committal." But surely, quite apart from introducing a scheme of nomenclature by Christian names, which may easily lead to ridicule, the fact of its being non-committal is against its employment. Personally, I have been much exercised to discover exactly what type or types of implements it is intended to include under the term. Prof. Sollas originally applied it to a type of *flake* implement, but the present author and others employ it to designate *core* implements. It would be better to drop the term altogether and adopt a series of more committal and distinctive type-names.

The author does not refer to the discovery in Rhodesia of minute implements of Tardenoisian type, though it is many years since the first example was found in Buluwayo. Tardenoisian types are now being discovered abundantly in South Africa, and are a noteworthy feature of the region.

The illustrations of implements in this book vary much in value. Some (*e.g.* Fig. 39) are quite good; others are so lacking in detail and 'crispness' that they convey little beyond mere outline and nothing as regards technique. The description (p. 54) and the figure referred to (Fig. 13, No. 26) appear to be totally unrelated.

Apart, however, from these and several other points which invite criticism, the book is a welcome one, dealing with problems of ever-increasing interest. The author endeavours to approach his subject without bias, and to treat the evidence as he finds it. The task of correlating the South African stone age cultures with those of Europe is beset with pitfalls, but is none the less attractive on that account.

The author's diagnosis of Bushman art is carefully thought out and is in agreement with the most widely held views. His statement of the case for magic versus 'art for art's sake,' as the primary incentive, would have been greatly reinforced had he brought to bear upon it the evidence afforded by late Palæolithic art in Europe. It is interesting to note that he adopts the theory that the gravels lying along the top of the gorge of the Zambezi, below the Victoria Falls, are the remains of ancient gravels deposited by the Zambezi itself. My own investigations, conducted during three visits to the region (in 1905, 1907, and 1910), led me to adopt this view, which, *pace* Dr. Codrington, has been supported by several very able geologists. The Appendix III. in Mr. Jones's book, detailing the views of Dr. Hrdlička upon this problem, should not be taken too seriously. The very hurried survey conducted by a distinguished physical anthropologist, in company with two American newspaper men and a South African engineer, does not carry conviction, nor does it dispose of the

views of such capable geologists as Lamplugh, Zealley, and others. Further, close examination by trained geologists is needed to settle the matter finally. The age of these Zambezi gravels is one of the most important problems awaiting solution.

HENRY BALFOUR.

Chemist and Philosopher.

The Anatomy of Science. By Prof. Gilbert N. Lewis. (Yale University: Mrs. Hepsa Ely Silliman Memorial Lectures.) Pp. x + 221. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1926.) 14*s.* net.

"AS the artist, after painstaking effort, steps back from his easel to view his picture as a whole, so it may not be unprofitable for the scientist to forsake from time to time his own specialty and survey the general trend of science." So writes the author of this volume of Silliman lectures. Not only is such action not unprofitable, but also it is of the highest importance that leading men of science who, like Prof. G. N. Lewis, possess in such high degree wide scientific knowledge, clear philosophic insight, and the power of lucid and interesting expression, should from time to time examine the existing state of science and the directions along which our knowledge of the universe is advancing. The author's purpose in this volume is to present "a kind of contemporaneous cross section showing the inner structure of science," and the book is addressed to those "who are interested not so much in the products of science as in its methods." By all such, these lectures will be given a hearty welcome.

After a short survey of the methods of science, in which perhaps the rather too facile view is expressed that the scientific method is "hardly more than the native method of solving problems," the author proceeds to a discussion of the theory of numbers, space and geometry, time and motion, matter in motion, light and the quantum, probability and entropy, the non-mathematical sciences, and life, body and mind.

In the lecture on space and geometry are discussed the non-Euclidean geometries, more especially Minkowski's geometry of asymptotic rotation, the details of which have been worked out by the author and Prof. E. B. Wilson, and the geometry of shear rotation. According to Minkowski's geometry, all points on the hyperbolic curve are equidistant from the point of intersection of the asymptotes, and any interval marked off on one of these asymptotes is of zero length. To a Euclidean mind such language is nonsense, but, as the author points out, each geometry has its own definitions and postulates just as each game has its own rules; and to the query whether such geometry is true or false, the author replies that the question has no meaning in science. All that one is concerned with, as in the case of all scientific theories, is its usefulness; and the usefulness of the Minkowski geometry is demonstrated by the author in connexion with the new kinematics based on the Einstein theory of relativity—a kinematics which Euclidean geometry is powerless to express.

In discussing light and the quantum, the author introduces his theory of absorption of light and interference, an account of which has already been published in NATURE (**117**, 236, 1926). In this theory the assumption is made that an atom never emits light except to another atom, and one can no longer regard the one atom as an active agent and the other as a passive recipient. According to this theory, when one arranges an optical apparatus so that interference bands are produced, one not only brings it about that no light is received on the dark band, but also the light which otherwise would have fallen in the region of the dark band is not *emitted*. The author recognises that such an idea, which is really equivalent to saying that we can influence events which are already past, is offensive to our established notions of causality and temporal sequence, but he holds that we need not therefore be deterred from making use of the hypothesis so long as no actual fact of experiment or observation can be brought against it, especially since by its means "certain inconsistencies between prevailing physical ideas and the geometry which so admirably interprets the kinematics of relativity are removed." This view can of course be accepted, but does it not imply that we are here dealing merely with a mathematical device which may later have to be discarded or receive interpretation by a more complete physics?

In the concluding lecture, the author boldly, but apparently with a certain amount of trepidation, attacks the problem of life. While professing ignorance of the meaning of the term 'vitalist,' the author proclaims that "it is indisputable that many of the characteristic properties of living beings are not only far beyond the reach of existing physical science, but are not even suggested by the most remote extrapolation of the laws and theories that we have made to fit the inorganic world." Of the phenomena which have no counterpart in inanimate Nature, one of the most

striking is known as the struggle for existence. In concluding his lectures the author says: "The sciences of physics and biology comprise sets of man-made postulates and laws which no more need to be compatible with one another than do the geometries of Euclid and Lobachevski. The science of physics rests upon the postulate of determinism; the science of biology, unless it is to ignore deliberately the phenomena of behaviour, must abandon this postulate and substitute therefor a postulate of choice or freedom."

The book is most refreshing to read, owing to the sense of humour of the author and the clearness with which he expresses his views, and it is also most stimulating and provocative of thought. It suffers, however, from over-condensation. The author confesses that the collection of "simple essays" has been brought "by the publishers to the dimensions of a book only by generous spacing between the lines," and he obviously expects the reader to read rather extensively between these lines. There are, however, very many people, not all of them laymen in the domains of science and philosophy, who are intensely curious concerning the subjects treated in these lectures, but will find it very difficult, if not impossible, to make the necessary interlections. May we not express the hope, therefore, that the author will place the world still more in his debt by giving to it an expansion of this excellent outline of a system of philosophy? Meanwhile, we are grateful for this smaller work.

ALEX. FINDLAY.

Carbohydrate Metabolism and Insulin.

Carbohydrate Metabolism and Insulin. By Prof. J. J. R. Macleod. (Monographs on Physiology.) Pp. xii + 357 + 4 plates. (London: Longmans, Green and Co., Ltd., 1926.) 18*s*. net.

THIS comparatively large volume furnishes an excellent description of carbohydrate metabolism in general. This is only what might be expected from such a well-known author as Prof. Macleod, who has done so much useful work on this subject. To anybody wishing to get a fundamental idea of our present knowledge in this field of metabolism the book can be confidently recommended. Of all the volumes of literature on the difficult and evasive problem of carbohydrate changes in the animal body, the present appears certainly to be the best. It deals with the subject in a clear though fundamental manner, and embraces everything that is known as to the physiology of carbohydrate metabolism.

The book opens with a chapter on the structure of the islets of Langerhans and their cytological characteristics. This is followed by a useful description of the structural changes which the pancreas undergoes under various experimental conditions. The various mechanisms of the different forms of glycosuria are concisely discussed, followed by a complete description of glycogen and the various changes this substance undergoes in the body. Methods for the estimation of blood sugar are mentioned, and the manner of existence of the sugar in the blood is discussed briefly. The author does not accept the view propounded a few years ago to the effect that the sugar in the blood of the healthy animal is not ordinary glucose, but a very reactive modification known as γ-glucose. It is pointed out that the alleged evidence for the occurrence of γ-glucose in the animal organism is exceedingly unsatisfactory, for this substance is so labile and unstable that even if it did occur in the body, it would be almost impossible, with our present methods, to isolate and identify it.

Naturally, a great deal of the volume is devoted to a study of the action of insulin, and while this part of the book is done just as well as the rest of it, it must be admitted that a perusal of Prof. Macleod's critical compilation on this subject leaves the impression that there is yet very much to learn. The hopes held out a few years ago that the advent of insulin would solve many of our hitherto insoluble problems have been almost entirely unfulfilled. In spite of the very large amount of experimental research, both good and bad, carried out on the particular influence of insulin in the utilisation of carbohydrate in the animal body, it is safe to say that as yet but little advance has been made in this difficult field. When we consider that the products of sugar destruction are comparatively simple, and, from the chemical point of view, necessarily limited to a few substances, it is a matter for wonder that, so far, we have failed to trace the various steps through which sugar is broken down to carbon dioxide and water. It is true that some glimmerings of light have now and again appeared within the last few years, but nothing definite has so far transpired.

Insulin has, on the whole, been a disappointment so far as it has afforded any insight into the physiological processes which the body employs. Very many papers have appeared, and are still appearing, which deal with the manner in which insulin acts, but the many controversies and

difficulties which have arisen seem to have been solved by the work of Dale and his collaborators, who state that insulin acts by changing some of the sugar of the body into glycogen, and by oxidising the rest of it. These authors believe that the disappearance of sugar, after insulin administration, can be accounted for by the sugar destroyed and the glycogen formed.

This means, as was to have been anticipated from the very beginning, that insulin acts when injected just as it does when supplied normally by the pancreas. The problem is, how does insulin act when it is supplied in the natural manner to the healthy individual ? That problem still awaits solution, and we know little or nothing at present with regard to it.

From the clinical point of view, it would appear that insulin in several cases produces changes in the diabetic which are not obvious in the normal individual, but it is quite possible that these changes may be dependent on the difficulty of administering the optimum dose when insulin is given artificially. However, the rapidity with which several diabetic patients become abnormally fat when taking insulin, suggests that insulin probably has some direct influence on the formation of fat from sugar in the body.

To anybody interested in this fascinating though difficult subject of carbohydrate metabolism, a perusal of Prof. Macleod's volume will serve to give an exact and well-reasoned view of the present position of this subject. It would appear probable, however, that what is believed to be true to-day will undergo vast modification in the future. The subject, so far, has not yielded to attack, and whatever we write or think, it is certain that we know but little of the real facts. H. MACLEAN.

The Terminology of Electrical Engineering.

British Engineering Standards Association. Publication No. 205, 1926: *British Standard Glossary of Terms used in Electrical Engineering.* Pp. 263. (London: British Engineering Standards Association; Crosby Lockwood and Son, 1926.) 5*s*. net.

PURSUING its work of standardisation, the British Engineering Standards Association has issued a glossary in which the terms in common use in electrical engineering are defined, so as to provide engineers with a uniform nomenclature. With this end in view, the compilers frequently give a list of the synonyms actually in use, indicating their preference by heavy type, and in some instances marking others as 'deprecated.' From this point of view, the sections on composite machines (*i.e.* converters of all types) and transformers, and that part which deals with the exact uses of such terms as 'protected,' 'enclosed,' and 'flame-proof,' will be valuable in giving exact meanings to terms which have not always been used in the same way by different writers.

As is to be expected in such an undertaking, there are cases where the choice will not meet with general agreement; particularly is it to be hoped that the engineering world will not adopt the suggestion of calling the extreme range of a wave the 'double amplitude,' whilst it will be interesting to see if the terms 'active current' (the tabulated alternatives being active component, energy component, power component, and in-phase component of the current) and 'reactive current' (for the other component) succeed in ousting their rivals. We also note that the distinction between an oscillating and an alternating current is made to depend on whether the frequency is or is not dependent solely on the constants of the system in which it flows.

As to the definitions themselves, they are for the most part adequate for their purpose, but it is doubtful whether much good is done by defining, for example, the blade of a switch, and the contact jaws, in a reciprocal manner, except in cases where it is desired to indicate that one of a number of alternatives is preferred. It is, however, in the general section that the weakest definitions occur. Apart from the vexed 4π question, we find separate definitions of quantity and of charge, and each of them is logically unsatisfactory, although no doubt adequate for the restricted purpose of this glossary. Quantity is given as the product of current and time, whilst current is earlier defined as quantity per second. Charge is stated to be 'an excess or deficiency of electrons on a body, causing electric effects in the neighbourhood'; but definition 1102 gives the meaning of 'electron' as the fundamental unit of negative electricity. On this subject of electrical units it seems rather a pity that the term selected for the B.T.U. should make the definition commence 'Unit of Electricity: a Unit of Electrical Energy.' It is also to be regretted that while the numerical value of the electronic charge is quoted, and values given for the B.Th.U. in joules, other useful figures, such as the ratio of the true to the international volt, and the E.M.F. of the Clark and cadmium cells, are omitted. One would also have liked more information on the International Candle, which is here stated simply to be a unit of luminous intensity, arrived at by

common agreement between certain specified institutions. It is also to be regretted that the term 'thermo-electric effect' has been restricted to one particular effect.

Lest this catalogue of blemishes (impossible to avoid in reviewing a work in the form of a glossary) should convey a wrong impression, it must be pointed out that they concern but a small fraction of the total number of entries, most of which are very clear, and should materially assist in attaining the ideal of one definite term for each concept requiring expression. The book is excellently produced, is divided into sections, and provided with a very complete alphabetical index, in which all the terms are indexed, whether or not they are 'deprecated' in the body of the work. Misprints are very few, the following list including all that have been noted: in definition 1510 the second 'per sec.' is omitted, and in No. 1901 the figure 3·68 should be 36·8. In the index, under 'charge' the figures 1210 and 1310 should be 1201 and 1301.

J. H. A.

The People of China.

Anthropology of Eastern China and Kwangtung Province. By S. M. Shirokogoroff. Pp. vi + 162. (Shanghai: Royal Asiatic Society, North China Branch, 1925.) 5 dollars.

AN account has already been given in NATURE (Dec. 12, 1925, p. 855) of the anthropological inquiries now being conducted in China by Dr. Shirokogoroff and described by him in a series of reports. The volume already discussed dealt with the populations of the provinces of Kiangsu and Chekiang. The present work gives further information relating to the living people of these provinces as well as of Kwangtung, and in fact of the eastern part of China. It is essentially a statistical investigation, and is free from speculations as to the assumed influence of the endocrine glands in causing racial differentiation, to which particular reference was made in the previous review.

The real value of the present, like the former, report is the new data submitted by Dr. Shirokogoroff, who seems to have cast his net widely in the process of collecting both measurements of living people and comparisons from the literature of anthropology, especially many references to eastern Asia not readily accessible to students in western Europe.

By the analysis of series of measurements, the attempt is made to define different types and to estimate their relative representation in the populations of the various provinces. The commonest of these types in the northern provinces and in Manchuria is characterised by high stature (1·75 m.), a low cephalic index, and a high nasal index. In the provinces of Kiangsu and Kwangtung this type is said to be absent. It is rare in Anhwei and Chekiang. In central China (Honan) it is common, and in Chili and Shantung it is the usual and characteristic type. His second type is distinguished by a smaller stature (1·60 m.), a high cephalic index, and very high nasal index. Its geographical distribution is very wide, being the dominant type in eastern China and Korea (possibly also in Japan). It is also common among the Manchurians and the Northern Tungus.

If these results should be confirmed by further studies, they will necessitate considerable reorientation of current views on the distribution of Mongolian types. So far, however, the conclusions are tentative. They have met with severe criticism, especially (according to this memoir) from Prof. Tschepourkowsky of the University of Vladivostok, "one of the leading sovietic anthropologists," who has asserted that types claimed to have been identified by Dr. Shirokogoroff in northern China "are a mere phantasy."

G. ELLIOT SMITH.

Our Bookshelf.

Getting out the Coal: Stripping, Underground Mining, Loading Machines, Roof Support. Compiled by Frank H. Kneeland. (Practical Coal Production, Vol. 2.) Pp. vii + 403. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s*. net.

THE present volume is a continuation of a volume on preliminaries of coal mining, etc., compiled and published in the same way as the present volume, which was reviewed in these columns in June last year. Practically the same criticism that was applied to the previous volume holds good for the one now before us. It deals almost entirely with American methods and American practice, though a few pages are devoted here and there to English methods by way of directing the attention of American engineers to them, though it cannot be said that the British illustrations which have been suggested are at all typical of the best British practice.

The work is divided into four chapters: Stripping or surface mining; underground methods of mining, constituting the bulk of the book, so that more than half the text is contained in this one chapter; loading, loading machines, and conveyors; timbering and roof support. The first chapter is naturally of no use to the British colliery engineer, especially as the greater part of it is devoted to the stripping of anthracite. As regards the second

chapter, it is of no use to engineers in England, and probably of but little use even to American engineers, because the most recent methods are not discussed. The chapter on loading machines and conveyors is decidedly disappointing; the compiler appears to have got his information on the subject of loaders mainly from the builders of the machines, rather than from their users, and gives the impression of not having been in touch with their practical use underground. He entirely ignores the existence of the gate-end loader which is making considerable headway in Great Britain, and omits from the discussion some of the modern American cutting and loading machines which are being tried out in West Virginia.

The last chapter on timbering, etc., again is unsatisfactory. The compiler has attempted to work out certain formulæ for determining the size of timbers to be employed; he gives one of these on p. 307, and is apparently unaware of the fact that he is repeating the same formula only slightly altered in form and in the letters used in designation on p. 331. His confidence in his own formulæ is best expressed by the statement that he solves a particular example, and shows that according to his formula "a $4\frac{3}{8}$-in. stick will support the load"; he goes on to say, however, that "in this case it would be advisable to use a larger stick, say, 8 in. diameter."

Geologie von Europa. Von Prof. Dr. Serge von Bubnoff. (Geologie der Erde.) Band 1: *Einführung, Osteuropa, Baltischer Schild.* Pp. viii + 322 + 8 Tafeln. (Berlin: Gebrüder Borntraeger, 1926.) 22·50 gold marks.

THE present volume forms the second instalment of the "Geologie der Erde," vol. 1 of Prof. E. Krenkel's "Geologie Afrikas" having been published about a year ago. The whole project is a decidedly ambitious one, for the aim is to give a comprehensive and correlative account, from the structural as well as from the stratigraphical point of view, of the geology of the earth, each continent being dealt with separately.

Prof. von Bubnoff has been faced with a task more formidable than that of any of the other contributors, so complicated is the structure of the continent of Europe, and so extensive the literature. He sets out in the first place to determine from palæogeographical considerations what are the fundamental structural divisions of the whole area, and shows how, with certain modifications due chiefly to the great mountain-building movements, the character of each region has tended to remain constant throughout geological history. He then discusses the variations in gravity over the continent, the general distribution of ore-deposits, and the present-day morphology.

The rest of the present volume is devoted to a detailed account of eastern Europe, the development of which is shown to have been independent of that of western Europe since Palæozoic times. The Ural Mountains, the Posthumous Uralides, the Russian Platform, the Baltic Shield, and the Podolian Massif are dealt with in turn, and an account given of the stratigraphy, the orogenesis, the ore-deposits, and the morphology of each region, together with references to the more important literature. As might be expected, the text makes rather solid reading, but, fortunately, it is well illustrated by explanatory maps and sections. The appearance of the remaining two volumes, which are to deal with western and with Mediterranean Europe, will be awaited with interest, since the complete treatise will undoubtedly fill a gap in geological literature and be of considerable use as a work of reference.

Die Ökologie der blattminierenden Insektenlarven. Von Dr. Martin Hering. (Zoologische Bausteine: Ausschnitte aus dem Gesamtgebiet der Zoologie, Band 1, Heft 2.) Pp. iv + 253 + 2 Tafeln. (Berlin: Gebrüder Borntraeger, 1926.) 18 gold marks.

ONLY a few months ago we had the opportunity of noticing Dr. Hering's "Biologie der Schmetterlinge," and it is seldom that an author is able to produce two works of evident scientific merit within a period of less than a year. The treatise before us is the result of the study of the specialised subject of leaf-mining insect larvæ.

A great deal of the information that lies scattered through the pages of numerous periodicals has been critically examined and gathered together in producing this book. At the same time, Dr. Hering has incorporated much of his own studies, and has imparted greater exactness and a more scientific viewpoint, in what has hitherto remained an ill-defined branch of entomology. In order to achieve his object he has coined a special terminology which differentiates the various characteristic features of miners. As the names which he adopts are short and convenient, it is possible that they may find acceptance.

The book is divided into sixteen chapters, each one being devoted to a particular aspect of the subject. Thus, Chap. i. is concerned with the definitions and the general morphology of mines. Chap. ii. deals with mines in different parts of plants; Chap. iii. with 'stationary' and 'temporary' miners; and Chap. vii. discusses larval structure in relation to mining habits. Chap. x. is concerned with problems relative to the nutrition of miners, and there are chapters dealing with aquatic mines and on the parasites, inquilines, and symbionts of mining larvæ. The book is well printed and illustrated; it is provided with a very complete bibliography, and the price on the whole is reasonable. A. D. I.

Meteorological Office: Air Ministry. British Rainfall, 1925: the Sixty-fifth Annual Volume of the British Rainfall Organization. (M.O. 285.) Issued by the authority of the Meteorological Committee. Pp. xviii + 279. (London: H.M. Stationery Office, 1926.) 15*s.* net.

FOR the year 1925 the rainfall over the British Isles was very slightly above the average and can be taken as normal. In some districts abnormalities occurred; among the most remarkable of these was the exceptionally dry June, which was

absolutely rainless in many localities and one of the driest months on record for the British Isles as a whole. The cold and cheerless summer was the fourth summer in succession of that nature. In spite of the large number of thunderstorms, especially in May and June, there were few days with heavy falls of rain.

A special article is given showing a comparison of the fluctuations experienced at two standard stations—Oxford, fairly central in England, and Glenquoich in the western Highlands of Scotland—and maps are given showing the results of these statistical investigations, considering also their relation to other places in western Europe. A classified list appears of the papers published in "British Rainfall" in the last twenty-five years. A summary is also given of some experiments on the shielding of rain-gauges made at Valencia Observatory in Ireland. The question of over-exposure is discussed as well as insufficient exposure. The effect of wind conditions is considered upon the catches in recording gauges.

Post-Prandial Proceedings of the Cavendish Society. Sixth edition. Pp. 37. (Cambridge: Bowes and Bowes, 1926.) 2*s*. net.

THIS collection of verses began with a few songs written for 'community singing' at the annual dinners of the research students of the Cavendish Laboratory. The first collection was privately printed in 1904, and similar editions with new songs added appeared in 1906, 1907, and 1911. Some of these were of a purely ephemeral interest and were omitted in the first published edition of 1920. The present edition was published in connexion with the dinner held in celebration of the seventieth birthday of Sir J. J. Thomson. Several of the songs are tributes to him, including a "Biographical Sketch," which gives a versified account of his career up to date. The author of this, as of most of the best songs in the volume, shelters himself modestly behind the initials "A. A. R." The 'J. J.' songs reveal the extraordinarily happy personal relations which have always bound the research students to their professor, while the songs in honour of Sir Ernest Rutherford are sufficient evidence that the old tradition is being carried on. The remaining songs deal with important branches of modern physics from the electromagnetic theory to the quantum theory. All old Cavendish students will welcome the appearance of this new edition, which is greatly improved in form, and a much wider public will find it both interesting and entertaining. A. W.

Animals Looking into the Future. By Prof. W. A. Kepner. Pp. xi + 197. (New York: The Macmillan Co., 1925.) 7*s*. 6*d*. net.

THE author aims, in this book, to demonstrate that in all animals, from the lowliest protozoa to man, prescience is a marked characteristic, and one that fundamentally distinguishes the organic from the inorganic world. Both mice and men have plans, and from a brief consideration of the habits and organisation of certain colonial and solitary insects, and of the structure and physiology of more lowly animals like Hydra, Microstoma, and even the protozoa, the author seeks to emphasise this point of view. Even plants look into the future. It is true that a distinction is made between the conscious prescience of man and the instinctive prescience of insects or Hydra. The author, however, in his enthusiasm for the text of his sermon, has imparted too anthropomorphic a bias to his presentation. "Therefore, in the formation of nematocysts by the interstitial cells of Hydra we see these living units sacrificing themselves in a prescient manner with reference to the welfare of the individual polyp." This quotation, which gives an idea of the author's thesis, may easily suggest conscious thought to the layman, and it is for the layman that this book is written. It is a little dangerous to attempt the popular exposition of biological phenomena in language which may convey an erroneous interpretation to the lay mind.

Contributions to the Art and Science of Otology. Lectures and Papers by Richard Lake, 1892–1925. Pp. vi + 255. (London: Macmillan and Co., Ltd., 1926.) 15*s*. net.

THIS book consists of a collection of the author's more important contributions to current medical literature extending over a period of thirty-three years. It comprises within the limits of 255 pages fifty separate items, made up of case records, clinical lectures, addresses to medical societies, and articles, more or less controversial, on current otological topics. It is the index of an industrious and intellectually active professional career, which may well be a source of legitimate satisfaction to the author, and of interest to his colleagues and to the students who have received their training at his hands. There is not much in it that is of general scientific value at the present day. So far as the scientific side of his subject is concerned, we may cite some careful observations on tuning-fork tests of hearing in various forms of deafness. The author lays emphasis on common sources of error arising from the personal factor in examiner and examinee. No doubt in the near future our estimate of the value and significance of the various methods of testing hearing will have to be recast in view of the recent introduction of more absolute methods of audiometry.

Biochemie des Menschen und der Tiere seit 1914. Bearbeitet von Dr. Felix Haurowitz. (Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe, Band 12.) Pp. xii + 148. (Dresden und Leipzig: Theodor Steinkopff, 1925.) 7 gold marks.

THIS little volume gives, in a handy form, short reviews of a wide selection of biochemical subjects: each is accompanied by a large number of references to the literature, which appear to have been well selected. The arrangement follows that usual in text-books of biochemistry and physiology. The volume should be of use to those who wish to look up recent work on a specified subject without the necessity of referring to the original papers.

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.*]

A Quantum Relation in Large Scale Electric Wave Phenomena.

IT is well known that associated with a medium containing free electrons of mass m and charge e there is a definite critical frequency ν_o where $\nu_o^2 = \frac{Ne^2}{\pi m}$. This frequency is characterised by the fact that electric waves of frequency less than ν_o cannot travel through the medium.

The group and phase velocities of waves of greater frequency than ν_o are given by the relations :

$$V_{\text{phase}} = \frac{c}{\sqrt{1 - \frac{\nu_o^2}{\nu^2}}},$$

$$V_{\text{group}} = c\sqrt{1 - \frac{\nu_o^2}{\nu^2}},$$

so that they tend to ∞ and 0 respectively as : $\nu \longrightarrow \nu_o$.

This relation :

$$\nu = \nu_o \text{ or } \frac{Ne^2}{\pi m \nu^2} = 1,$$

which determines the critical frequency of the medium, can be expressed in a way which connects it up with the quantum theory. In a paper in the *Philosophical Magazine* (July 1926, vol. 2, p. 267) I showed how to calculate the ratio $\frac{4\pi h\nu}{\beta^2}$, which is the ratio of the total energy of a quantum (engaged in an encounter with an electron) to the energy per unit volume. This ratio must therefore be of the dimensions of a volume which, for want of a better expression, was called "The Volume Occupied by the Quantum."

The expression which represented this quantity was found to be :

$$\frac{e^2}{\pi \nu^2 m_o} = V \text{ say},$$

so that the relation giving the critical frequency can be expressed in the simple form $NV = 1$. Since $1/N$ is the average volume occupied by each electron, we may say that the critical frequency occurs when this is such that the 'volume occupied by the quantum' is equal to the average volume occupied by each electron. In order to conform with the ideas of statistical mechanics, of which long wave propagation appears to be an example, I prefer to consider that $NV = \nu_o^2/\nu^2$ represents the probability of a direct hit of the quantum and electron, or more precisely the fraction of quanta per unit volume which are in collision at any instant with the electrons in that volume. In the case of the critical frequency this probability is unity, and the relations of quantum mechanics gives a justification for the use of this description. For the analysis of the 'Compton scattering' shows that when a direct hit occurs the momentum given to the electron $M = \frac{h\nu}{c}(1 - \cos\theta)$, where θ is angle of scattering ; the average of which may be considered to be : $h\nu/c$ the momentum in the wave.

It follows that when the probability of a direct hit is unity all the wave momentum will on the average be given up to the electrons and the wave can travel no farther, this state of affairs resulting in the zero group velocity which occurs at the critical frequency.

In one respect this analysis seems to shatter the picture of a quantum as an objective particle of radiation, for such a picture would inevitably imply that the probability of a direct hit should be jointly proportional to the radiation energy density or density of quanta and the electron density, whereas the foregoing analysis shows this probability to be independent of the density of quanta.

This aspect of the quantum theory has already been pointed out by Eddington in his discussion of Einstein's derivation of Planck's law of radiation ("The Internal Constitution of the Stars," p. 56).

T. L. ECKERSLEY.

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Non-Magnetic Films of Iron, Nickel, and Cobalt.

A YEAR and a half ago one of us (Ingersoll and De Vinney, *Phys. Rev.*, 26, 86, 1925) reported the results of some experiments on films of nickel cathodically sputtered in hydrogen at a pressure of 1 mm. or less. These films as produced were entirely non-magnetic, showing no tractive effects in a strong magnetic field. Upon heating to about 350° C. for a few minutes, however, they become strongly magnetic.

We have since continued this work on nickel and extended it to iron and cobalt, and find that, while it does not seem possible to produce non-magnetic films of these latter metals in hydrogen, they can be made in helium. Argon has also been used as a residual gas with nickel. In all cases heating for a few minutes to 350° or more in a vacuum—or, for that matter, passage through a bunsen flame in air—makes films of these three metals strongly ferro-magnetic.

The crystal structure of these films has been investigated by the X-ray method (iron and tungsten anticathodes). In the original work on nickel the evidence was to the effect that, while the film after heating showed the normal lattice for nickel, as originally produced it was amorphous, giving no clear evidence of crystal structure. In our recent work, however, we find—using an improved technique, whereby the crystal structure is determined without removing the film from the glass—that the film as produced (*i.e.* non-magnetic state) has in general the same crystal structure as after heating but *with a larger lattice spacing*. The distension or swelling may be so much as 20 per cent. In most cases the lattice shown by the film after it has been heated and rendered magnetic is the normal one for the metal : the exceptions may be explained on reasonable grounds.

The basis on which we are seeking to explain these facts is the occlusion by the metal of large amounts of the residual gas, *i.e.* hydrogen, helium, or argon, during the process of sputtering. Palladium, as is well known, absorbs in favourable circumstances hundreds of volumes of hydrogen, and, as has been shown (McKeehan, *Phys. Rev.*, 21, p. 334, 1923), this results in a lattice distension of some 2 or 3 per cent. It is true that it is a long step from this to the 6 to 20 per cent. distension we have found in many cases—and this too in metals such as iron, nickel, and cobalt, which are by no means so notable in their gas-occluding properties as palladium; nevertheless, it is the only explanation we can offer at this time.

If the presence of such large volumes of gas in these non-magnetic films be granted, although the direct experimental proof of its existence seems difficult

because of the very minute amount of material in a film a light wave or less in thickness, it is of interest to inquire if it is in the form of a chemical compound with the metal or not. This must of course be answered eventually, if at all, on the basis of proved stoichiometrical proportions. We cannot decide this at present, but we can, however, adduce certain evidence. Each of the three cobalt films sputtered in helium had exactly the same crystal dimensions—20 per cent. increase above the normal face-centred cubic cobalt (the cathode was a mixture of face-centred cubic and hexagonal)—in spite of somewhat different sputtering conditions. All of the seven iron films sputtered in helium had exactly the same crystal dimensions, apparently a swelling of nearly 22 per cent. above the normal. Ten different specimens of nickel, sputtered in different gases, had a common distension of 6 per cent., although with this metal there were other values which occurred in some specimens and not in others. It was possible in the above cases to reduce, by controlled heating, part of the specimen to the pure metal leaving the rest unchanged, as shown by the X-ray picture which showed both forms present at once. This is fair evidence against the idea of simply a solution of the gas in the metal. The case seems to be somewhat different from that of palladium: we sputtered this in hydrogen and found various distensions up to 3 per cent. It was possible, by suitable heating, to reduce the distension, *i.e.* the gas in the palladium, by any desired amount.

We regard this as evidence of a chemical or at least quasi-chemical union of the metal and the gas. Compounds with hydrogen would of course be possible, and with helium and argon at least not unthinkable. The loss of magnetism is possibly to be associated with a changed electron distribution in the metallic atom, due either to the influence of the chemical combination or simply to the increased distance of the atoms apart. (See also L. C. Jackson, *Phil. Mag.*, 2, p. 86, 1926.)

We have been at some pains to forestall the most obvious point of criticism, which would be to the effect that small traces of oxygen in the residual gas might cause these metals to sputter as (non-magnetic) oxides which reduced on heating to the pure metal. Some colour is lent to this point of view by the fact that the lattice spacing of cobalt as deposited is almost exactly that of cobalt oxide. There are several reasons why we do not believe this view tenable: (1) We have taken great pains in purifying the gases, particularly as regards removing hydrogen and oxygen from the helium and argon: there was probably a trace of nitrogen in each. (2) If the metal, *e.g.* cobalt, is sputtered as an oxide, it must be of such a character as can be reduced to the metal by heating in a vacuum for a few minutes to, say, 350° C. This possibility is contradicted by chemical evidence, and experiments we have made on cobalt oxide indicate that such reduction is impossible. (3) There are minor differences between the lattice shown by the original cobalt films and cobalt oxide which clearly separate them. It would seem, nevertheless, as if we had here a cobalt helium compound very like cobalt oxide.

The work is to be continued with certain improvements, such as the use of fused quartz instead of glass, on which to deposit the films: also with better means for thorough outgassing and for extreme purification of the residual gases.

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L. R. INGERSOLL.

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Dec. 18.

The Spectra of NH Compounds.

IT is well known that the flame of ammonia emits several characteristic bands. The appearance of the bands is strongly influenced by the temperature of the source. Thus the spectrum of the cool flame of ammonia is dominated by the diffuse so-called α-group in the yellow region. In the spectrum of a hot source of ammonia, burning in the electric arc, the β-group with its intensity maxima at $\lambda\lambda$ 3370, 3360 is photographically by far the most intense. From investigations on the exciting conditions and on the structure of these bands, one may suppose that the very complicated α-group is emitted by the excited NH_3 or NH_2 molecules, or a mixture of both, as one can distinguish with some degree of certainty two different systems in α. Judging from some very distinct structural relations holding between the β-group and the long series of known hydride spectra, we refer the origin of this group to the NH dipole. This will be discussed later. Other bands of the ammonia-oxygen flame are referred by Eder to NO compounds. Very recently, K. Gleu, in an interesting

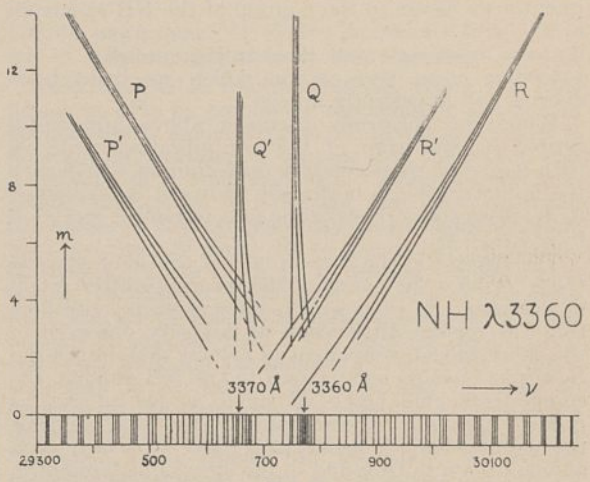

FIG. 1.

paper on the chemi-luminescence of chlorine trinitride in hydrogen trinitride (*Zeits. f. Phys.*, 38, p. 176, 1926), reported some new bands of nitrogen hydride. From their symmetric positions around the β-group and their comparatively simple structure we suggest that they also belong to the spectrum of the NH dipole.

We have lately studied the structure of the β-group, using Fowler and Gregory's measurements (*Phil. Trans. Roy. Soc. London*, A, 218, p. 351, 1919) as well as our own, taken from spectrograms of high dispersion (1 Å.U. = 1·2 mm.). Fig. 1 gives a rough view of the system arranged in a ν-m diagram. The characteristic triplets on both sides of the intensity maximum at λ 3360 are shown as P- and R-branches, while the intensity maximum itself is supposed to be made up of the overlapping lines of the corresponding Q-branch. The long-wave component (Q_1), especially in the Q-triplets, thus causes the region which is still unresolved with a very high dispersion at λ 3360·31. As in the cases of many other band spectra, this arrangement gives rise to a 'combination defect' which has to be explained by assuming a separate set of rotational terms for the Q-branches *vis-à-vis* with those of the P- and R-branches. From a closer analysis of the spectral terms, it appears that the initial state contains an electronic triplet, while the final state is a singlet. The final state, however, includes a rotational triplet of unknown nature in which the very

small term separation increases linearly with m ($\sim 0{\cdot}010\ m$). Accurate figures for the electronic frequencies cannot be obtained (~ 29750 cm.$^{-1}$) owing to the difficulties in computing the series down to their origins. If we denote by σ and ϵ the quantum numbers of the total electronic angular momenta parallel and perpendicular to the figure axis of the dipole, it appears from the analysis that the initial term contains distinct σ, ϵ components, while in the final state, $\sigma = 0$, $\epsilon = \frac{1}{2}$. The nuclear spacing of the molecule in its final state is $r_0 = 1{\cdot}10 \times 10^{-8}$ cm.

The above statements are in agreement with the hypothesis on the appearance of Q-branches in band spectra, and also point to some clear relations holding between this spectrum and those of the hydrides as they appear in the periodic table. All the known hydride spectra are associated with electronic transitions of the type $S \longrightarrow S$ or $S \rightleftarrows P$. These two types can sometimes be distinguished from each other by the fact that bands of the first type contain only P- and R-branches, while those of the second type have Q-branches in addition. This seems to be a general rule holding for all band spectra. Consequently we assign to the β-group of the NH spectrum a $^3P \longrightarrow {}^1S$ transition, where ^3P separations should agree in magnitude with those in the spectrum of the preceding atom, here carbon, which spectrum, however, is still imperfectly known.

While the spectrum discussed above apparently forms the spectrum of the non-vibrating molecule ($n_1 = 0$, $n_2 = 0$), the secondary maximum at λ 3370 with the faint triplets on both sides of it can be explained in detail as the corresponding first vibration spectrum ($n_1 = 1$, $n_2 = 1$).

The triplets in the β-group are of the same type as those forming the bands of the second positive group of nitrogen. It is, however, interesting to note here that the regular alternation of intensity observed in the short-waved component (a narrow doublet) of the N_2 triplets has no counterpart in the NH triplets, the components here being all single so far as can be judged from our spectrograms. This also confirms the assumption of Mecke, according to which such anomalies are to be found in the spectra of symmetric molecules as H_2, He_2, HCCH, N_2 (see also Slater's hypothesis on this problem, NATURE, April 17, 1926, p. 555).

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(Intern. Board of Educ.).
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Icebergs in Relation to Water-Temperature.

IN an article in NATURE of Nov. 20, p. 750, which discusses means of enabling a vessel to detect the proximity of icebergs at sea, a remark is made which indicates that the attempt to do so by means of the temperature of the water has proved unavailing. When the conditions are considered it could scarcely be otherwise. I was impressed by this during two seasons spent in investigating the currents in Belle Isle strait, in 1894 and 1906, when the matter was looked into.

In that strait the surface water may warm up to 57° F. in summer, while the deeper water remains little above freezing point. Hence, with a heavy wind across the strait, the surface water may be driven to the leeward shore, allowing the cold under-water to come up to the surface. A vessel on its way through the strait might thus find the temperature so low as 45° or even 35° in the summer time, which is a large change compared to any lowering of the temperature by ice.

It is also to be noted that in currents at sea the velocity decreases from the surface downward; and an iceberg which may have a draught of 150 feet to 300 feet (as shown by the depth in which it grounds) will move at the average velocity of the current between the surface and that draught. Accordingly, there is normally a flow of surface water past an iceberg, due to difference of velocity, when it travels in a marine current. The only chill to the water is therefore in the tailing or wake, on one side of the iceberg, in the line of flow. Unless a vessel approaches towards that side it would detect no difference in the water temperature.

The amount of chill in the region of Belle Isle strait, in water which is already cold, was investigated with a boat, going close up on all sides of the icebergs. When the general surface temperature was 35·5° F. the water tailing from an iceberg was 35°, while on its other sides no difference was found. A small berg aground in a bay in which the surface temperature ranged from 34° to 34·5°, chilled the water to 33·5° close around it. In the case of a large iceberg (780 feet by 290 feet at the water-line, and aground in 57 fathoms) the water temperature, 37°, did not vary within 130 feet of it. Such small differences could not be considered as an indication of practical value, especially when within a few hundred feet of the bergs.

Nevertheless, Dr. H. J. Barnes was hopeful of more definite indications by means of his highly sensitive thermometer, especially near the meeting-place of the Labrador Current and the Gulf Stream, where the water is warmer and almost motionless. But a further feature was encountered under these conditions; for the water chilled by the iceberg sank vertically down from its sides. With an iceberg in relatively warm and still water there is thus theoretically a movement of the surface water inward towards the berg, instead of any spread of chilled water around it. The lowered density of the sea water due to dilution from the melting ice does not seem to counteract this, because of the rapid rate of increase in the density of water with fall of temperature.

When such conditions are understood, the uncertainty of any temperature warning against floating ice will be appreciated.

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Dec. 24.

The Chromosome Number in *Dactylis glomerata* (Cocksfoot).

IT is only recently that the attention of cytologists has been directed to the ascertaining of the chromosome number in the herbage grasses. In a letter to NATURE of Dec. 11 (vol. 118), p. 841, Mr. Gwilym Evans states that he has discovered the number in the Lolium spp. and has given a tentative estimate of the number in the two varieties of *Festuca elatior*.

Whilst engaged at the Welsh Plant Breeding Station, Aberystwyth, in carrying out preliminary investigations on the genetical behaviour of *Dactylis glomerata*, it was thought expedient to ascertain the chromosome number of this species. The nuclear divisions, both somatic and meiotic, have been extensively investigated; the root-tips being selected as the most promising material for an examination of the somatic, whilst the meiotic divisions were studied in the anther.

The root-tips were fixed in Flemming's Solutions, in some cases a little modified. For the fixation of the anthers, Flemming's Solutions proved entirely unsuitable. Excellent fixation was, however, obtained with Bouin's Picro-formol and with Allen's modifica-

tion of this solution. Belling's Aceto-carmine gave only indifferent results as a medium for chromosome counts on this species.

The conclusions drawn are entirely based on the examination of permanent slides of the root-tips and of the anthers. The number in *Dactylis glomerata* is clearly established as being twenty-eight in the diploid somatic nucleus of the root-tip and fourteen in the haploid nucleus. The count in the root-tip cells was made when the chromosomes were arranged equatorially on the spindle, and before the separation of the daughter chromosomes. In the case of the heterotype division it was much easier to count the univalents when in mid- and late-anaphase. Fourteen univalent chromosomes were readily distinguished. This number was again to be seen in the homotype division immediately following, the best stage for counting being the equatorial plate stage, just previous to the commencement of anaphase.

It is thus established that the chromosome number in *Dactylis glomerata* is fourteen in the haploid and twenty-eight in the diploid generation.

The investigation of the chromosome number in *Arrhenatherum avenaceum* and *Phleum pratense* is now proceeding. It is as yet too early to state definitely the number obtaining in these two species, but an examination of the root-tip of *Arrhenatherum avenaceum* (the indigenous form with swollen basal internodes is the one hitherto examined) enables me to state that the diploid number in this species is in the neighbourhood of forty.

It is hoped in the near future to state definitely the chromosome number of both these species.

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Hyperfine Structure in the Neon Spectrum.

IN an investigation of the neon spectrum I have found that all lines, which arise from an *s*-term, have a component of shorter wave-length. The intensity of the satellite ranges from one-fourth to one-tenth that of the main line (according to a rough estimation). The separation of the components varies with the *s*-term concerned; for a $2s_2$ term it is 0·076 cm.$^{-1}$; for a $2s_3$ term, 0·054 cm.$^{-1}$; for a $2s_4$ term, 0·056 cm.$^{-1}$; and for a $2s_5$ term, 0·058 cm.$^{-1}$. The structure is apparently due to a multiplicity in the *s*-levels. There are also evidences of a fine structure in the *pd* series lines, but complete resolution has not yet been attained.

The fine structure of the neon-lines has a certain importance for their use as wave-length standards. In an inhomogeneous discharge the intensity of the main line will be weakened by self-reversal more than that of the satellite; thus with incomplete resolution of the structure the maximum intensity will be displaced towards shorter wave-lengths by increasing self-reversal. The fine structure must also be considered in absorption and intensity measurements. The question whether the neon isotope of atomic weight 22 emits the component of the neon lines is to be decided by an investigation of the Zeeman effect for the fine structure.

Structure of the Mercury Line λ4916.—This line has hitherto been found simple by all observers: it consists, however, of five components separated from the strongest members by the following intervals:

+ 0·098 cm.$^{-1}$ (2), + 0·056 (4), ± 0 (10), − 0·066 (3), − 0·121 (5).

Structure of the D_3-Line of Helium.—At the suggestion of Prof. Paschen the structure of the lines of orthohelium has been investigated. The intensity measurements for the line λ5876 ($2^3P_i - 3^3D$), which is usually regarded as consisting of two components with intensities 1 and 8, made it seem probable that this line was really a triplet with relative intensities 5 : 3 : 1, of which the two strongest components had not been resolved (MacNair and McCurdy, NATURE, 117, p. 159, 1926). The theory of Heisenberg (*Zs. f. Phys.*, 39, p. 499, 1926) requires a separation of the components ($^3P_2 - {}^3P_1$) of about 1/10 ($^3P_1 - {}^3P_0$). With the aid of the Fabry-Perot interferometer and a direct current discharge at the lowest possible pressure, the apparatus being cooled with liquid air, I have succeeded in resolving the components $^3P_2$ and $^3P_1$. The resolution was improved when the discharge tube was immersed in liquid hydrogen. The frequency differences are: $^3P_2 - {}^3P_1$, 0·075 cm.$^{-1}$; $^3P_1 - {}^3P_0$, 0·98 cm.$^{-1}$. The relative intensities have not been measured, but they apparently agree with expectation.

G. HANSEN.

Physikalisch-Technische Reichsanstalt,
Berlin, Jan. 10.

(Translated by R. A. Sawyer.)

Spinning Electrons and Protons.

THE remarkable results obtained within the past fifteen months by employing the spinning electron in Bohr's atomic model suggest the question whether it may not be necessary to suppose that the proton also is capable of a quantised spin. Although the analytical difficulties in applying the new quantum mechanics to this problem may be considerable, they may not be too great to be overcome by mathematicians. There seem to be several arguments in favour of such a hypothesis. If, as is generally assumed, the proton is the positive electron, it seems natural to suppose that if the negative electron can spin with unit angular momentum the positive electron may do the same. Again, it may be easier to understand the structure of a complex nucleus if the units of which it is composed can act as elementary magnets. Prof. Duane has attempted to explain corpuscular emission from a radioactive nucleus on these lines. Finally, recent experiments on the deflection of protons and alpha particles in collision with an atomic nucleus seem to lend support to the idea of a magnetic field in the vicinity of a nucleus.

A spinning electron is one example of a *magneton*. My main object in this letter is to remind readers of NATURE that a quantised magneton was first described in these columns (vol. 92, p. 165, Oct. 9, 1913) by Prof. G. B. McLaren, a victim of the War. "The natural unit of angular momentum," postulated by Nicholson and employed by Bohr, "actually exists. It is the angular momentum of the magneton." It is true that McLaren's magneton is in one sense not spinning, for he rejected entirely the idea of magnetic or electric substance, and the angular momentum is located in the electromagnetic field. It is true also that he assumed his magneton to represent a *positive* electron, but this choice was, as he himself pointed out, an arbitrary one (*Phil. Mag.*, vol. 26, pp. 667-8, 1913). The essential fact remains that the idea of a magneton having angular momentum determined by the quantum condition was clearly stated, and was thereafter employed without question by other writers. It may be found, for example, in my paper on an atomic model with a magnetic core (*Phil. Mag.*, vol. 29, p. 719 footnote, 1915), in connexion with a positive electron, and in the discussion of the 'ring electron' (or Parson magneton) at the Physical Society of London on Oct. 25, 1918 (*Proceedings*, vol. 31, p. 61, 1919).

It is almost needless to add that there is no intention of detracting in any measure from the credit due to those who have recently been so successful in applying the spinning electron in connexion with the Bohr atom. There is satisfaction in finding that ideas for which the time was not ripe ten or more years ago now have a wide field of application, and are accepted by the leaders in physics, who were at one time unwilling to ascribe structure of any kind to the electron.

H. S. ALLEN.

The University, St. Andrews.

Rotation of Dielectric Bodies in Electrostatic Fields.

THE rotation of dielectric bodies when suspended between the knobs of a Wimshurst machine was first observed by me about a year ago. Since then the phenomenon has been studied by Messrs. L. G. Vedy and G. Gowlland and other pupils of mine. Experiments illustrating the phenomenon were shown at the recent Physical and Optical Societies' exhibition at the Imperial College of Science and Technology, particulars of some of which are given below.

Pieces of paraffin wax (including a sphere of 5 cm. radius), ebonite, sealing-wax, and a glass beaker rotated when suspended between the knobs of a Wimshurst machine. A covering of metal foil prevented rotation.

Brass spheres covered with paraffin wax rotated, the greatest rate being attained by the sphere with the thickest wax layer. Better results were obtained with bodies mounted on bearings (steel needles in glass sockets) as this arrangement prevented the bodies from swaying and striking the knobs.

By using an alternative gap it was shown that rotation did not occur in the absence of a brush discharge. Also sparking usually decreased the effect.

The presence of a charge on the bodies was shown by using a proof plane and an ordinary gold leaf electroscope. When the paraffin wax sphere was mounted symmetrically between two nearly similar knobs the charge was shown to be very small.

When the bodies were suspended inside a glass beaker or between ebonite plates, which shielded them from the discharge, rotation did not occur; but the ordinary orientation phenomenon was quite marked.

The general conclusion arrived at so far is that the phenomenon is due to the effect of the discharge, but that it is not wholly a surface effect. The influence of the presence of moisture on the surface and of the air surrounding the bodies, *inter alia*, deserve careful examination and further experiments are contemplated.

S. W. RICHARDSON.

The Royal Institution,
21 Albemarle Street, W.1,
Jan. 9.

Two-way Communication with the Antarctic.

CONTACT with the Norwegian whaler, *Sir James Clark Ross*, call sign AQE, by the south shore of the Ross Sea, 78° 30′ south latitude, was obtained by C. W. Goyder from the Mill Hill School station, 2SZ, on Jan. 30, and the messages exchanged constituted the first two-way communication with the Antarctic. Contact was again established at 8.30 A.M. to-day with the double object of putting the whaler in touch with a Norwegian station and of getting particulars of the ship *C. A. Larsen*, with the call sign ARDI, which is within a few miles of AQE.

Two-way working was easy and expeditious, and the first object was partially secured, for the signals of LGN (the Bergen Radio Coast station) and of AQE were both of good strength here. They were unable to hear one another, but an arrangement was made with each that they should attempt to get in touch with one another at 7.30 A.M. to-morrow (Feb. 7). Meanwhile AQE reports having been in touch yesterday with LA.IX (J. O. Berven, Stavanger).

The ship ARDI was thought to be a scientific expedition because the north-bound expedition into Norwegian waters, organised last summer from Cambridge, had the call sign ARDS, but was reported this morning by AQE to be another Norwegian whaler in their vicinity. ARDI was heard calling, but communication was not established. Direction-finding work, alluded to by AQE, is being carried on for the purpose of keeping in touch with the whaling boats in foggy weather.

W. H. BROWN.

Mill Hill School,
London, N.W.7,
Feb. 6.

The Fayum Lakes.

THE question of silting which is raised by Mr. G. W. Grabham (NATURE, 118, 911, 1926) depends on the velocity of the water. In water that is slackening, silt will be dropped; but if the flow is quickening, it will be carried on. In the case of the Fayum channel an inflow during two or three months had to make up for four or five feet of evaporation and also a previous outflow over a large area. As the water in this six miles of channel had therefore a gradient much greater than that of the Nile, it is unlikely that any silting would be caused during the inflow. During the stationary periods only suspended silt would be dropped, which only amounts to one inch in 15 or 20 years. During the outflow no rolled silt would be carried, as it would have slipped into deeper water in the lake. It does not therefore seem likely that any fluctuations of level could be caused by silt obstruction. Two queries that are asked may be noted here: (1) The high level taken appears to be due to a pre-human estuarine condition of the Nile; (2) there is no question about the sources of the flints which I bought in the Fayum, as they are like those found there, and none in similar condition are found in the Nile valley.

FLINDERS PETRIE.

Tell Jemmeh, Gaza.

The Supposed Law of Flame Speeds.

MR. A. G. WHITE, in his letter in NATURE of Jan. 8, p. 51, correctly recalls the fact, which we discussed fully in our original publications in the *Journal of the Chemical Society*, that deviations from the law of speeds may be expected if one of the combustible gases in a complex mixture interferes with the burning of another. The deviations are, however, small and their nature can be predicted.

The behaviour of mixtures, near the limit of inflammability, containing ether vapour or carbon disulphide, to which Mr. White refers, was considered during the discussion of Prof. Jorissen's paper at the meeting of the Faraday Society in June. We do not attach any importance to such mixtures from the point of view of the law of speeds, for the reason that they exhibit the peculiar phenomena of the 'cool flame' (cf. White, *J.C.S.*, 115, 1462, 1919), which is quite distinct from a normal flame.

WM. PAYMAN.
R. V. WHEELER.

Safety in Mines Research Laboratories,
University, Sheffield,
Jan. 12.

Matrix and Wave Mechanics.

By R. H. FOWLER, F.R.S.

IN an article on spinning electrons (NATURE, Jan. 15, p. 90) it was stated that recent progress in atomic physics is mainly due to two primary ideas: the use of a better model of the electron and of a better formal mechanics more suited than classical mechanics to the description of atomic phenomena. The changes and successes consequent on the adoption of this new model of the electron have already been described. We shall try here to give some sort of description of the ideas of the new mechanics and some of the successes to which they have led. We shall try at the same time to exhibit the two independent lines of thought which have led separately to the same new system of mechanics, but by such widely divergent paths that they have justifiably received the different names of *matrix mechanics* and *wave mechanics*. The equivalence of these two systems is perhaps the most striking and satisfactory feature of the present development.

The really fundamental features of atomic systems, as analysed with the help of the older quantum theory, are described in Bohr's first two postulates—the existence of stationary states and the frequency relation $E_1 - E_2 = h\nu_{12}$. Of these, the first is perhaps the most fundamental characteristic of all, for it is this characteristic, properly viewed, which imposes on us the particular change of the laws of mechanics which has had to be made. To describe an atom and its interaction with radiation we may agree (apart almost from all theory) that we must have (1) a set of stationary states, (2) a set of interconnexions between the stationary states which we may call transition probabilities. Collision interactions have proved harder to analyse with certainty than radiative, but we all agree that they fit perfectly into the same scheme. Our requirements, therefore, are very different from anything that can be satisfied by a system of particles obeying classical dynamics. Such systems do not have discrete stationary states. This difficulty was provisionally turned by Bohr by his third postulate ($J_u = n_u h$) which, of course, had striking successes. But these were only partial, for though the postulate gives us stationary states it cannot give us transition probabilities, except on occasions by temporary devices of interpretation based on the correspondence principle. Transition probabilities are essentially connexions between two states, whereas all the characteristics of a classical motion are functions of the one state alone. In short, a classical system in any (multiply periodic) state can be fully described by Fourier series, the coefficients and fundamental frequencies of which are functions of the parameters defining the state. An atom cannot be so described. Its coefficients must always be functions of two states, not one. Now that we know the answer it seems (as it should) very obvious—it is not a Fourier series or one-dimensional array of periodic terms with constant coefficients, but a matrix or two-dimensional array of such terms which is required to describe the atom. Any term of such an array depends on two integers m and n, defining the two states of the atom which the term connects or to which it belongs.

It may be helpful to interpolate here a few remarks on matrices. Matrices were introduced into algebra by Cayley, and form a branch of that subject interesting in itself, but hitherto not very familiar to physicists. The matrices with which the physicist is now concerned are, like determinants, square arrays of symbols, but, unlike the determinants, the matrix is not multiplied out. Instead, each symbol or term is regarded as a constituent member of the whole matrix. Thus, if we say that two matrixes are equal, we mean that each term of the first is equal to the corresponding term of the second. Matrices can be handled by a set of algebraic rules rather like the rules of the algebra of ordinary numbers. Many results go over into the new calculus unaffected, but there is one striking difference. The law of multiplication, which, loosely speaking, is that by which two determinants are multiplied together, is non-commutative—when matrix x is multiplied by matrix y the result, xy, is a matrix of which the terms are *not* the same as those of yx. The difference between these products provides exactly the necessary gap in the algebra into which the quantum theory can insert itself.

The question then arises, can one formulate a dynamics of matrices which is a natural generalisation of classical dynamics with classical dynamics as its limit, and yields rules for calculating the terms of any relevant matrix just like the classical rules for calculating any term of a Fourier series? Something, of course, must be given besides the laws of dynamics—that something is classically the potential energy function of the system, giving the field of force in which the particles of the system move, and we may demand that the same data shall suffice in the new form. This is equivalent to asking that everything shall be derived by direct unambiguous calculation from the Hamiltonian equation of the system, using generalisations of the classical laws. The quantum conditions of the older theory disappear and the essential h now enters the equations via the new non-commutative multiplication of conjugate canonical variables p and q, in the form

$$pq - qp = \frac{h}{2\pi i} \quad (i = \sqrt{-1}).$$

The answer to the opening question of the paragraph is, yes! Everything seems to work out as it should, as the work of Heisenberg, Born, Jordan, Dirac, and Pauli has abundantly shown.

The need for the matrix mechanics can nowadays perhaps be put forward as convincingly as possible in the manner adopted above, which shows that its constructs have direct physical counterparts. Every term in a matrix represents something ideally observable. Heisenberg was originally led to formulate the matrix mechanics by a deliberate development of a demand for ideal

observability of the counterpart of every construct, a demand which we have just seen to be satisfied by the matrix mechanics. He pointed out that the selected mechanical orbits of the older theory cannot satisfy this demand, because they cannot even ideally be directly presented to us for measurement. On the other hand, the frequencies and intensities of the light emitted, scattered, or absorbed by an atom, are observable in just this way. The older theory tried with partial success to derive the observed frequencies and amplitudes from the abstract theoretical ones. Heisenberg's new method was to do away entirely with every theoretical construct which could not be directly related to an observable property of the atom. Perhaps the distinction set up cannot always be rigidly maintained. It served at least to suggest to Heisenberg that we should stop trying to *interpret the results* of classical calculations and instead should *re-formulate the equations* of the motion, and re-formulate in such a way that every symbol has a physical meaning, just as in an astronomical problem in the classical mechanics. Physical meaning is no longer to be confined to interpretations of the final result. Since the matrix is the mathematical construct with the properties of any natural atomic co-ordinate, Heisenberg's idea led at once to the formulation of the matrix mechanics.

An entirely different point of view has been developed by Schrödinger. Following up the speculations of L. de Broglie, in which he drew an illuminating analogy between the free motion of particles such as electrons and groups of plane waves of a special type, Schrödinger came to examine more closely than before the analogy between mechanics and optics which formed in fact the basis of Hamilton's whole treatment of mechanics. The analogy due to Hamilton is that between the dynamics of particles and geometrical optics, let us say between the paths of particles and of light *rays*. We all know, however, that the propagation of light can only be adequately discussed by the optics of rays so long as the wave length of the light is very small compared with the dimensions of every obstacle encountered. Once this condition is broken diffraction effects occur, and we need the *wave* theory of physical optics with which to describe the phenomena. To this breakdown of the *ray* theory of light there has been hitherto no Hamiltonian analogy. In setting out to find such an analogy Schrödinger has formulated what we now call the wave mechanics. We shall not attempt here to describe his arguments but only the results. Instead of thinking of an atom as a set of particles, we retain from the particle picture only the potential energy V, and the masses of the particles, m. The atomic motion can be derived from a wave equation of the usual type

$$\text{Div. grad. } \psi + \frac{4\pi^2\nu^2}{u^2}\psi = 0.$$

In this equation u is the phase-velocity of waves of frequency ν, and ψ and its operators must probably be taken to refer to the configuration-space of the whole system, of dimensions equal to the number of freedoms. The Hamiltonian analogy demands, moreover, that u, E, the energy, and ν shall be connected by the relations

$$\nu = \frac{E}{h}, \quad \frac{1}{u^2} = \frac{2(E-V)}{E^2}.$$

A universal constant of action h enters naturally into the analogy; that it has exactly Planck's value is of course only fixed at a later stage. The resulting partial differential equation,

$$\text{Div. grad. } \psi + \frac{8\pi^2}{h^2}(E-V)\psi = 0, \quad . \quad . \quad (1)$$

must be conformed to by all wave forms which correspond to states of the atomic system with energy E. The wave function ψ must naturally be subjected to continuity and boundary conditions. To represent a possible stable state of the atom it is natural to suppose that ψ must satisfy (1) and besides be one-valued, bounded, twice differentiable over the whole configuration-space, and vanish at infinity. So far there has been no mention of discrete states. Any value of E would be admissible for which a suitable ψ exists. But we come now to the most beautiful point of Schrödinger's theory, for it appears in general that suitable ψ's only exist for a set of discrete values E_n of E, perhaps together with continuous ranges of values as well. The E_n are the energies of the various stationary states and the corresponding ψ_n the wave functions of these stationary states which specify what the atom is then doing.

For the simplest example let us take the linear harmonic oscillator. The wave equation then becomes

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - 2\pi^2\nu_o^2 x^2)\psi = 0,$$

where ν_o would be the classical frequency of the oscillator. The smallest value of E for which a satisfactory ψ exists is $E_o = \frac{1}{2}h\nu_o$, and then

$$\psi_o = e^{-2\pi^2 m\nu_o x^2/h}.$$

We observe that ψ_o never vanishes, so that the corresponding wave is of infinite length and has no finite nodes. The next solution is $E_1 = \frac{3}{2}h\nu_o$, and then

$$\psi_o = 4\pi\left(\frac{m\nu_o}{h}\right)^{\frac{1}{2}} x e^{-2\pi^2 m\nu_o x^2/h}.$$

The wave has now one finite node at $x = 0$. The following values of E are $E_n = (n + \frac{1}{2})h\nu_o$, and the corresponding ψ_n have each one more finite node, so that the wave-length of the atomic oscillation gets shorter as n increases, and tends to zero as n tends to infinity.

For the earlier values of the set E_n it is impossible to speak of orbits and point electrons. For the later values the behaviour of the simple example above is general. The wave mechanics then degenerates, so that from a group of waves of various frequencies and directions we can build up a small bundle of waves, in phase only in the immediate neighbourhood of one point. This point of coincidence in phase will move with the group-velocity of the group of waves, and actually in the limit propagates itself along an orbit obeying the

laws of classical mechanics. In this limit orbits and point electrons again have a meaning.

Two constructs more different in conception than the matrix mechanics and the wave mechanics can scarcely be imagined, except that they are both generalisations of classical mechanics, retaining classical mechanics as a common limit. Schrödinger has suggested a physical analogy which perhaps shows their connexion. Suppose we have a stretched string of variable density. Then the wave mechanics finds the various ways in which the string can vibrate, and determines, *inter alia*, the nodes of the possible vibrations. These nodes are what we want, and the matrix mechanics is a calculus which determines them directly. It is perhaps not surprising that the ignoration of the rest of the string should lead to an unfamiliar procedure. Both schemes appear to make just those changes in the energy values of the stationary states which the facts were known to require. But the connexion between them is very deep and amounts almost, if not quite, to complete equivalence. To illustrate the connexion we must temporarily become technical. The change made in the wave mechanics is equivalent to deriving from the ordinary Hamiltonian equation of the system

$$H(q, p) - E = 0,$$

where (p, q) are canonical variables, the wave equation

$$\left[H\left(q, \frac{h}{2\pi i}\frac{\partial}{\partial q}\right) - E\right]\psi = 0 \quad . \quad . \quad (2)$$

for the wave function ψ, instead of deriving the Hamilton-Jacobi equation

$$H\left(q, \frac{\partial S}{\partial q}\right) - E = 0$$

for the 'principal function' S. Equations (1) and (2) are different versions of the same equation. The p thus become differential operators. The close connexion between the operator algebra required in the wave mechanics and the matrix algebra of the matrix mechanics can be seen by a simple example. The commutative rule of the matrix mechanics already given becomes in the operator calculus, with $\frac{h}{2\pi i}\frac{\partial}{\partial q}$ for p,

$$\frac{\partial}{\partial q}(q\psi) - q\frac{\partial \psi}{\partial q} = \psi,$$

which is obviously satisfied. This example may perhaps remove the element of surprise at finding that Schrödinger has shown how to derive from the complete set of wave functions ψ_n for any atom a definite corresponding set of matrices which solve the problem of the same atom in the matrix mechanics. Whether the converse is true and the equivalence complete is less certain. At the moment it seems that matrix solutions may be possible which are not represented in the wave mechanics. The case in doubt is the rigid symmetrical top, for which in the matrix mechanics solutions appear to be possible both with whole and half quantum numbers, while only the former are allowable in the wave mechanics.[1]

It is probably futile at this stage to attempt to decide which of the new forms is the more fundamental. It will of course be found by the majority of workers that the wave mechanics, owing to the greater familiarity and convenience of its algebra, is the more powerful tool for solving any particular problem.

Let us now take a last glance at what the new mechanics in either form has done for us. In every case yet worked out completely, it has given us just exactly those changes of quantum numbers from the older theory, which had been forced on us already by the facts. Thus with the spinning electron the general theory of spectra is now an orderly whole. Weights, magnetic displacements, structure rules and intensity rules for multiplets and the complete form of the spectrum of the hydrogen atom are now at last correctly predicted by the theory. (It must be recorded that this requires us to assume that the spinning electron can be likened to a top with half quantum numbers. This assumption may require a trivial alteration of the wave mechanics in view of the wave theory of the top.) But the wave mechanics has done more than this. It has already led us successfully to the attack of problems in which the results of the older theory could not be described as qualitatively correct. Such problems are, for example, the calculation of the exact values of the higher terms of the spectrum of neutral helium and the calculation of the terms of the positive molecular ion of hydrogen. Of the latter it is too early to speak with certainty. The successful calculation of the higher terms of ortho- and par-helium by Heisenberg marks outstanding progress. In the course of this work he has been led to study with success the phenomena of resonance between similar atoms or between the necessarily similar electrons in one atom. These phenomena promise to be of outstanding importance in the further development of the theory, and have already thrown much light on Pauli's important empiral principle that no two electrons in an atom can have the same quantum numbers, and on the problems of statistical mechanics. Nor is this all. A successful attack has at last been opened on the quantum theory of collisions and on non-periodic orbits, largely by Born and Oppenheimer.

However abstract the new mechanics may yet seem to us, however incomplete our grasp of its fundamental principles, it is impossible to overestimate its value to theoretical physics. We have, at least in the simpler problems, ceased to grope, and fudge our results until they are useable. We have at last a general dynamical method to apply to any atom, which is capable of yielding us by direct calculation any result for which we may ask. We cannot yet expect all such results to be right, but we are confident that only minor modifications and generalisations will be required.

[1] For the matrix form, Dennison, *Phys. Rev.*, **28**, 318 (1926); the wave form, Reiche, *Zeit. f. Phys.*, **39**, 444 (1926). An interesting survey of wave mechanics is given by L. de Broglie, *J. de Phys. et le Radium*, **7**, 321 (1926). I have not attempted to enumerate the primary references, which will be familiar to students of the quantum theory.

The Principles of Biological Control in Economic Entomology.[1]

By Dr. R. J. TILLYARD, F.R.S., Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

II.

THE CONTROL OF INJURIOUS WEEDS.

WE turn now to the second problem, in which the introduced plant, not the insect, is the enemy of man. We have to decide the question whether it is advisable to undertake researches on the lines of introducing insects which will feed upon and tend to check the growth of those plants which, in new lands like Australia and New Zealand, have got beyond the control of man and threaten to swallow up large areas of valuable land.

I think the first point, undoubtedly, must be to insist that the method should only be used where a solution cannot be attained in any other direction. All are agreed that the unrestricted importation of plant-feeding insects into a new country is highly undesirable. The problem awaiting solution must be sufficiently grave in its nature to warrant the attempt being made with adequate safeguards, and under the guidance of the most competent experts obtainable.

We can turn again to the Hawaiian Islands for the pioneer experiments in this direction and learn very valuable lessons from them. The first attempt at biological control of a weed was that made in Hawaii on Lantana. This weed was attacked by the introduction of a considerable number of its natural insect enemies from Mexico. The result has been that it is prevented from seeding and has been successfully restrained from spreading all over the islands. Most fortunately for the experiment, none of the introduced insects has proved detrimental to crops or other cultivated plants, with the single exception of one species which occasionally does slight damage to the egg-plant or Aubergine. Considering the absence of the safeguards which I have elsewhere laid down as indispensable in these experiments, the result must be considered a lucky one rather than a strict precedent to follow.

Further experiments are now being carried out in Hawaii on the control of nut-grass by introduction of certain insect enemies from the Philippines, and also on the control of the Mexican weed 'Pamakani.' These are being carried out with good safeguards, and the results will be awaited with much interest.

I now come to the most remarkable attempt so far made in the direction of control of a noxious weed by insects, namely, the prickly pear campaign in Queensland and New South Wales. The prickly pear, *Opuntia inermis*, was introduced into eastern Australia long ago as a botanical curiosity, and was even propagated and distributed in pots to visiting squatter's wives. When these ladies tired of it as a pot plant it was thrown out. But instead of dying, as an ordinary plant would do, it proceeded to take root and multiply exceedingly. The luscious fruit were fed on by many species of birds, and the ripe seeds were carried far and wide in their droppings. This went on until about thirty million acres of land had been put out of cultivation by the pest, and the rate of increase was about one million acres per annum.

Then at last the long-suffering Australian populace raised its voice and demanded that something should be done. A Prickly Pear Board was set up, and the first attempts to control the pest were carried out along chemical lines, resulting in the discovery of certain poisonous gases which could be liberated over the infected areas, destroying the weed. This method, however, failed, as the cost of manufacture and application of the remedy proved far too high. Failure also resulted from all attempts to utilise the pest commercially; the water content was found to be exceptionally high, the quality of the fibre very poor, and the fodder value very low. Thus the vision arose of eastern Australia becoming in about a hundred years time a vast desert of prickly pear, with a few walled cities alone holding out against it. Then the demand for a remedy became so insistent that the natural prejudice against the introduction of insect enemies was at last overcome, and an organised attempt was made to deal with the pest in this manner. Prof. T. Harvey Johnston took charge of the work, which was later on further advanced under the charge of his original assistant, Mr. W. B. Alexander. These men travelled far and wide in the warmer parts of America to find insect enemies of the pest, and large consignments were shipped to Australia. They were then placed in special insectaries and tested out on all varieties of prickly pear and also on a large number of important economic plants.

It is interesting to note, as showing the high degree of specialisation attained by cactus-feeding insects, that not one of the many species introduced could be induced to feed on any other kind of plant; indeed, a number of the species would only eat a single variety of Opuntia and would not even change to a closely allied and botanically scarcely distinguishable species. A few larvæ, faced by the 'starvation test,' made slight attempts to eat unaccustomed plants, but the result in each case was severe indigestion followed by death.

The first Opuntia-feeding insect experimented with was the cochineal insect, *Dactylopius indicus*. It entirely destroyed some thousands of acres of one species of prickly pear, *Opuntia monacantha*, but was quite unable to feed upon the allied pest pear, *Opuntia inermis*. A search was therefore made for other species of Dactylopius, and finally *Dactylopius tomentosus* was found capable of attacking *O. inermis*. This little insect is now being distributed in enormous quantities through the infested districts, and is doing wonderful work in helping to destroy the pest. Though it does not do equally well in all districts and under all the varying conditions, yet it is now generally admitted that this species will prove one of the chief factors in the control of the pest.

[1] Continued from p. 205.

Of many other species studied, the most promising appear to be the large coreid bug *Chelinidea tabulata*, the moth *Cactoblastis cactorum*, and perhaps the large longicorn beetles of the genus Moneilema. Large supplies of these insects are being reared in the insectaries, and it will be interesting to watch the progress of events when they are liberated.

It is of special importance to note that, in spite of the immensity of the insect fauna of eastern Australia, only one enemy has so far made its appearance in the field, namely, our old friend *Cryptolæmus montrouzieri*, the well-known enemy of mealy-bug. This lady-bird beetle has begun to attack *Dactylopius tomentosus*, but, so far, it has been found that the latter can more than hold its own, as it starts earlier and increases more quickly than its rival.

To sum up, it appears to be the general opinion in Australia that this formidable problem is in process of solution by means of the biological control gained by insect enemies over the pest.

This brings me logically to the consideration of the problems of weed-control which brought me to Europe. The most pressing of these for New Zealand, and to a considerable extent for Australia also, is the control of blackberry, *Rubus fruticosus*. The extent of the infestation in New Zealand may be judged by the saying current on the west coast of the South Island that they have only one blackberry bush, and that is 200 miles long. Certain areas in the North Island are almost as badly infested also. Not only does this terrible weed, originally introduced for its luscious fruit, spread vegetatively underground, so that each little plant soon grows into a great thicket, but the introduced European birds, especially the blackbird, feed ravenously on the fruit and so carry the seeds far and wide in their droppings. Nobody who has not seen this pest under the conditions prevailing in New Zealand to-day can really understand the menace that it offers to our civilisation. It seems simple to advocate 'closer settlement' and 'more careful cultivation' as the best methods of control; but when the extent and inaccessibility of the vast mountain fastnesses captured by the blackberry, from which with ever-increasing vigour it is spread far and wide over the richer lands, are realised, it will be understood that the hard-working men who are being driven off their farms after years of toil against this weed demand something more than this kind of advice.

The general insistence on something being done has led the Cawthron Institute to consider the taking up of this admittedly difficult problem on the lines of biological control. The chief difficulty is the central position occupied by the genus Rubus in the great natural order Rosaceæ, to which most of our finest economic plants belong. Thus the risk of damage to other valuable plants is appreciably higher than in the case of prickly pear or Lantana, and the safeguards imposed against the chance of such injury must be made correspondingly more severe. We will not even consider the introduction of any insect which is known to feed on plants other than Rubus, and we require very severe testing of these on a long series of native and introduced plants before we can consider their liberation.

Another bad weed which has taken possession of a very large area of ground in New Zealand and parts of Australia is gorse or furze, *Ulex europæus*. It is, however, a useful hedge plant, and, when young, provides good fodder for sheep; also, being leguminous, it improves the soil by the formation of nitrogen nodules. The problem of controlling gorse is therefore one of preventing it seeding, as it is the bursting of the seed-pods which is the main method of spread of this weed. This problem, I am glad to say, appears to have a fairly simple solution, for there are in England two or three insects which live wholly within the seed-pods of gorse and broom, and thus prevent them seeding without doing further injury to the plant.

Ragwort, *Senecio jacobæa*, is a poisonous plant which is becoming exceedingly abundant in New Zealand. When this plant is eaten by horses or cattle, cirrhosis of the liver results, ending in death, and no remedy is known for it. The control of ragwort by its insect enemies appears to be a feasible proposition, and is being undertaken by the Cawthron Institute at the present time.

St. John's wort, *Hypericum perforatum*, would scarcely appear likely to people in England to become a weed of importance. Yet it has so increased in size and vigour in parts of Victoria as to become a very serious menace, and the careful study of the possibility of controlling it by insects is one of the tasks which I have undertaken during my visit to England.

In conclusion, I would like to emphasise again the Imperial point of view in these researches. There are a large number of weeds introduced into various parts of the British Empire which we tolerate without having much idea of how far they rob us of the products of our labour. It has been calculated on a conservative basis that 10 per cent. of the world's crops are lost annually through the depredations of insects. I would like to ask whether anybody has attempted to make an estimate of what percentage of the Empire's crops are lost annually through the encroachments of noxious weeds? Think of the thirty million acres in Australia put entirely out of action by prickly pear, and the huge areas of cultivable land in New Zealand now 'going under' to blackberry and bracken-fern. Moreover, can we say that any weed, tolerated to-day as of no importance, may not in a few years time become a menace as great as the apparently harmless St. John's wort?

I declare emphatically that the menace is a most serious one in many parts of the Empire, and that we run the serious risk of being judged a race unfit to occupy these great areas, to the exclusion of other races, if we are going to allow them to 'go under' in the grip of introduced noxious weeds. The position demands the most careful consideration from those in responsible positions. Nothing less than an Empire-wide campaign will, in my opinion, suffice.

The Telephone.

IN June last, Sir Oliver Lodge read a paper on the history and development of the telephone to the Institution of Electrical Engineers.[1] The occasion was the jubilee of the invention of the telephone by Graham Bell. The lecturer remembered Graham Bell speaking to the Physical Society of London in 1877. He was impressed by his clear and precise articulation. Graham Bell had devoted himself to the accurate production of human speech not only by his own lips and larynx but also by instrumental means. It is reported that he once said that it was fortunate that he was not a scientifically trained physicist; for if he had been, he would probably have thought that an articulating machine of a simple character was an impossibility. Talking machines had been invented before, but they were very complicated arrangements for producing vowel sounds. In this respect they were unlike the apparatus devised so successfully in our own day by Sir Richard Paget.

Graham Bell's machine took the sounds emanating from the human voice and sought to reproduce them at a distance by electrical methods. The way in which he found that this could be accomplished was surprisingly simple, and on Mar. 10, 1876, the first telephone worked successfully. Sir Oliver recalls how Kelvin showed two of Bell's early instruments at the British Association meeting in Glasgow, and how enthusiastic he was over the marvellous discovery. In these early days the same instrument could be used as a transmitter or a receiver. All the energy put into the circuit, therefore, came from the voice. Very soon, however, the Edison carbon and the Hughes microphone transmitter were invented, batteries were introduced, and the transmission was greatly improved.

When Clerk Maxwell first heard of the telephone, he pictured it in his mind as some instrument of marvellous ingenuity and constructive skill, as much excelling the siphon recorder as the recorder excelled an electric bell. When it first came over he has described his disappointment at its humble appearance, a disappointment only partly relieved by finding that it was able to talk. In this connexion Sir Richard Paget relates how, when Kelvin was staying with Lord Winchelsea, notice arrived that a talking machine, sent by Graham Bell, was coming. Lord Winchelsea dispatched a farm wagon to the station to collect it.

In 1888, Heaviside emphasised the similarity between Lodge's observations on electric waves in wires and Hertz's discovery of waves in free space. They both measured wave-lengths by reflecting them and converting them into stationary waves. Sparks were first used as detectors, but they were given up in 1890 in favour of the coherer principle, which was independently rediscovered and improved by Branly, who used iron filings and smeared metallic filings. This method was used in the earliest radio experiments. The discovery of the rectifying power of crystals and thermionic valves in the early years of the present century enormously improved the power to transmit speech and music, and improvements are still continually being made.

Wired and wireless telephony are constantly tending to approximate to one another. It is well known that by the use of accurate tuning and syntonised circuits it is possible to select from the multitude of disturbances in the ether only those of a given frequency. In practice, each sending station sends out carrier waves of definite wave-lengths, the voice modifying slightly the shape of these waves. This principle, so extensively used in broadcasting work, can be used for transmitting many telephone messages simultaneously by the same wire. Graham Bell also attempted to use this system in his harmonic telegraph.

In the transmitter and receiver we make use of Faraday's discovery—now nearly a century old—of the induction of currents by moving magnets. The transmitter may be regarded as a kind of dynamo and the receiver as a kind of motor. The transmission takes place by alternating currents flowing round the circuit. Owing to resistance, much of the electric energy is converted into heat. This leads to attenuation of the signals. The circuit also possesses capacity, and this Kelvin took theoretically into account. Heaviside next completed the practical theory by taking the inductance into account, and this led to the discovery of the distortionless circuit. Finally, Pupin persuaded American business men to construct 'loaded cables' and long-distance telephony was born.

Fleming's invention of the valve detector, further improved by Lee de Forest, has put into our hands an automatic relay of surpassing docility. Long-line transmission can be attained by a succession of short lengths of land line connected together by valve relays. The currents from the sending stations can now be sent great distances before they are relayed on with fresh energy. The American Telephone and Telegraph Company has in this way effected admirable speech transmission across the American continent.

In radio communication there is little attenuation and distortion. In free space there would be none. The theory of wave transmission in free space is extremely simple. It is only when matter is present that complications are introduced. It is true that there are many things which still seem mysterious to us, but there seems to be nothing that will ultimately be wholly unintelligible. We have bridged the Atlantic with radio telephony and can look forward to the time when sounds will veritably go out unto all lands and be heard by all who care to listen to them. "The progress of science is based upon faith in the ultimate intelligibility of everything: and so far wisdom has been justified of her children."

[1] "The History and Development of the Telephone," *Jour. Inst. of Elect. Engin.*, vol. 64, p. 1098.

Obituary.

SIR ALFRED SEALE HASLAM.

BY the sudden death of Sir Alfred Haslam on Jan. 13 at the age of eighty-three years, Great Britain loses one of its principal pioneers in the development of the practice of refrigeration. More than any country, Great Britain depends on its overseas food supply, and the maintenance of that supply is only possible to-day through the application of artificial cold. Sir Alfred Haslam was one of the first British engineers to manufacture refrigerating machines, and the success of his work was recognised so long ago as 1888, when he received the freedom of the City of London for "services rendered to commerce."

The production of cold by artificial means can be traced back to Cullen and Leslie, and an important step was taken by Dr. Gorrie of New Orleans, who about 1845 caused compressed and cooled air to expand, working a piston in a cylinder. Other experimenters about that time used either ether or sulphur dioxide; but little progress was made until the mechanical theory of heat had been developed. The earliest attempt to preserve a cargo of meat by ice was made in 1860, but proved a failure. In 1876 the French worker Charles Tellier directed the fitting-out of the *Le Frigorique* with refrigerating apparatus for running between France and Buenos Ayres. Other workers in the field were Linde, John and Henry Bell, and James Coleman, who in 1877 produced a cold-air machine and with this brought home a cargo of meat from Australia.

It was about this time Sir Alfred Haslam took up the matter, and his great improvement was the invention of a dryer through which the air passed after compression and cooling, but prior to expansion. This successfully solved the problem of the prevention of the formation of snow. He bought up the Bell-Coleman patents, and one of the first Haslam machines was fitted in the R.M.S. *Orient* in 1881. By 1889 some 350 Haslam machines were at work ashore or afloat. In the development of the carbon dioxide and ammonia machines he also took a leading part. There are many types of refrigerators now in use, but the growth of the cold-storage industry has been remarkable, while in 1925 no fewer than 340 ships with a total insulated space of 70,000,000 cubic feet possessed Lloyds' refrigerating machinery certificate. Refrigerating machinery is also used largely in warships for maintaining explosives at a moderate temperature.

Sir Alfred Haslam came of a family long connected with the iron trade of Derby, and the Haslam Engineering Works there grew out of a small iron works belonging to his father. His knighthood was bestowed upon him in 1891 when Queen Victoria visited Derby.

DR. L. P. MANOUVRIER.

IN the *Times* of Jan. 20 appeared a brief announcement of the death of Dr. Leonce Pierre Manouvrier, of Paris, at the age of seventy-seven years. This is a loss to French anthropology which, notwithstanding his advanced age, will be deeply deplored. Manouvrier was Director of the laboratory at the Collège de France of the School of Advanced Studies (Anthropology) and professor of the School of Anthropology. He was secretary-general of the Society of Anthropology of Paris, which he joined in 1889, following Ch. Letourneau as secretary on the death of the latter in 1902. Latterly, Prof. Anthony has been associated with him as *Secrétaire adjoint*. Although Manouvrier never attained the commanding position of his great predecessors in office at the Society—Broca and Topinard—he had long been regarded as one of the foremost of French anthropologists. As a teacher of the School he was pre-eminent. His published work was characterised by its accurate and minute attention to detail, as was shown particularly in his many contributions to the *Bulletin* of the Society of Anthropology. He rarely failed to take part in the meetings of the Society, and his contributions to the discussions were marked by clarity and precision. He was an honorary fellow of the Royal Anthropological Institute of Great Britain, and an honorary or corresponding member of most of the important anthropological societies on the Continent.

BY the death of Frederick Gordon Pearcey at Newport, Mon., on Jan. 26, at the age of seventy years, there passed away the last survivor of the scientific staff of the *Challenger* Expedition. Mr. Pearcey was attached to the biological laboratory of the *Challenger* in 1872 as taxidermist and general assistant, and on the completion of the voyage he assisted Sir Wyville Thomson and Sir John Murray in the *Challenger* Office at Edinburgh, acquiring great skill in identifying species, especially of Foraminifera, on which he wrote several papers. He devised methods for cutting microscopical sections of marine deposits, and became proficient in all branches of practical oceanography and museum arrangement. His alert intelligence and obliging disposition made him a favourite with all contributors to the *Challenger* memoirs. When the last of the *Reports* was published he worked for a time at the Marine Biological Station at Granton and at Millport on the Clyde. In 1889 he went to the Owens College Museum in Manchester. Nine years later he joined the staff of the Scottish Fishery Board, but in 1905 he returned to museum work, going to the Bristol Museum as assistant curator of zoology; there he remained until his retirement after the breakdown of his health last year.

WE regret to announce the following deaths:

Mr. J. J. Lister, F.R.S., distinguished for his work on the Foraminifera and author of the article on Mycetozoa in the eleventh edition of the "Encyclopædia Britannica," on Feb. 5, aged sixty-nine years.

Prof. Thorkild Rovsing, professor of clinical surgery and sometime Rector Magnificus of the University of Copenhagen, on Jan. 13, aged sixty-two years.

News and Views.

THE retirement on Mar. 9, under the age clause, of Sir Sidney Harmer from the directorship of the Natural History Museum, South Kensington, will remove from active professional life one who has been for forty years conspicuous for his researches in zoology and influence upon this branch of science. Fellow of University College, London (1884), and later fellow, lecturer, and tutor of King's College, Cambridge, he made the latter his home until in 1908 he came to London as keeper in zoology at the Natural History Museum, afterwards becoming director in 1919. Trained under F. M. Balfour, his first researches were directed to the elucidation of the anatomy, embryology, and position of the Polyzoa; later, his interest shifted to the natural history, evolution, and classification of the group. With Sir Arthur Shipley he edited the "Cambridge Natural History," 1896–1909, which owing to his painstaking care is recognised as giving a complete epitome of the facts of zoology at the dates of publication. He was president of Section D of the British Association in 1908, choosing the Polyzoa as his subject—suggesting that there may be segregation in the formation of a bud analogous to the segregation of characters in the formation of gametes. In recent years his interest turned to the whales, and this was the underlying force in sending out the *Discovery* expedition to South Georgia to investigate these forms. It says much for his enthusiasm and determination that he induced the British Government, in a time of great financial stress, to send out this the greatest British expedition since the *Challenger*, the results of which will be the monument to him as director of the Natural History Museum.

SIR SIDNEY HARMER'S directorship has not been marked by any great changes in the main fabric of the exhibition building or in the arrangements of the exhibits of the Natural History Museum. A new wing to the Museum was projected and actually agreed to before the War, but this has never been proceeded with. It is true that a new spirit building has been erected, and most of the staff dealing with water-living animals has removed there. The space thus vacated in the basement was assigned to entomology; space intended solely for store purposes, but used also as research rooms by the staff. It is not too much to say that the congestion here is appalling, especially as housing has had to be found for the Imperial Bureau of Entomology. The best results, too, are not to be obtained by setting sedentary workers in relatively dark basements. Of new material, the large collection of deposits of the late Sir John Murray is housed in a temporary building in the grounds, and the exhibition of the Cetacea cannot be deemed satisfactory. The present condition of the Natural History Museum reflects the highest credit on the members of the whole staff, but there is no possibility of overlooking the fact that progress on all sides is being seriously impeded by the lack of storage and working space. If storage space is provided, it will be possible so to rearrange and reduce the exhibits as the better to expose their beauty and scientific importance, thus adding to the attractiveness of the Museum to the public.

THE Commonwealth Council for Scientific and Industrial Research held its second session last November and made a number of important decisions regarding future policy. Prof. A. C. D. Rivett, a member of the executive committee, will devote his full time to the work of the Council during 1927, as its chief executive officer, having been granted leave of absence for this purpose by the University of Melbourne. Mr. Gerald Lightfoot is to be secretary to the Council. In connexion with work on fruit storage and transport, Dr. Kidd, of the Cambridge Low Temperature Research Station, will visit Australia during the first half of this year in order to survey the position and suggest a comprehensive scheme of work. Dr. W. J. Young, associate professor of biochemistry at Melbourne, will meet Dr. Kidd at Cape Town and with him study existing practice there before proceeding with the investigation of Australian conditions. It is hoped that Dr. Young will take charge permanently of later developments in Australia. Prof. T. Brailsford Robertson, of the University of Adelaide, has been invited to take the position of officer in charge of investigations into problems of the nutrition of stock. He will probably continue his present fundamental researches at Adelaide while organising and developing national investigations prompted by the needs of the wool, meat, and dairying industries.

INQUIRIES are being made throughout the British Empire by the Commonwealth Council for an entomologist and a mycologist to initiate and steadily develop organisations for research work upon the numerous insect and fungus pests that annually levy great toll on primary industry. A considerable scheme for attacking the diverse problems of the irrigation settlements in the Murray and Murrumbidgee river areas is being put into operation with the hearty co-operation of the departments of the State Governments concerned. Prof. Prescott, of the Waite Agricultural Research Institute, is to be asked to supervise and co-ordinate all soil survey work. The solution of certain problems in these irrigation areas is of importance in relation to possible increased settlement by migration from Britain. Forestry matters are also receiving attention, and it is expected that a prominent officer from the Indian Forestry Service will visit Australia early this year to report upon the establishment of a forest products research laboratory.

IN these and other actions the Commonwealth Council is following the definite plan of seeking competent full-time officers to take charge of a number of departments of investigation. Committees will no doubt be formed to assist so far as possible in the work, but the system of relying on such com-

mittees to supervise extensive researches, the details of which are carried out by officers acting under their instructions, has been abandoned. It is hoped that the Council will very soon possess a highly trained senior staff and be able to proceed with intensive study of the seemingly innumerable problems which beset Australian industries. For the time being, attention will be directed mainly to primary industries, though decisions to proceed with radio research work and with the provision and maintenance of ultimate physical standards, in close co-operation with the physics departments of the universities and the Defence Department, indicate that advance in other directions will not be long delayed. Throughout its programme the Council aims at the closest possible association with the Department of Scientific and Industrial Research in London, from the officers of which it is receiving very valuable assistance and advice.

THE Friday evening discourse on Feb. 4 at the Royal Institution was delivered by Sir Arthur Keith, on "Human Races, Old and New." Five well-marked types or stocks are recognised among the living representatives of mankind: the white or Caucasian type, the Mongolian peoples—between them making up fully seven-tenths of the total population of the world—the black or Negro type, the brown or Dravidian race south of the Himalayas, and the Australoid. However numerous or extensive human migrations may have been in long-past times, they have left the great breeding grounds of the primary races of mankind untouched. How are we to account for the fact that each part of the world is populated by a distinctive breed of mankind? There is only one theory which offers an explanation, and that is the one put forward by Darwin. He held that the most favourable sites for the evolution of new forms were the centres of wide continental spaces. All that we know of the past and present distribution of human races favours this theory. If we accept such an explanation we must regard the Negro, the Chinaman, and the European as the most recent expression of their respective types. Each we may regard as the type of being best adapted for the country and culture in which it has been evolved. On each side of the racial frontiers of the world we find intermediate types.

THERE has been, beyond any doubt, much intermarriage and intermingling across racial frontiers, but such an explanation, although accepted by the majority of anthropologists, does not, in Sir Arthur Keith's opinion, account for the gradual transition which we usually find in passing from the centre of one racial area to the centre of another. Those who seek to explain the existence of intermediate types by interbreeding of primary forms forget that the first duty of an anthropologist is to account for the primary forms—the Nord, the Negro, the Mongol, or the Caucasian. If evolution is true, and Negro and Caucasian are the descendants of a common ancestor, then we ought to find, just as we do find, a series of intermediate types joining the centres where the new types have been cradled; the extreme and most fully differentiated types represent the older and less-changed forms. Politicians and anthropologists differ altogether in their conceptions as to what constitutes a separate race. The politician concentrates his attention on tradition, language, and spirit; a race, to claim the title in an anthropological sense, must have characteristics which mark it off from all other peoples. In this sense the races of western Europe are very imperfectly separable—not because of the interminglings which have occurred, but because they are branches of the same stock, and time and space have been insufficient to permit more than a partial differentiation.

ON Tuesday, Feb. 1, the second lecture of the series being given at Bedford College for Women, London, was delivered by Sir Thomas Heath, who dealt with "Conceptions of the Cosmos in the Classical Period." Sir Thomas reviewed in detail the speculations of the early Greek philosophers. Thales showed little advance upon the popular cosmology derived from Egypt and Babylon; but original thought began with Anaximander (early sixth century B.C.), who held that the earth was a cylinder suspended in equilibrium in the centre of the universe, and explained the light of the heavenly bodies by hollow rings or hoops encircling it, containing fire visible only at one point. He said there were other worlds than ours, and also propounded a primitive theory of evolution. Anaxagoras strikingly anticipated Laplace when he traced the origin of the cosmos to a rotatory movement imposed by mind upon primal chaos and postulated centrifugal as well as centripetal force. While the geocentric conception tended to prevail, and was adopted both by Plato and by Aristotle (who worked out, under the influence of Eudoxus, an elaborate system of concentric spheres to explain the movements of the heavenly bodies), the Copernican theory was anticipated partly by the later Pythagoreans and by Heraclides of Pontus, and wholly by Aristarchus of Samos, who said that the earth revolves round the sun, while the sun and the fixed stars (whose sphere is of immense size) are unmoved. The method of Tycho Brahe was anticipated by Appolonius of Samos in his attempts to explain the movements of the planets. On the physical side, the atomic theory propounded by Leucippus and Democritus and adopted by the Epicureans was remarkably in accord with modern thought. Sir Thomas gave a masterly exposition of much of the detailed astronomical and mathematical work of these early thinkers, whose conclusions, often sounder than their methods, illustrate the saying of Aristotle that "not once nor twice, but times without number, the same thoughts occur to men."

ON Feb. 1 the University of Oxford was presented with the most valuable property that it has ever received. The Radcliffe Library, the great dome of which figures so prominently in the best-known of Oxford views; the freehold of the adjacent land on which it stands; the books in the Science Library at the University Museum, and an income of £1500

a year for the upkeep of that Library, were all conveyed by the Radcliffe Trustees as a gift and were gratefully accepted. The Radcliffe Library is a scientific institution of international importance, and so its future government, on which so much depends, is a matter for grave deliberation. Its success hitherto has been due to the strict observance of the Radcliffe Trust as defined by Dr. Radcliffe in his will, namely, the appointment of a librarian. For some unpublished reason neither the Trustees nor the Radcliffe electors have done anything to carry out their duty in this respect during the past three years that have elapsed since the death of the last eminent holder of the office, Dr. Jackson. During these three years the Library has lost many books by theft, the scientific world has been deprived of one of its most useful officials, and the Radcliffe Trust has not been carried out.

THE reason sometimes suggested for the inactivity of the Radcliffe Trustees is that this unique and admirably arranged scientific Library is to be reduced to the condition of an appanage of the Bodleian, a library that is primarily managed in the interests of literary and classical scholars, and the lack of accessibility of its books makes it unsuited to the every-day needs of the student of science. Moreover, scientific literature in the Bodleian is rarely quite up to date; a recent visit disclosed the fact that the 'current' number of NATURE was nearly two months old. Many have found it impossible to do scientific work in so lethargic an atmosphere, and all who are well acquainted with the condition obtaining in the two libraries fear that the substitution of Bodleian control for control by an independent scientific Radcliffe librarian will be a disaster rather than a gain to the cause both of academic and of international learning.

THE University of Oxford has every reason to be grateful to the generosity of the Evans family. During and after his keepership of the Ashmolean Museum (1884–1908) Sir A. J. Evans presented his Cretan collections as well as the magnificent series of Anglo-Saxon and Teutonic ornaments collected by his father, Sir John Evans, that have gone so far to elucidate the early history of Ægean and North European culture. His brother, Dr. Lewis Evans, has given those splendid examples of early scientific instruments which are now one of the established sights of Oxford in the Old Ashmolean Building, where they form the nucleus of a museum for illustrating the history of science. Now Sir Arthur has presented yet another of his father's collections, in illustration of the palæolithic, neolithic, bronze, and early iron ages not only in Britain but also in many parts of central, southern, and northern Europe, including a fine series of ancient British gold ornaments and of objects from the well-known cemetery of Hallstadt. A large number of the specimens have been figured in the classical works of Sir John Evans on the stone age, and with these are coming a number of Romano-British relics and some Egyptian antiquities of great variety. It is not easy to draw the line between civilisation and barbarism, but the united gifts of the Evans family now cover both sides of the line, and in a manner which can never be accomplished again.

THE Italian Government has voted the sum of two million lire for the purpose of resuming the excavation of Herculaneum according to the plan drawn up by Prof. Majuri of Naples and approved by Signor Mussolini and the Minister of Public Instruction. This sum will cover the initial expenses of beginning excavation in the coming spring, and further sums, it is said, will be forthcoming year by year as the work proceeds. The greatest obstacle in pursuing the excavation hitherto has been the fear that the villages of Resina and Portici, which overlie the site, would have to be expropriated and the inhabitants evicted. According to a well-informed writer in the *Italian Mail* of Jan. 29, this step is not now considered necessary. Excavations will be carried on at the south-east of the ruins at a point midway between Resina and Torre del Greco, use being made of the shafts left by former excavators to penetrate the city. As much as possible will be laid open, but those parts which cannot be opened up will be lit by electric light. Both what is known of the status of the inhabitants of Herculaneum at the time of its destruction, and previous finds of objects of art and manuscripts, make it difficult to overestimate the additions to our knowledge of Italian life and culture at the beginning of our era, and of classical literature which may follow, should the Italian Government carry out the excavations on the scale projected.

PREPARATIONS are now being made for an expedition of anthropological investigation among the tribes of the south Abyssinian frontier. The expedition is to be conducted by Mr. J. H. P. Driberg, the author of a valuable book on the Lango, and formerly an official in East Africa, who will go out under the auspices of the Royal Anthropological Institute. If the arrangements are sufficiently far advanced and the funds received towards the expenses justify, the expedition will leave England some time during the month of April. The object of the expedition will be to investigate the physical anthropology and social organisation of the Pagan Galla of southern Abyssinia, and of various nomad tribes in Abyssinia and Kenya. Tribes on the north-eastern frontier of Uganda and the south-eastern Sudan will be on the way to Abyssinia, and it is hoped that it may be possible to get into touch with the Turkana of Kenya, a very important group of people which is but little known. In addition to the ethnological investigations, zoological observations will be made and economic plants, as well as plants and drugs used by the natives for magical purposes, will be collected. Mr. Driberg will be accompanied by Dr. J. O. Beaven, who will be responsible for physical anthropology, pathology, and zoology as well as the bulk of the photographic work. If funds allow, the expedition will last for three years, about eighteen months of which will be spent in a preliminary investigation of the smaller tribes before going on to the main objective, the Galla.

The expedition has the support of the Royal Society and the British Association for the Advancement of Science, both of which bodies have made grants towards the expenses.

MR. GORDON HUME, in *Discovery* for February, directs attention to an anomalous conclusion, drawn from the results of an inspection of strata and their contents on an excavated site in King Street, Cheapside, which would appear to suggest caution in the chronological interpretation of archæological evidence in the City of London area. In a section measuring 4ft. 3 in. in depth were revealed eight archæological levels—seven well-marked, the eighth confused—between virgin soil (18 ft. below street level) and an upper stratum consisting of a series of deposits superimposed closely one upon another. Samian ware was found in varying frequency in levels 1, 2, 6, 7, and 8—in the last named merely a tiny fragment. The eight layers, on the usual reckoning for the city of London of one foot per century, would represent at least four hundred years; yet, as stated, throughout the series there occurs Samian ware which is usually attributed to the period A.D. 1 to 110, and no specimen of post-Trajanic pottery was found. It would therefore seem either that material accumulated on this site at a rate unheard of in the rest of London—it shows no signs of exceptional circumstances such as the existence of a rubbish heap—or else that, if the four feet of deposit does really represent four centuries, Samian pottery of the first-century type was used and manufactured in London so late as the fifth century. As all the London Samian ware belongs to the type of that of the King Street site, Mr. Hume finds himself left with the dilemma that either the accepted scheme of dating of Dragendorff and Déchelette requires reconsideration or that the rate of accumulation of soil in London represents problems yet to be solved.

THE subject of Prof. Eddington's third Gifford Lecture in the University of Edinburgh on Friday, Feb. 4, was "The Running-down of the World." It began with a consideration of the random element in the world, the study of which rests on the law of chance, a law on which the physicist, perhaps, places greater trust than on any other accepted law of Nature. The scientific measure of that random element in the world is called entropy. From the point of view of the philosophy of science, Prof. Eddington thinks that entropy must be ranked as the great contribution of the nineteenth century to scientific thought. It made a reaction from the view that all that is essential can be found by applying a microscope to the world. While Einstein's theory of spherical space has removed all difficulty as to the infinity of space, we are still confronted with the dilemma of an infinity of time, especially the difficulty of an infinite past. But between us and the infinite past lies a more pressing difficulty, namely, the winding-up of the universe. The organisation of the energy of the world is being continually reduced by the continual increase of the random element; in the past we must attribute a greater and greater degree of organisation, and it is impossible to follow such an increase back indefinitely.

WHILE deprecating any hasty inference that this involves the interference of a creator of organisation at a not infinitely remote time in the past, Prof. Eddington thinks we must recognise that current physics rests on the view that there is in the world not only chance but also the antithesis of chance. We may not be justified in relating this 'antichance' at all closely to that which appears to our consciousness in the guise of purpose and design. Chance requires its complement 'antichance' as much as positive electricity requires its complement negative electricity, and physics should not be regarded as wedded to one rather than to the other. The 'fortuitous concourse of atoms' which has been so much of a bugbear is now definitely limited in physics to a well-recognised type of system, namely, a system in thermodynamical equilibrium; physicists, however, would be the first to protest against the idea that that condition is typical of the world in general.

FURTHER details of the information acquired by the Dutch-American Expedition to New Guinea during its stay among the pygmies of the Nassau Mountains have been issued by the Smithsonian Institution of Washington. Dr. Stirling, the leader of the expedition, states that the pygmies are mild-mannered, quiet, and unobtrusive, and not in the least nervous. They are energetic agriculturists and entirely vegetarian, cultivating sweet potato, sugar-cane, taro, raspberries, tobacco, and a number of other plants not recognised. They raise pigs in considerable numbers and have dogs. Various implements of stone are in use—axes, knives, hoes, wedges, and so on. They have no knowledge of iron. Their principal weapon is the bow and arrow. In an interview with a representative of the *Times* at Port Said which appeared in the issue of that paper of Feb. 2, Dr. Stirling gave a further account of the culture of the negritos, in the course of which he referred to their use of tobacco in pipes and in cigarettes, and their trade by means of barter or with cowries as their medium of exchange. Each village is administered by a headman and elders, but there are no chiefs. Before marriage the bridegroom has to undergo an ordeal in which arrows are shot at him, and when a wife is divorced the top joint of the index finger is cut off; the same mutilation is performed on the other fingers for succeeding divorces. Polygamy is practised. Their religion is animistic, and they have a great faith in the virtue of amulets The average height of the pygmies is said to be 4 ft. 2 in. and their colour quite black.

ON Dec. 27 last, Prof. M. Pupin, the retiring president of the American Association for the Advancement of Science, gave an address on "Fifty Years' Progress in Electrical Communications." He lays stress on the important part played by Maxwell's electromagnetic theory in the development of telegraphic and telephonic science. He also points out how invaluable thermionic tubes are in everyday

work. Perhaps undue importance is attached to those who gave the first experimental demonstrations of the new methods. For example, in 1853 William Thomson proved theoretically that in certain cases the discharge of a Leyden jar is oscillatory, and Feddersen deserves great credit for verifying this experimentally six years later. But Thomson's formulæ are still quoted in every treatise on radio communication. Heaviside describes clearly how the variables of his distortionless circuit are connected, and if the adjustment is not perfect we can easily see how it can be improved by varying any one of the four variables. A knowledge of what Maxwell has done does not help us to do this. One interesting point Pupin mentions is that, since Faraday, every great advancement in the art of electrical communication has originated in the research laboratories of the universities, and not in the test-rooms or research laboratories of manufacturing companies. He points out that the natural electrical disturbances which take place in electrical circuits, such as static disturbances, fading, earth currents in cables, etc., deserve close study, as they may enable us to find the secrets of the natural processes going on in the sun, the central power-station which supplies the moving power to all our organic and human activities.

AN account issued to the Press by the New York Electrical Society of an address on fused quartz given by Dr. Berry, of the American General Electric Co., would be singularly misleading to any one not familiar with the subject. We read that fused quartz is a "new and remarkable material" which by its property of inexpansibility "opens new scientific advances in fields as distinct from each other as astronomy and fire prevention." From this one might be led to conclude that fused quartz is an American discovery of recent date; and so with each application of the material to science and industry—the material being newly discovered, its applications must also be new. The application of fused quartz to fire-sprinkler bulbs, and again the suggestion of its use to replace glass in astronomical instruments and the like, scarcely merit the designation of "new scientific advances." Sprinkler bulbs of fused quartz were made commercially in England so long ago as 1912—and there seems little novelty in the suggested application of quartz to the second purpose mentioned, although the successful manufacture of blocks 8 ft. to 10 ft. diameter would certainly be an advance.

ONE of the activating motives of the work on fused quartz done in England in the last twenty odd years, has been the commercial production of really large pieces of transparent fused quartz (such as discs 2 ft. and upwards in diameter)—as yet such pieces are not available. The paper mentioned above suggests that sizeable 'blocks' of transparent quartz are available in America for astronomical purposes. This reference, occurring as it does in a paragraph immediately following reference to glass "blocks 8-10 ft. diameter," would make clearer reading if the actual size of the fused quartz 'blocks' were specified. No novelty attaches to the suggestion to use fused quartz for astronomical purposes. An actual installation will, however, be a matter worthy of adulatory comment. Reading further, we find that Dr. Berry 'discloses' the use of fused quartz in experimental biological studies of the effects of ultra-violet radiation; what recent obscurity there has been about such a use must have been purely local. It is not to be doubted that the American scientific worker is as an individual anxious to acknowledge prior discovery and development in a field of activity which he may enter. It is unfortunate, therefore, that a statement issued by a well-known American society should be so misleading, and we are forced to the conclusion that there must have been in this case a singular lack of knowledge of the facts.

THE botanical library of Capt. John Donnel Smith of Baltimore, consisting of some 1600 carefully selected and beautifully bound volumes, with his plant collection of more than 100,000 specimens, which was presented to the Smithsonian Institution of Washington twenty-two years ago, has only now been deposited there, and constitutes the most valuable botanical gift ever made to the Institution. The library includes some valuable and very rare volumes, and is particularly rich in works descriptive of tropical American plants, especially those of Central America. At the time of presentation to the Smithsonian, Capt. Smith's herbarium was the finest in existence for Central America, and is of great scientific interest because it includes so many type forms. Besides American species, the collection includes sets of plants from all over the face of the globe, China, Tibet, Central Asia, India, Australia, Africa, and has already been the basis of much important work by the Smithsonian botanists. The results of the labours of one of America's most enthusiastic and indefatigable botanists thus become available for general reference.

THE January number of the *Empire Cotton Growing Review* (vol. 4, No. 1) is the first to be issued by the new publishers, Messrs. P. S. King and Son, Ltd., 14 Great Smith Street, London, S.W.1. The journal is the organ of the Empire Cotton Growing Corporation, and the work and aims of that organisation should be more widely known than they are at present. Any attempt to further the economic independence of the Empire is worthy of support; and it is the endeavour of the Corporation to extend the cultivation of cotton within the British Empire, for "an increase in the number of sources of raw cotton is a matter of the most urgent importance." With this end in view, the services of skilled plant physiologists, pathologists, geneticists, economists, and others have been concentrated on improving and extending the cotton yield, and the results of the researches of those specialists are published in the Corporation's journal. The present issue contains some interesting and useful articles, and preserves an even balance between the scientific and economic aspects of the problem. For those engaged in any branch of the cotton industry the "Notes on Current Literature" at the end will be found invaluable.

THE Rockefeller Foundation has issued a fifth series of "Methods and Problems of Medical Education." Descriptions are given of the Departments of Anatomy, Pathology, Bacteriology and Public Health, and Physiology of the Washington University School of Medicine, St. Louis, Mo.; of the Departments of Physiology, Botany, Anatomy, Zoology, Biochemistry, and Pharmacology of McGill University, Montreal; of the Institute of Pathology of the University of Utrecht, and others. The descriptions are by the heads of the Departments, are copiously illustrated and show plans of the buildings, while details of finance and research are also given. "Le Service de Prophylaxie Mentale du Département de la Seine, Paris," and the "Centre Régional de Toulouse pour la lutte contre le Cancer" are also described. Dr. Bela Schick gives the method of charting clinical records of children's diseases adopted at Mt. Sinai Hospital, New York, and Profs. Estor and Pech, of Montpellier, describe an apparatus for viewing an operation at a distance from the surgeon, or even in an adjoining room. It consists of two large mirrors, one above the other; the upper mirror receives the image of the operation and reflects it down into the lower mirror in which it is viewed, a special illuminating lamp being employed.

THE first congress of the International Association of Soil Science will convene on June 13 in Washington, D.C. The congress will be followed by a field excursion to visit the various important soil belts in the United States. Opportunity will also be given to the delegates to acquaint themselves with various agricultural industries, some of the leading agricultural experiment stations and, in general, with the agricultural resources of the country. The association is made up of six international commissions, each acting under an independent chairman, and the programmes of the commissions are now in course of preparation. Each will consist of papers presented by invitation by outstanding investigators in the respective fields, and of papers presented by various workers in the different branches of soil science, by members or non-members of the association. Titles of the papers to be presented and brief abstracts in English, French, and German should be sent to Dr. J. G. Lipman, New Brunswick, New Jersey, U.S.A. The congress will bring together workers interested in the different problems of soil classification, soil analysis, fertilisation and treatment, as well as the relation of the soil to plant growth. Extensive exhibits of various soil types, of apparatus used in soil analysis, and of the soil microflora and microfauna will be held during the congress.

SIR ERNEST RUTHERFORD will deliver the twelfth Guthrie lecture to the Physical Society of London on Friday, Feb. 25, taking as his subject "Atomic Nuclei and their Transformations."

WITH the view of encouraging original research in sanitary science, scholarships of the yearly value of £300, plus an allowance for apparatus, etc., are being offered by the Grocers' Company. The scholarships will be tenable for one year, but renewable for a second or third year. Applications must be made before the end of April to the Clerk of the Grocers' Company, Grocers' Hall, E.C.2, upon a form obtainable upon request.

THE Edison Medal of the American Institute of Electrical Engineers for 1926 has been awarded to Dr. William David Coolidge, the assistant director of the research laboratory of the General Electric Company, for the production of ductile tungsten and the fundamental improvement of the X-ray tube. Dr. Coolidge, who is an honorary member of the Röntgen Society, was born in Hudson, Massachusetts, on Oct. 23, 1873, and is a graduate of the Massachusetts Institute of Technology and a Ph.D. of Leipzig. After some years as a teacher of physical chemistry at Massachusetts he became associated with the General Electric Company in 1905, and was made assistant-director of research three years later.

PROF. J. BRONTË GATENBY, Zoological Department, Trinity College, Dublin, informs us that, in conjunction with Dr. E. V. Cowdry, of the Rockefeller Institute, N.Y., he is editing a new edition—the ninth—of Lee's "Microtomist's Vademecum." He invites research workers and others to forward to him, as soon as possible, any new information suitable for incorporation in the forthcoming edition. It is not proposed to include bacteriological technique.

THE seventieth birthday of Prof. D. A. Low, of East London College, was celebrated on Feb. 9 by a dinner arranged by his old students. Prof. Low came from Dundee, and after serving his apprenticeship as an engineer, studied at Owen's College, Manchester, and at the University of Glasgow. In 1887 he was appointed headmaster of the Day Technical School for boys at the People's Palace, London, and on the formation of East London College he was made professor of engineering, a post which he held for twenty-six years. During this time he served on the Faculty of Engineering of the University of London, later becoming secretary, and on his retirement he was made emeritus professor. Prof. Low is the author of many textbooks on machine drawing and allied subjects.

AT the general committee which closed the fourteenth annual meeting of the Indian Science Congress held at Lahore during the week Jan. 3-8, the president, Sir J. C. Bose, announced that since meeting in Bombay the past presidents had associated themselves in a presentation to Dr. J. L. Simonsen on his retirement from the office of honorary general secretary. In taking this action the past presidents were confident of thus giving tangible form to the feeling among members of the Congress, that the development of scientific thought and practice in India will remain heavily indebted to Dr. Simonsen, who has not only served as honorary general secretary during thirteen years, but to whose activity and enthusiasm in its early stages the foundation and survival of the Congress are substantially due. The general committee approved this action of the past presidents,

and unanimously elected Dr. Simonsen president of the fifteenth annual meeting of the Indian Science Congress to be held in Calcutta during the week Jan. 2-7, 1928.

A NEW and cheaper impression of Prof. A. N. Whitehead's "Science and the Modern World" is to be published almost at once by the Cambridge University Press, and at a later date a new impression of the same author's "Religion in the Making." The same house also promises a new book by Dr. C. Davison entitled "Founders of Seismology," being in effect a history of the study of earthquakes ranged round the founders of the science from John Bevis and Elie Bertrand down to Prof. John Milne and Prof. Fusakichi Omori.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A full-time assistant lecturer in pharmaceutics at the Cardiff Technical College—The Principal, The Technical College, Cardiff (Feb. 19). A keeper of the laboratories of the Royal Horticultural Society at Wisley—The Secretary, Royal Horticultural Society, Vincent Square, S.W.1 (Feb. 22). An assistant entomologist at the Rothamsted Experimental Station—The Secretary, Rothamsted Experimental Station, Harpenden (Feb. 26). A lecturer in the department of botany (special subject—plant physiology), King's College, London—The Secretary, King's College, Strand, W.C.2 (March 2). A professor of physiology in the University of Birmingham—The Secretary, The University, Birmingham (April 23). A head of the agricultural department and farm director of the Harper Adams Agricultural College, Newport, Salop—The Principal, Harper Adams Agricultural College, Newport, Salop. An assistant bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum—The Director of the Laboratories. A head of the department of bakery and confectionery of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. A technical officer, grade II., at the Royal Aircraft Establishment, South Farnborough, for duties in the technical supervision of the application of all equipment used in aeroplanes built under contract for the Air Ministry—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting A 127).

Our Astronomical Column.

COMETS.—An orbit of comet 1927 *b* (Reid) has been telegraphed from South Africa, from which it appears to have passed perihelion in 1926, so it will presumably be numbered as 1926 VII. The orbit indicates that the motion in R.A. in the former telegram was erroneous; it was sent as +44 sec., but it should be about +11 min. The comet has begun to travel northward, and should be visible in Europe about the middle of March.

$$\begin{aligned} T &= 1926 \text{ Dec. } 30{\cdot}54 \text{ U.T.} \\ \omega &= 224^\circ\ 45' \\ \Omega &= 108\ \ 42 \\ i &= \ \ 83\ \ 40 \\ \log q &= 9{\cdot}87703 \end{aligned}$$

Annals of Moscow Observatory, Vol. 8, No. 1, contain definitive elements of comet 1904 I. (Brooks) by M. S. Kasakov.

$$\begin{aligned} T &= 1904 \text{ Mar. } 7{\cdot}138756 \text{ G.M.T.} \\ \omega &= \ \ 53^\circ\ 32'\ 34''{\cdot}0 \\ \Omega &= 275\ \ 47\ 25{\cdot}4 \quad 1904{\cdot}0 \\ i &= 125\ \ \ 7\ 42{\cdot}5 \\ e &= 1{\cdot}0013646 \\ \log q &= 0{\cdot}432643 \end{aligned}$$

As the comet was observed from April 16, 1904, until June 5, 1905 (besides a photograph on May 14, 1903, not used in the above orbit), the hyperbolic character is well established.

MERCURY AS AN EVENING STAR.—Mercury will be well placed as an evening star in the second half of February, reaching elongation on Feb. 25, when it is 18° from the sun and $8\frac{1}{3}^\circ$ north of it. The latter point is of importance for increasing its height above the horizon at sunset. Herr Carl Schoch, who is well known for his researches in ancient astronomy, contributes an article to the *Steglitzer Anzeiger* of Jan. 20 in which he points out the assiduity with which Mercury was observed in Babylon, and the importance of the *arcus visionis*, or length of time of visibility of the planet. On Feb. 22 it will set $1^h\ 40^m$ after the sun, and should be visible to the naked eye for nearly half an hour. This is the best evening elongation of the present year. The presence of Venus some 5° further east will add to the interest.

Herr Schoch asks naked-eye observers to send him notes of the duration of visibility of Mercury, that he may compare them with the Babylonian records.

PHOTOGRAPHS OF MARS IN 1926.—An extensive series of photographs of Mars during September and October of last year was made by Mr. F. E. Ross at the Mount Wilson and Lick observatories. A preliminary account of the results obtained are given by him in the *Astrophysical Journal*, vol. 64, p. 243. A special enlarging camera was used, attached to the 60-inch telescope at Mount Wilson, and photographs were taken in light of five different colours (ultra-violet, blue, yellow, red, and infra-red) with the aid of suitable filters. At the Lick Observatory the camera was attached to the 36-inch refractor, the photographs being taken only in yellow and infra-red light. The photographs discussed in this preliminary paper are extremely interesting in showing that surface markings appear only in light of long wave-lengths (yellow to infra-red), whereas clouds and atmospheric effects require short-wave light to render them visible in the photographs. This is the reverse of what might be expected, especially as the prominent rim light in the ultra-violet photographs seems to point to the existence of a strongly scattering atmosphere. The decrease of diameter in the infra-red photographs, discovered by Wright in 1924, is confirmed. The method appears to be a very valuable one for studying atmospheric conditions in Mars, and a further discussion of the photographs will be awaited with interest.

Research Items.

THE PEOPLING OF THE EARTH.—Dr. Aleš Hrdlička in No. 3, vol. 55, of the *Proceedings of the American Philosophical Society*, reviews conclusions on the place of origin and distribution of man put forward in 1921 in the light of the evidence collected by him in his recent journey through parts of Europe and Asia, Australia, and South Africa. On the question of the origin and cradle of mankind, he holds to the view that this must be sought in western and south-western Europe, with probably an early extension of the species, on one hand towards central Europe, and on the other, over the watershed of the Mediterranean. It is probable that by the time the last or Würmian glaciation was approaching, man existed in only one general form—the Neanderthal, which persisted for a very long time into post-glacial times. The view that Neanderthal is a separate species which completely died out is erroneous. It is a necessary stage of man's evolution, and if *Homo sapiens* is given another place of origin, say Asia, a Neanderthal phase must be postulated there. Probably he became much reduced in numbers in western Europe and his place was taken by transitional Aurignacian man who was nearing the modern type, having developed from an extension of the Neanderthal eastwards beyond central Europe, which afterwards returned westwards as Aurignacian man to the place of his Neanderthal forefathers. After the last glacial period there is a rapid extension of culture, and man for the first time in his history becomes capable of furnishing a surplus of numbers needing an extension of his domain. It was during this time that the foundation was laid for man's differentiation into the older human stocks and races. Apart from the corroboration of the above views, three, or rather four, conclusions emerge as a result of Dr. Hrdlička's journey. A link between the Negritos of Africa and of south-eastern Asia has been found in India; it is clear that the Australian (and Tasmanian) is one of the more fundamental races of the world with close connexion with our own ancestral stock; there are in Asia remnants of the old yellow-brown stock from which is derived the American Indian, *e.g.* the Tibetans; and lastly, in Australia and South Africa new types of white man are developing.

NORTHERN TUNGUS MIGRATIONS.—An examination of the ethnological affinities of the Goldi of the Amur and Ussuri rivers by Prof. S. M. Shirokogoroff in Vol. 57 of the *Journal of the North China Branch of the Royal Asiatic Society* has afforded the author an opportunity to offer suggestions towards the elucidation of the obscure question of the date and course of the various Tungus migrations. The Goldi, sometimes known by the Chinese name of *Yu-pi-ta-tse*, *i.e.* Fish-skin Barbarians, on account of the use of this material for articles of dress, belong to the southern branch of the Tungus linguistic family; their language may perhaps be regarded as a branch of spoken Manchu, but it shows elements characteristic of northern Tungus dialects. Their culture shows traces of the northern Tungus complex, as well as of Palæasiatic influence. Recently, Chinese influence has been brought to bear upon them by colonisers. From neolithic times to the present day their territory, it is known, has been the scene of struggles between various groups, Palæasiatics, Koreans, Mongols, Tungus, and, later, Chinese. Archæological evidence—walled cities, cemeteries, etc.—shows that at times it has been thickly populated. A comparative study of the cultural and linguistic elements of the Goldi complex shows that this people is of mixed character and origin, which may be explained as an absorption of the northern Tungus, who went from north and west to the south and east, by the southern Tungus and perhaps Palæasiatic groups. Four different waves of Tungus migration can be distinguished. The first wave occurred before the tenth century, and brought various groups of northern Tungus, probably reindeer breeders and including the Goldi, to the lower Amur, Ussuri, and Sunjari basins. The second wave, about the twelfth century, occupied the territory left by the reindeer breeders. A third wave in the seventeenth century, after the Manchus depopulated the Amur valley, led to certain tribal redistributions in and about eastern Transbaikalia. The fourth wave, which began in the nineteenth century and still continues, is one in which the last of the northern Tungus stock living south of Yakuts are moving eastward into the Amur Government and on to the Manchurian plateau.

ANCIENT SHIPS.—The ships of early explorers were described by Mr. G. S. Laird-Clowes in a recent lecture to the Royal Geographical Society, in which he pointed out how imperfect is the record of early shipping, not merely in actual specimens but also in pictorial representation. Among early forms of vessels the only ones that have been preserved are one or two small Egyptian processional boats; two Roman vessels, not yet raised from the bottom of Lake Nemi; a portion of a lighter of about A.D. 270 found in the Thames; a Frisian ship; and two Viking ships. In the British Isles, beyond the Thames lighter and some dug-outs of doubtful age, there is nothing earlier than a barge of the time of William and Mary, another nearly a century later, and then Nelson's *Victory* and the *Implacable*; or as Mr. Laird-Clowes puts it, there is a blank in the preservation of actual ships from Roman times until the seventeenth century. The pictorial record is less inadequate, but it consists largely of ships broadside on and so gives comparatively little detail of the build and method of construction. Moreover, it is concerned mainly with large ships; the small vessels, which were of chief importance in exploration, were seldom drawn in any detail.

GRAFTING IN PLANARIA.—Prof. H. W. Rand and Amy Browne describe (*Proc. U.S. Nat. Acad. Sci.*, vol. 12, Sept.) the technique they have employed in their grafting experiments on *Planaria maculata* undertaken with the view of ascertaining whether regeneration of a head at an exposed anterior cut surface may be inhibited by the presence of a head grafted relatively near this cut surface. The difficulties of the grafting operation arise from the extreme softness and delicacy of the tissues, the mobility of the pieces and the contamination of the cut surface with mucus. A 3·5 per cent. solution of pure acid-free gelatin in distilled water was made and allowed to cool until it began to stiffen, and was then poured on to cold glass slides where it set, forming a layer about 1 mm. thick. Two Planaria, preferably narcotised by chloretone, were taken, and from the side of the body of one was excised a piece of tissue, leaving a wound appropriate in size for the reception of the graft. The wound was made deep enough to interrupt the lateral nerve cord. This animal having been placed on the prepared gelatin surface, the head was immediately excised from the second Planaria and placed with its cut surface against the wound surface of the first one, and strips and fragments of moist gelatin were packed tightly around to prevent separation of the grafted head from the body. The slide was placed in a moist chamber for 18 to 24 hours, after which the gelatin

was carefully picked away and the graft compound transferred to a small dish of pond water. Eight successful grafts of a head on to the side of a body were obtained. After the graft had become well healed in place, the animal's original head was removed. The question was: Will the presence of the foreign head in close proximity to the wound affect the regeneration of a head which would take place in an ordinary beheaded Planaria? In one case the stock head was removed and regenerated five successive times, but in other cases it would appear that retardation and inhibition of regeneration was due to the presence of the grafted head.

NEW MOLLUSCA FROM MEXICO, CENTRAL AND SOUTH AMERICA.—Three short papers are before us dealing with new mollusca from these regions. Mr. W. B. Marshall describes eleven new species of "Land and Fresh-water Mollusks from Central and South America" (*Proc. U.S. Nat. Mus.*, vol. 69, art. 12) belonging to the genera Cyclodina, Succinea, Ampullaria, and various Unionidæ. Dr. Paul Bartsch, in continuation of a paper published in 1924, treats of "Additional new Mollusks from Santa Elena Bay, Ecuador" (*Proc. U.S. Nat. Mus.*, vol. 69, art. 20). As in the original note, they are marine genera, mostly Turbonilla, Pyramidella, and Odostomia. The same author also writes on some "New Urocoptid Land Shells from Mexico" obtained by Mr. C. R. Orcutt during his recent botanical explorations (*Proc. U.S. Nat. Mus.*, vol. 70, art. 4). Sixteen species of Holospira supposed to be new are described and illustrated.

BOTANY AND HYDROLOGY.—Oscar Edward Meinzer has investigated the uses of plants as indicators of ground water (*Jour. Wash. Acad. Sciences*, vol. 16, No. 21, 1926). He groups desert plants into two general classes according to the adjustments they make for the scarcity of water. On one hand are the true xerophytes, depending for their scanty supply of water on the rains that occur at long intervals, and during periods of drought maintaining themselves in a nearly dormant condition; on the other hand are those plants, termed by the author "phreatophytes" or "well plants," which grow where they can send their roots down to the water table. These plants group themselves in zones and communities according as the topography of the surface varies the depth of the water table. Thus salt grass (*Distichlis spicata*) indicates water 8 ft. to 12 ft. from surface, while mesquite (*Prosopis juliflora*) can reach water so far as 50 ft. below ground. After twenty years of hydrological work, and contrary to popular belief, the author is unable to establish any definite relation between the occurrence of phreatophytes and the quality of the ground water, or to suggest that any species that can grow in even moderately alkaline soil will invariably indicate potable water. Even in desert country, a substantial supply of water is thus available, and the loss of water per acre due to transpiration is probably less than the quantity required to irrigate useful crops. Pumping, however, is an expensive operation, and it is suggested that those hundreds of thousands of acres of desert land should be made productive rather by the cultivation of such promising phreatophytes of economic value as alfalfa (for seed mostly), Bermuda grass, and pecan.

RECENT LOWERING OF SEA-LEVEL.—It is well known that Daly has presented evidence supporting the view that a world-wide lowering of sea-level, amounting on an average to about six metres, has taken place during post-glacial time. This has been recently extended by the observations of Wentworth and Palmer on the islands of the North Pacific. They find a lowering of the ocean level of 12 to 15 feet. W. A. Johnston, however (*Am. Jour. Sci.*, 1926, p. 253), has failed to find evidence of such a relative movement along the Pacific Coast of Canada. A further contribution to the subject of recent movements of the strand line is now made by A. F. Buddington in the *Am. Jour. Sci.*, 1927, p. 45. He has examined more than four thousand miles of coast in south-eastern Alaska, and he states that wherever the conditions have been favourable, remnants of relatively uplifted sea-cut rock benches are found near the present level of high tide. The estimated lowering of sea-level is between 12 and 16 feet. This, however, is but the last of a series of post-glacial uplifts. Near Juneau, old beach deposits have been found at elevations of 600 feet or more, and well-marked platforms produced by marine planation occur at various levels up to 200 feet.

LAND MOVEMENTS DURING THE JAPANESE EARTHQUAKE OF SEPT. 1, 1923.—The remarkable elevations and depressions measured in the bed of Sagami Bay have already been referred to in NATURE (Mar. 29, 1924, vol. 113, pp. 473-474). The corresponding movements on land form the subject of a valuable paper by Major-General H. Omura, of the Land Survey Department (*Bulletin of the Earthquake Research Institute*, vol. 1, 1926, pp. 65-68). Immediately after the earthquake this Department began the revision of precise levelling, and during the following years, from 1924 onwards, it has been engaged in carrying out a revision of the triangulations over the central region. The admirable map which accompanies the paper shows the changes of level in the land surrounding Sagami Bay, zones of uplift and depression for every fifth of a metre being represented, from +2 metres and upwards to −1·2 metres and below. The more important elevations occur along the coast of Sagami Bay and in the Boso peninsula. The main area of depression lies inland to the north-west of the bay, and it is noteworthy that one of the principal zones of depression is about 30 miles north-north-west of the centre of the first disturbance, that is, it is close to the centre of the second movement (see NATURE, Jan. 22, 1927, vol. 119, p. 139).

IGNEOUS ROCKS OF MOUNT GIRNAR.—More than twenty years ago Dr. J. W. Evans made a representative collection of rocks from the Girnar and Osham Hills in Kathiawar. A systematic examination of the types represented has now been made by M. S. Krishnan, and his results are published in the *Records of the Geol. Surv. India*, 58, 1926, p. 380. Almost simultaneously a field and structural study of the Girnar rocks appeared in the *Journal of Geology*, 34, 1926, p. 289, by K. K. Mathur, V. S. Dubey, and N. L. Sharma. These two papers taken together have greatly extended our hitherto scanty knowledge of the phases of igneous activity which followed the great outpourings of the Deccan plateau-basalts. At Girnar the basalts were domed up by a laccolith in which olivine gabbro, diorite, and monzonite crystallised. A circular system of fractures around the dome was intruded by granophyre; and, in the gabbro, dykes of nepheline-syenite and lamprophyres are found in close association. The differentiation of the parent magma is attributed to fractional crystallisation, and support is given to Bowen's hypothesis of the origin of nepheline-syenite, involving the removal of orthosilicate molecules by volatile fluxes. A series of analyses is presented by Dr. Krishnan, and it is noteworthy that the variation diagram constructed from the results is of the broken

and jerky type which seems to correspond with the suggested process of fractional crystallisation.

GABB'S CALIFORNIAN FOSSIL GASTROPODS.—The well-known American palæontologist, W. M. Gabb, described in two volumes, published in 1864–69 by the Geological Survey of California, the fossils collected by the members of that Survey. He did not, however, designate type specimens or indicate type localities, items required in present-day palæontological research, while in some cases his figures were restored and embodied parts of more than one specimen. Mr. R. B. Stewart now seeks to rectify all this so far as the Gastropoda are concerned (*Proc. Acad. Nat. Sci. Philad.*, vol. 78), and after careful study of the original specimens deposited by Gabb with the Academy of Natural Sciences of Philadelphia, and those which had drifted into other collections, has carefully described and illustrated the now selected types. More than 150 species have been dealt with, but 20 are still missing. It has been considered necessary to create 14 new genera. The 13 plates of figures from retouched photographs by Miss H. Winchester are good and should amply meet the requirements of students.

RADIO IN THE WHALING INDUSTRY.—The use of radio telephony by fleets of whaling ships has made the whaling industry a much less strenuous one. When one of the vessels, equipped with a ½-kilowatt Marconi telephone set, sights a number of whales, possibly after several weeks' searching, the other ships of the same fleet are immediately informed by telephone, and all can then make for the best spot for hunting. The 'factory ship' that also accompanies the fleet is simultaneously directed to the most suitable position for taking charge of the catches. A simple code is employed, so only the ships concerned can interpret the messages. The apparatus used is highly efficient, as messages have been heard up to distances of two thousand miles. Until a few years ago, whales were caught by harpooning from rowing boats. Now fast steam launches equipped with 1000 horse-power engines are used for the pursuit. Harpoons are projected from guns instead of being thrown by hand. Practically all the carcase is converted into oil, cattle cake, and other marketable commodities. On several ships this season, Marconi direction finders have also been fitted. As the magnetic compass is of little use in the Antarctic regions, these finders, which are independent of the earth's magnetism, have proved of great value. Like the telephone sets, the direction finders are worked by the harpoon-gunner and require no special operator. The Ross Sea, which is enclosed by an ice barrier with only one seasonal outlet, can now be safely invaded and large catches have been made in it.

DETECTION OF INTERNAL FLAWS IN RAILS.—For some years it has been known that it is possible to detect internal flaws in steel samples of uniform section by magnetic means. The method has not hitherto received much attention, since it is necessary to thread on to the end of the sample the magnetising and test coils. A recent improvement which eliminates this difficulty is described in a paper by Masuhiro Suzuki in *Science Reports*, Tohoku Imp. Univ., vol. 15, No. 4, p. 479. The method has been applied to rails actually in service with important results. The magnetisation of the steel is effected by a large horse-shoe electro-magnet which rests a very short distance above the surface of the rail on small rollers. Between the poles is one test coil which need only be placed on the surface. Any irregularity in the rail is then detected by a deflexion of a galvanometer connected to this coil as the whole apparatus is traversed along the rail. Flaws, segregated areas, and overstrained regions are then readily detected. The latter is an important point, since portions of the steel which, although not yet actually flawed are potential flaws, are clearly picked out. As an example of this may be mentioned periodic irregularities found in a new rail free from marked segregation or flaws. The author ascribes these to the effects produced in the rail-straightening process after it had been rolled. Although the present work is confined to rails, the modified method is applicable to a large number of similar examinations such as tyres and ropes.

THERMAL DECOMPOSITION OF OZONE IN THE PRESENCE OF HYDROGEN.—R. O. Griffith and K. McKeown have extended their experiments on the catalytic effect of gases on the thermal decomposition of ozone to include the effect of hydrogen on the same reaction at 78° and 100°. Details of the work have been published in the *Journal of the Chemical Society* for Dec. In addition to the deozonisation process, water is formed by the reaction, $H_2 + O_3 = H_2O + O_2$, and the interpretation of the results is more difficult. The velocity coefficients of the two reactions show that the catalytic effect of the hydrogen is positive, and a possible explanation of the results, involving a series of intermediate reactions, is given.

EFFECT OF SUNLIGHT ON COTTON.—The effect of sunlight on cotton fabric is the subject of No. 1016 of the Aeronautical Research Committee's Reports and Memoranda (London: H.M. Stationery Office, 1926. 1*s.* net), by G. Barr and Isabel Hadfield. It has been found that the determination of the viscosity of a solution of cotton in cuprammonium hydroxide forms a much more sensitive method of following the deterioration in sunlight than that used in the past, namely, the change in tensile strength. After exposure, the cotton shows increased reducing properties, and it is evident that chemical and not merely physical change has taken place, although further work on fabric exposed in the absence of oxygen is necessary before it will be possible to decide to what extent the change in the fabric is an oxidation process.

A NEW TRANSFORMATION OF COBALT.—Measurements have been made by Hakar Masumoto (*Science Reports*, Tohoku Imp. Univ., vol. 15, No. 4, Oct. 1926) of the electrical conductivity, thermal expansion, heat changes, and magnetic properties of cobalt at high temperatures. For the purest sample, all of these show a discontinuity around 477° C. on heating and 403° C. on cooling. From X-ray analysis it is shown to be probable that below this temperature cobalt crystallises as close-packed hexagonal material, while above it is face-centred. Both forms are ferromagnetic. The effects of iron and nickel on this change have been investigated, and in each case the added metal lowers the temperature of the change rapidly. Especially is this the case with iron, about 4 per cent. of which element lowers the change point to 0° C. Some observations are made on the changes in the iron-cobalt and nickel-cobalt systems respectively which occur below the solidus. So far as the latter alloys are concerned, they appear to form one series of solid solutions throughout. The system iron-cobalt is more complex, and as the iron content is raised the structure at room temperatures passes from close-packed hexagonal to face-centred cubic, and then finally to body-centred cubic at about 21 per cent. of iron. In each case there is a small zone in which the mixed phases are found.

Meteorology and Air Routes.

THERE are few forms of transport which are not influenced to some extent by meteorological conditions, but there is none which makes greater demands on meteorological science and practice than the aeroplane and the airship. The importance which is attached by the Air Ministry to the provision of the necessary meteorological advice and organisation in connexion with the development of Empire air routes is rendered evident by a document recently issued under the title of "The Approach towards a System of Imperial Air Communications" (H.M. Stationery Office, price 5*s*.). This document consists of the memorandum by the Secretary of State for Air laid before the Imperial Conference, 1926, together with the report of the Imperial Air Communications Special Sub-Committee. The memorandum contains appendices giving a clear statement of the principles governing the application of meteorology to air navigation, both as regards investigational work and as regards the provision of a ground organisation along the routes. At the same time, the main portion of the memorandum sets out, in the section on airships, some general remarks on the bearing of meteorological conditions on airship navigation, supported by very interesting examples of the results to date of an intensive meteorological investigation of the projected England-Egypt-India airship routes, illustrated by charts well reproduced in colours. Meteorological work for airships is in the hands of a specially created division of the Meteorological Office, and it is hinted that the aim of the work on the England-India routes is to provide for the airship pilot, information in atlas and handbook form analogous to that which has long been available to seamen.

Examples of average thunderstorm and upper wind conditions show that the 'normal' routes may differ outward and homeward, and also from month to month. Further, the pilot will find that in particular cases departures from the 'normal' route for the month will be advantageous. The memorandum reminds us that "the air and its currents are to the aircraft what the oceans and their currents are to the ships, . . ." and proceeds: "A high wind, even of gale force, should cause no more danger or discomfort to an aircraft in flight in free air than an increase of speed in an ocean current to a surface vessel in mid-ocean; but there are, however, certain atmospheric disturbances, such as tornados or waterspouts, and violent vertical currents associated with thunderstorms and line-squalls, which do constitute a potential source of danger to airships." It is then pointed out that these must be avoided by suitable choice of route, the report continuing: "It is particularly on long-distance airship flights that such alteration of route will be made in order to avoid adverse and utilise favouring weather conditions. It will, in fact, be the rule rather than the exception, for the commander of an airship to choose his route between any two points for each separate flight, having regard to the meteorological conditions prevailing at the time." An example is reproduced from a special series of daily weather charts for a whole year covering Europe, N. Africa, and a large part of Asia, being prepared from past data to study such problems. This shows how the pilot, given the weather chart and forecasts, could have made a quicker passage in better weather from London to the Mediterranean via the west coast of France than by the more direct route via the Rhone valley.

It is not alone the navigation of airships which has made demands on meteorology. Airship mooring is requiring, for its ultimate perfection, a knowledge of the finer wind and thermal structure of the lower layers of the atmosphere and the changes with time, beyond that existing at present. The former is being investigated at Cardington (Beds.) by a special network of electrically synchronised anemometers with very open time-scale, while it is proposed to instal instruments on a mast at Ismailia (Egypt) to give a continuous record of the lapse-rate of temperature in the first 200 feet or so above the desert surface. It is thus evident that airship development is calling for information which is of very special interest to meteorologists, so that the science of meteorology should itself benefit considerably in meeting these demands.

Attention has not been confined to the England-India airship route. An appendix contains the results of a preliminary survey of meteorological conditions with the view of delimiting areas within which main Imperial airship routes may be expected to develop, and these are shown in a chart. The flying areas are in the form of strips, some hundreds of miles wide, extending from base to base. They lie mostly over the sea. In addition to the routes to Canada across the North Atlantic, there are alternative routes to South Africa, namely, via the west coast and via the Red Sea and east coast. Australia and New Zealand are reached both from South Africa and also as an extension of the England-India route. The passage from South Africa is outward by the northern boundary of the 'Roaring Forties' and back in the south-east trade belt. That from India to Australia is wholly across the ocean to south-western Australia, avoiding the well-known Java thunderstorm area.

The recommendations of the Imperial Air Communications Sub-Committee, afterwards adopted by the Conference, take cognisance of the importance of active co-operation of the Dominions in providing meteorological facilities if Imperial Air Routes are to be developed successfully.

Mycology in Great Britain.

THE British Mycological Society is one of the most vigorous scientific bodies in Great Britain, and this is reflected in its Transactions, of which vol. 11, Parts 1 and 2, edited by Carleton Rea and J. Ramsbottom, has recently been published (London: Cambridge University Press, 15*s*. net). Amongst its most useful activities are the spring and autumn forays, when members visit some specially chosen locality and spend several days studying lichens, mycetozoa, and fungi in the field. These forays are almost unique training grounds for students of systematic mycology, and at the same time give opportunity for the very valuable work of recording local floras and thus adding permanently to mycological science. The published lists, as for example those of the Tintern and Dublin Forays of 1925 which appear in this issue, nearly always show a number of additions to the British flora and not infrequently species new to science.

The present issue contains the president's address, which is of interest as giving the views of a herbarium systematist on certain controversial problems. That such a one can write "one of the great hopes of the systematist is the phytopathologist" shows a very commendable broadening of a point of view more usual in herbaria. Mr. Ramsbottom discusses the 'species concept' at some length but in what cannot be regarded as a very helpful manner, and his sug-

gestion that Prof. Lotsy is a writer of undergraduate essays on this subject is wide of the mark. The more important portions of the address are those in which attention is directed to the widespread occurrence of heterothallism and hybridisation in fungi and to the increasing acceptance of behaviouristic criteria in specific delimitation.

The question of heterothallism has been studied by Dr. Derx, who records its occurrence in the genus Penicillium. Problems of strain and species in the genus Colletotrichum are discussed in relation to diseases of certain tropical crop plants by Dr. Small and Mr. M'Donald in two very interesting papers.

Dr. Petch of Ceylon, surely one of the most voluminous writers on mycological topics, continues his monumental series of studies in entomogenous fungi, dealing in the present paper with *Aegerita Webberi*. The same author also contributes an interesting paper on Matula. Dr. Petch's line-drawings are models of what such illustrations should be.

Miss Lorrain-Smith's note on lichen-dyes will be of use to the many people nowadays who are interested in the home-dyeing of hand-woven fabrics. From time to time, controversy has arisen as to the possible harmful effects of feeding bunted grain to stock, and as the result of thorough trials, Mr. Dobson is able to show that, from the point of view of the practical stock feeder, the danger is negligible.

The introduction of any new fungus pest is of importance, more particularly when, as in the present case of the downy mildew of the hop (*Pseudoperonospora Humuli*), every stage of its invasion of England is known. Mr. Ware has discovered the interesting fact that this fungus can overwinter in the rootstock, and from that region invades developing shoots in early spring. An interesting paper by Mr. Maxwell and Dr. Wallace deals with the classical disease of black rust of cereals, *Puccinia graminis*, which was one of the first species of fungus in which strains specialised to particular hosts were described, and five of these (sp. f. Tritici, Secalis, Avenæ, Agrostidis, Phlei-pratensis) are now recorded for Scotland. The obligate relation of the fungus to the barberry plant is also confirmed. Mr. Dowson describes an interesting core-rot and premature fall of apples associated with the fungus *Sclerotinia fructigena*, and Mrs. Alcock discusses the important and somewhat neglected phenomenon of successional disease in plants. She shows clearly how *Cryptomyces maximus*, which is a parasite, weakens *Salix fragilis* so that *Scleroderris fuliginosum*, a semi-parasite, can attack it. This in turn so weakens the tree that such a fungus as *Myxosporium scutellatum*, which is mostly a saprophyte, can then invade the tissues.

This issue of the Transactions opens with a fine portrait of Mr. Cheeseman, the president elect of the Society in 1925. Mr. Cheeseman was the type of amateur field-naturalist to which botanical science in England owes so much. Such men are now, unfortunately, all too rare, and Mr. Cheeseman's untimely death removes one who can little be spared in mycology. Many of us will remember him, in addition, as a very fine type of English gentleman. W. B. B.

Forest Administration in British Honduras.

BEFORE the War, forestry administration in many British smaller colonies and dependencies remained a dead letter. The governors were either men trained to diplomacy or distinguished soldiers. If consideration was given to the matter, it was dismissed with the argument that forestry would not pay. That the argument was fallacious can already be demonstrated by practical examples. For many years British Honduras has been noted for its mahogany, which was extracted on the principles that have destroyed so many forests in the world. Four years ago, the first attempt at introducing a forest administration into the country was made—not without many doubts as to the wisdom of the projected step, both at home and in the colony. A two years' trial was to be made, and three Forest Officers were appointed.

The fourth annual forest report on this new departure has just been issued. From its pages it is easy to see that the young department has already made good. So far, the work has been mainly devoted to assisting the several lumbering companies at work in the forests on government leases. In some respects the operations are proceeding on lines similar to the working of the Burmese forests by the British forest officers of earlier days. Already, however, the work of exploring the government forests, collecting topographical and other details, has been commenced (the superior staff now amounting to six), and it is hoped to be able to carry out the exploration of the practically unknown territory of the Western Highlands. The following remark in the report illustrates how fascinating and valuable this work will prove :

"At the time of writing a reliable base-line has been established between Vaca and the Rio Grande and a good general idea of the forests of this region obtained. The investigation has brought to light the presence of tree species hitherto unknown to occur in the Colony, and types of forest which, though mentioned in the narrative of Fowler and Sapper, have never been closely studied or described." The small staff have already commenced to study the sylviculture of some of the more important species such as mahogany and sapodilla, both at the successful and promising Botanic Station and elsewhere.

It may come as a surprise to many to realise that the forest produce of British Honduras is exported to the United Kingdom, Canada, and Bermuda, in the British Empire, and to the United States, France, Guatemala, Honduras, and Mexico. "The indications," says the Conservator of Forests, "of a developing trade in forest produce with Canada in the form of mahogany lumber, and with the neighbouring republics in the form of pine lumber, are satisfactory features. The general swing of the pendulum from foreign to British markets is governed by movements in mahogany : one would like to regard it as a permanent gain for British trade, but this would not be justifiable." It seems almost incredible that in view of the fact that four-fifths of the Colony's wealth is derived from its forests, the forest officer was only introduced four years ago, and that opposition should still exist to expenditure on the proper conservation and management of the forests; for this work, to be successful, will require a far larger staff than at present exists.

In the interests of the Empire it would be of value if the leaders responsible for the coal strike would give consideration to the following remark in the report : "The effects of the Coal Strike are at least in part responsible for a set-back in the price of mahogany." The report displays unmistakably the great possibilities of development in front of this Colony. The Conservator's attention may be directed to the oft-reiterated suggestion that vernacular names of trees, without their scientific ones, and also local vernacular terms untranslated, detract from the value of such reports outside the Colonies for which they are written.

University and Educational Intelligence.

CAMBRIDGE.—The late Prof. E. G. Browne has bequeathed to the University the sum of £2000 for the promotion of the study of the languages, literature, history, and religion of the Arabs, Persians, Turks, or other cognate Asiatic peoples.

The Gordon Wigan Prize for research in chemistry has been awarded to W. A. Waters, Gonville and Caius College, for an investigation on "Substitution in the Diphenyl Series." E. J. H. Corner, Sidney Sussex College, has been nominated to occupy the University table at the laboratory of the Marine Biological Association at Plymouth in March next.

Proposed regulations for the new professorship in political science have been published. Amongst points of interest are the proposals that the professor shall be excused residence in the University for one term in each year, if his absence is for the purpose of studying the working of political institutions or the development of political theory, and that grants may be made from the income of the endowment of the chair to the professor towards his travelling expenses or to students for purposes of travel or research.

EDINBURGH.—Dr. F. G. Banting, professor of medical research in the University of Toronto, has been awarded the Cameron Prize in recognition of his investigations on insulin and on the treatment of diabetes. This prize, which was founded in 1878, "may be awarded annually to a person who, in the course of the five years immediately preceding, has made a highly important and valuable addition to Practical Therapeutics."

LONDON.—The title of professor of psychology in the University has been conferred on Dr. Beatrice Edgell, in respect of the post held by her at Bedford College. The title of reader in psychology was conferred on her in Feb. 1913. She is the author of "Theories of Memory" (1924), "Mental Life" (1926), and numerous papers in the *Proceedings of the Aristotelian Society*, *Mind*, and similar publications.

Three further courses of free public lectures are announced, namely, "Allergic Diseases caused by Factors of Climate," by Prof. W. Storm van Leeuwen (University of Leyden), at the Sherrington School of Physiology, St. Thomas's Hospital, at 5 o'clock on Feb. 14, 15, and 16; "The Ostracoderms, their Organisation and Relationships," by Prof. E. A. Stensio (of the Royal State Museum of Natural History, Stockholm), at University College, at 5.30 on Feb. 17, 18, 22, and 24; "Trigonometrical Series," by Prof. G. H. Hardy, at the Imperial College of Science and Technology, at 5.30 on Feb. 17, 24, and Mar. 3.

OXFORD.—The first professors of Oxford to receive the title 'emeritus' under a new statute are two former occupants of the Linacre and Sherardian chairs, Dr. Gilbert Bourne and Dr. Sydney Vines. The qualification is an automatic and a curious one, namely, "at least 15 years' service as professor." Under this clause of the new statute, Dr. Bourne's great predecessor, Sir Ray Lankester, would appear not to be eligible for the new title, whereas nearly one-half of Oxford's professors of botany are easily, if posthumously, emeritus, their years of service having been: Bobart, 36 years; Humphrey Sibthorp, 37 years; Williams, 38 years; Daubeny, 33 years; Vines, 31 years.

In the Regulations for the Memorial Prize founded in memory of Prof. Rolleston and open to members of the Universities of Oxford and Cambridge, the title of the subject has been redefined as for zoology and comparative anatomy instead of for human and comparative anatomy.

TATE scholarships at the Battersea Polytechnic in engineering, science, and domestic science, ranging in value from £20 to £30 a year, with free tuition and tenable for three years, will shortly be awarded. The examinations for the scholarships will begin on June 14. The latest date of entry is April 23.

THE Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.C.3, is celebrating its twenty-fifth anniversary on Feb. 21, when the Institute will be open for inspection. A number of exhibits and demonstrations has been arranged in the laboratories by students and by manufacturers of scientific and other apparatus.

RANGING from Feb. 21 to April 1 inclusive, a series of twelve free public Swiney lectures on geology will be given by Dr. W. T. Gordon in the lecture theatre of the Imperial College of Science, South Kensington, under the title of "The Origin and Structure of Rocks." The lectures will be delivered at 5.30 on Mondays and Fridays. No tickets will be required.

THE Council of the Royal Statistical Society will this year award the Frances Wood Memorial Prize, value £30, for the best investigation, on statistical lines, of any problem affecting the economic or social conditions of the wage-earning classes. Particulars can be obtained from the honorary secretaries of the Society, 9 Adelphi Terrace, W.C.2, not later than Oct. 31.

THE University of London Animal Welfare Society, which has been formed to arouse interest in the welfare of animals among university students and teachers, has arranged a series of four public lectures by Major R. F. Wall on the care of domestic animals. The lectures are being delivered at Birkbeck College, London, on Feb. 9, 16, and 23, and Mar. 2, at 5.45 P.M. On Feb. 25, at 5.30 P.M., a discussion on the humane slaughtering of animals will be opened by Prof. G. H. Wooldridge, at King's College. By the rules of the Society it is precluded from taking part in controversies relating to vivisection. The honorary secretary is Capt. C. W. Hume, 14 The Hawthorns, Finchley, London, N.3.

THE West of Scotland Agricultural College annual report for 1925–26 records an increase in enrolment in central classes at Glasgow from 265 to 334, while the number of students in central classes at Kilmarnock (chiefly dairy and poultry schools) decreased from 292 to 277. The extension work included lectures and demonstrations with 35,661 attendances and 11,297 visits to farms, etc., by members of the College staff. Attention is directed to an important bequest by Mr. Colin Thomson for research work in connexion with the College and, in particular, with its dairy school at Kilmarnock. A first allocation proposed to be assigned under the bequest by the trustees amounted to £20,000, which is as much as two-thirds of the annual income of the College. A list of appointments gained by students during the year includes several in distant parts of the Empire: Canada, British West Indies, East and West Africa, the Sudan, the Federated Malay States, and Hong Kong. The report of the North of Scotland College of Agriculture records an attendance of 72 students at central classes, while extension work included lectures and demonstrations with 45,557 attendances, 14,135 visits to farms, etc., and 34,735 attendances at systematic and continuation classes.

Calendar of Discovery and Invention.

February 14, 1748.—The two great discoveries of Bradley were those of aberration and nutation. Both resulted from his attempt to determine the parallax of the stars. Aberration was discovered in 1727; he recognised nutation twenty years later, his discovery being made known in a letter dated Feb. 14, 1748, addressed to the Earl of Macclesfield. Bradley at that time was Astronomer-Royal, having succeeded Halley in 1742.

February 14, 1876.—In his attempts to transmit musical sounds by electricity, Alexander Graham Bell in 1875 devised a harmonic telegraph, in which reeds at the receiving end were set in motion by electro-magnets. It was an irregularity in the working of this which led Bell to the invention of the telephone. Elisha Gray had also been working at a telephone, and on Feb. 14, 1876, both filed applications for patents with the American Patent Office. It was found, however, that Bell's application had been received first, and a patent was granted him.

February 15, 1615.—Among the early works of interest to the engineer is "Les Raisons des forces mouvantes avec diverses machines . . ." of Salomon de Caus, the French architect. The author dedicated his work to Louis XI. on Feb. 15, 1615. It is in this work that he enunciated the theorem of the expansion and condensation of steam and his application of steam for raising water.

February 16, 1889.—Formally opened in March 1851, Owens College, Manchester, was referred to in 1858 by the *Manchester Guardian* as "a mortifying failure." Its later success was largely due to Roscoe, who had been appointed to the chair of chemistry in 1857. Thirty years later he retired, and in an address dated Feb. 16, 1889, presented to him by his former students, it was said: "For upwards of thirty years you have had the control and direction of the chemical department of the Owens College. You leave it the best-organised and best-equipped school of chemistry in the kingdom, numbering its students by hundreds, and the acknowledged model of the many similar institutions which the success of your own school has called into existence." Roscoe, like Playfair in after life, entered Parliament and was one of the recognised spokesmen for science in Great Britain.

February 17, 1753.—Stephen Gray, a pensioner of the Charterhouse, Dufay, a French military officer, the Abbé Nollet, and Sir William Watson, all transmitted electricity along wires, but the earliest distinct proposal for an electric telegraph is that contained in a letter signed "C. M." in the *Scots Magazine* for Feb. 17, 1753. By some "C. M." is believed to stand for Charles Morrison; by others for Charles Marshall, both of whom lived at Renfrew. The suggested telegraph had an insulated wire for each symbol; the receiver noted the attraction by a ball attached to the wire of a strip of paper about $\frac{1}{8}$ inch below it, on which was the symbol.

February 19, 1878.—During the summer of 1877, while engaged in the invention of a telegraph repeater for increasing the speed of sending telegrams, Edison used a metal disc with paper on it on which an embossing point worked by an electro-magnet indented dots and dashes. By reversing the operations and revolving the disc rapidly, musical notes were obtained. This suggested to Edison a means of recording and reproducing the sounds of the human voice, the first sketch of the phonograph being made on Aug. 12, 1877, and a patent being obtained on Feb. 19, 1878. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Feb. 3.—W. A. Bone, R. P. Fraser, and D. A. Winter: The initial stages of gaseous explosions. Part 1—Flame speeds during the initial 'uniform movement.' A gaseous explosive mixture is ignited at the *open* end of a horizontal tube 2·5 cm. in diameter. So long as the initial flame speed does not exceed about 4000 cm. per sec., there is a definite initial 'uniform movement,' the speed of which, under standard conditions of experiment, was nearly always fairly constant. But with initial flame speeds exceeding such limits, in ethylene-oxygen and acetylene-oxygen mixtures, the flame speed was continuously accelerated *ab initio* until detonation is set up, just as though the explosive mixture had been fired near the *closed* end of the tube. In hydrogen-oxygen mixtures, whilst the uniformity of the initial movement was still maintained, its speed tended to vary. In certain circumstances, a slow 'uniform movement' of flame can be developed in an explosive mixture after an initial period of continuous acceleration. Thus the speed at which a slow uniform flame movement can travel through an explosive mixture cannot be regarded as a physical constant of it, in the same sense as its rate of explosion (that is, detonation).

W. A. Bone, R. P. Fraser, and D. A. Winter: The initial stages of gaseous explosions. Part 2—An examination of the supposed law of flame speeds. The mixtures used for the tests have included several complex hydrocarbon and hydrogen-oxygen mixtures, in which the hydrocarbon has been either acetylene, ethylene, or methane; also a series of complex methane-hydrogen-air mixtures, all containing excess of combustible gas, have been examined. When ethylene, or methane was the hydrocarbon used, and the primary mixtures both contained excess of combustible gas, the effect of successive additions of the primary hydrogen-oxygen mixture to the primary hydrocarbon-oxygen mixture (both having the same initial uniform flame speed) is progressively to depress the initial uniform flame speed of the resulting complex mixture, until it refuses any longer to propagate flame. It therefore follows that Payman and Wheeler's 'law of flame speeds' is not generally applicable to gaseous explosions.

A. Egerton and S. F. Gates: On detonation of gaseous mixtures of acetylene and of pentane (1). The conditions for detonation to occur in the same place in a tube of certain dimensions have been investigated for acetylene and for pentane mixtures of definite composition. Detonation appears to take place slightly ahead of the combustion front. The 'anti-knock' compounds, lead tetraethyl and diethylselenide, did not affect the position of detonation at ordinary initial pressures and temperatures.

A. Egerton and S. F. Gates: On detonation of gaseous mixtures at high initial pressures and temperatures (2). Detonation in acetylene and in pentane mixtures at high initial temperatures (230° C.) and pressures (10 atmospheres) has been investigated photographically, using a steel tube fitted with glass windows. Increase of initial pressure engenders earlier detonation up to a certain limit, when further increase makes very little difference. At a given initial pressure, rise of initial temperature appears to render detonation slightly later. Lead tetraethyl does not affect the position of detonation at high pressure either at normal initial temperature or at 23° C.

W. A. Bone and A. Forshaw: Studies upon catalytic combustion. Part 5.—The union of carbonic oxide and other gases with oxygen in contact with a fireclay

surface at 500° C. The surface catalyses the combination of (moist) carbonic oxide and oxygen much in the same way as it does that of hydrogen and oxygen at the same temperature, though in a less degree. With a moist mixture of the carbonic oxide and oxygen in their combining proportions, the rate of combination is always directly proportional to the pressure of the dry mixture, provided that the surface is in a 'normal' condition, and the reaction product quickly removed from the system. The catalysing power of the surface can be greatly stimulated, but not permanently, by previous exposure at the reaction temperature to the combustible gas. When the carbonic oxide and oxygen are present in other than their combining proportions, their rate of combination is proportional to the partial pressure of the carbonic oxide. Of hydrogen, carbonic oxide, and methane, the first-named is the most, and the last-named the least, amenable to the catalytic combustion.

M. W. Garrett: Experiments to test the possibility of transmutation by electronic bombardment. An attempt to transmute tin into indium, in a quartz apparatus similar to that used by Smits, proved a failure, in spite of the employment of high current densities and the extraordinary sensitiveness of the spectroscopic method. Indium was detected in all the samples of 'pure' tin examined. The 4102 line was found to be the most persistent in the spectrum of this element (de Gramont lists 4511). Attempts were made to prepare scandium from titanium, using electrons of sufficient speed to be certain of penetrating the *K* ring of this element. Titanium was bombarded with 12,000-volt electrons from a hot filament in an evacuated bulb, but no evidence of any transmutation was obtained.

R. G. J. Fraser: The effective cross-section of the oriented hydrogen atom. Search for a change in the collision area of the hydrogen atom following space quantisation yields a negative result. The hydrogen atom in the normal (1*s*) state is thus isotropic. Spherical symmetry for an *s*-state follows as a necessary consequence of the Schrödinger atom theory; hence the present result, and also the absence of double refraction in space quantised sodium vapour (Schütz), are satisfactorily explained.

L. Pauling: The theoretical prediction of the physical properties of many electron atoms and ions: Mole refraction, diamagnetic susceptibility, and extension in space. The general method followed is capable of refinements which should make possible the accurate prediction of the properties of any atom or ion. The most obvious one is the use of the wave mechanics in determining the state of an electron under the influence of a positive nucleus and several idealised electron shells. Explicit expressions for the properties of an electron in such a state may then be derived, eliminating the necessity of the more or less inaccurate adaptation of the equations obtained for hydrogen-like atoms. Further progress may also be made in approximating an electron shell more closely than is possible with a spherical surface charge. All of these refinements will greatly complicate the treatment.

B. F. J. Schonland and J. Craib: The electric fields of South African thunderstorms. A station for measurements in electrical meteorology has been established at Somerset East, Cape Province, South Africa. Observations have been made of the electric fields and field changes associated with 18 distant and 5 near thunderstorms. The sudden changes of field due to distant lightning discharges (>8 km.) were predominately negative in sign, those due to near discharges (<6 km.) predominately positive. The relative frequencies of positive and negative changes were 1 : 5 in the former case and 4·3 : 1 in the latter. The steady electric fields below the five near storms were all strongly negative. These results indicate that the thunderclouds were bipolar in nature and that the polarity was generally, if not always, positive, the upper pole being positive and the lower pole negative. It is doubtful if any active storms of opposite polarity were observed at all. The mean value of the electric moments of the charges removed by 82 lightning discharges is 94 coulomb-kilometres.

Royal Microscopical Society, Dec. 15.—Stanley Hirst: Note on the development of *Allothrombium fuliginosum* Hermann. The six post-embryonal stages are: (1) ovum; (2) prelarval stage; (3) larval form; (4) resting stage of larval form; (5) nymph; (6) adult. The insects are parasitic on aphids both in the immature and adult stages. The adults suck the juices generally of the inert stages of the aphis. They also feed on freshly-killed flies and their maggots. Two species of aphids, *Macrosiphum gei* Koch. and *Myzus persicæ* Sulzer, both occurring on the common dock, were used as food for both larval and adult *A. fulginosum*.—A. Kefalas: A method of staining sections in acetone. Two staining solutions are used: (1) Liq. ferri sesquichlor (double B.P. strength), 3 c.c.; pure strong hydrochloric acid, 1 drop; 1 per cent. solution of ripe hæmatoxylin in good acetone, 100 c.c.; (2) is a saturated solution of Biebrich scarlet (Grübler) in acetone. The slides are passed through six stoppered cylinders of the old type containing xylol, acetone, solution (1), solution (2), acetone, and xylol. In solution (1) they are allowed to over-stain slightly. They are mounted in balsam. The method is cheap, rapid, and easy, well suited for routine work, and over-staining does not easily occur. The slides, moreover, are kept in a fixative solution all the time and are subjected to little change in osmotic tensions.—J. Ramsbottom and E. H. Ellis: Seedling structure of cultivated orchids. Fungal mycelium occurs in the roots of orchids, and in order to germinate the seeds, they must generally be infected by the same fungus. Germination can also be brought about by sterilising the seeds and supplying them with a nutrient solution containing some kind of sugar. Photomicrographs of numerous orchid seedlings and mature roots, the roots being of native British plants growing wild and of horticultural varieties, were examined. The seedlings showed fungal infection, distribution of the fungus, and 'clumping' of hyphæ in closely parallel series. Some of these seedlings (bi-generic hybrids, etc.) had been artificially inoculated by using cultures of one of the orchid fungi, whereas others had become infected when grown in the ordinary horticultural way. Seedlings of wild British orchids show the same sequence of events, and as the fungus is always the same for one species of orchid, it would appear that the process is an adaptative one and not merely chance parasitism.

Linnean Society, Jan. 6.—C. Norman: Pimpinellas of tropical Africa. This Umbelliferous genus is well represented in tropical Africa by about 25 species. It occurs in all parts of the tropical region, usually in open country at an elevation of not less than about 3000 ft., ascending to 10,000 ft. on the mountains. With one exception all the species belong to the sub-genus Eu-pimpinella, and they are nearly always found growing amongst grasses in open country. Only one species seems to occur in tropical and southern Africa, and that is the common *P. caffra*, which reappears unexpectedly in Abyssinia.

Mineralogical Society, Jan. 18.—A. Brammall and H. F. Harwood: The temperature-range of formation for tourmaline, rutile, brookite, and anatase in the

Dartmoor granite. Applying Wright and Larsen's conclusions concerning rock types in which quartz originated in the α- or the β-phase, the authors adduce petrological evidence to support the following approximations: The range for tourmaline extends from magma-temperatures *circa* 800° downwards through an optimum range *circa* 600°-300° into an unfavourable range with an undetermined lower limit. The range for rutile is at least co-extensive with that for tourmaline. The range for anatase extends downwards from temperatures connoted by crystallisations from small residual pools of boro-silicate flux accumulating at a late stage in the consolidation of the granite ground mass, to temperatures at which simple hydrolysis of biotite occurs. The range for brookite lies within that for anatase. For each species, extension of the range downwards may be necessary to cover cases of suspected authigenic growth in sediments.—A. Russell: Notice of an occurrence of niccolite and ullmannite at the Settlingstones Mine, Fourstones, Northumberland; of stichtite at the Island of Unst, Shetlands; and of serpierite at Ross Island Mine, Killarney, Co. Kerry, Ireland. In working a body of galena in the witherite vein of Settlingstones mine, a small quantity of very rich niccolite intimately associated with ullmannite, blende, galena, and witherite, was met with. Polished sections of the ore show the niccolite in roughly spherical to botryoidal forms, often surrounded by fringes of ullmannite and associated with brown blende and white witherite. Minute cubes of ullmannite occur in the witherite. Stichtite occurs in characteristic fibrous lilac-coloured specimens associated with kämmererite and chromite in serpentine at the "Kämmererite Quarry," Nikka Vord, Balta Sound, Island of Unst, Shetlands. The rare mineral serpierite occurs in cavities in cellular calamine ($ZnCO_3$) on the old dumps at Ross Island Mine, Killarney, Co. Kerry, Ireland. It forms small greenish-blue spherical aggregates composed of minute crystals flattened parallel to *c*(001) and elongated in the direction of the *a* axis.

Geological Society, Jan. 19.—L. J. Chubb: The geology of the Austral or Tubuai Islands (Southern Pacific). This group is situated about 350 miles south of Tahiti, and 1800 miles north-east of New Zealand. It includes seven islands, of which four are here described. Rapa is a crateriform island, the slopes of which have been deeply dissected by radial streams, while the ends of the spurs between the valleys have been strongly cliffed by the sea. After one of the radial streams had captured the drainage of the crater, the island was submerged, with the result that the river-valleys were embayed, and the crater flooded. Afterwards slight elevation occurred. Marotiri consists of a number of needle-like stacks rising out of the sea, and situated roughly on the circumference of a circle. Probably it represents the last stage of an island of the type of Rapa which has subsided. Rurutu is without the sharp peaks and serrated ridges characteristic of Rapa, and the valley-mouths are not embayed. The history of the island appears to be one of frequently-renewed, intermittent elevation, stationary periods being indicated by raised plateaux, and the different degrees of weathering of the rocks at different levels. In the later stages a fringing-reef came into existence, which was finally uplifted. A narrow fringing-reef has developed around the island in recent time. Rimatara is surrounded by a coral-reef about 2 miles wide. The outer edge of the central island is occupied by an elevated reef, which faces the sea in a line of cliffs 20 or 30 feet high. The islands are arranged along lines having a general west-north-westerly and east-south-easterly trend; their movements of elevation and subsidence may be due to their being situated on a submerged anticlinal fold, the crest of which has moved northwards.—W. Campbell Smith and L. J. Chubb: The petrography of the Austral or Tubuai Islands (South Pacific), with chemical analyses by E. D. Mountain. Except for a few small local occurrences of pyroclastic rocks, the volcanic rocks of Rapa consist of phonolitic and basaltic lavas invaded by many dykes and other small intrusions. Of the latter, the most interesting probably forms the plug in the vent of the main volcano. It is an extremely melanocratic olivine-theralite. The basic porphyritic basalts are the predominant lavas: they resemble the picritic basalts of Hawaii and the ankaramites (ultrabasic basalts) of Tahiti. All the acid and basic lavas compare very closely with rocks from Tahiti, while rocks comparable with the trachy-basalt and the basic andesine-andesite have been described from Hawaii. In Rurutu occurs an olivine-bearing nepheline-tephrite, which resembles a rock described from Franklin Island (Antarctica). Otherwise the basic lavas found in this island are similar to those of Rapa.

EDINBURGH.

Royal Physical Society, Jan. 17.—A. C. Stephen: A short list of mollusca collected off Franz Joseph Land and Spitsbergen by the British (Algarson) Arctic Expedition, 1925.—A. W. Greenwood: Pterylosis in the 'hackleless' fowl. A study of the distribution and development of plumage in the 'hackleless' fowl does not support the view that this is an example of the inheritance of an acquired pathological condition. The condition appears to be genetic in origin and is due to the complete absence of feather follicles in certain areas of the body.—Miss J. S. S. Blyth: The Manoilov reaction for the identification of sex and its application to the case of the sexually abnormal fowl. It can be shown that the Manoilov test is not an all-or-none reaction but a quantitative one. The intersexual individual gives a reaction intermediate between that of the normal male and the normal female, and varying with the degree and type of sexual abnormality.

MANCHESTER.

Literary and Philosophical Society, Jan. 11.—W. H. Lang and Isabel C. Cookson: Some early palæozoic plants from Victoria, with comparative remarks. These specimens have been brought from the collections of the Geological Survey of Victoria and the National Museum, Melbourne, for comparison with British pre-carboniferous plants. They were found in rocks of the Wallhalla syncline in the Gippsland region that are usually regarded as of Yeringian (Upper Silurian) Age. On palæontological grounds the chief plant-containing beds are, however, believed by Mr. F. Chapman to belong to a higher series, which he terms Tanjilian; the Geological Survey on stratigraphical grounds places these beds at a lower level in the Yeringian. While the geological age of the beds must largely depend on their animal fossils, it has been rightly pointed out by Chapman that the plant-remains would support an age considerably later than the Silurian. They include stems of uncertain affinity with crowded, long, simple leaves; shoots with small leaves or spines which have been described and figured as Arthrostigma, but appear more closely comparable with the Middle Devonian plant Thursophyton; smooth-branched axes that resemble those from the Middle Devonian which are known as *Hostimella sp.*, and sometimes even agree with these in the presence of a 'bud-like' structure in the axil of the branch; and fragments that may be of such

plants, though the possibility of the occurrence of Nematophyton must be kept in mind. The flora, as represented by these specimens, on the whole suggests comparison with that of the Middle Devonian or Middle Old Red Sandstone of the northern hemisphere. Its occurrence in rocks along with a Silurian fauna raises interesting problems.—E. J. **Williams**: The passage of α- and β-particles through matter. Experimental results for the number of ions per unit length of track produced by β-rays (velocity about 5×10^9 cm./sec.) in hydrogen, nitrogen, and oxygen are given. The theoretical values, according to Sir J. J. Thomson's theory, account for only about one-half of the observed ionisation. New calculations are given in which the motion of the atomic electrons is taken into account. The necessary data for the calculation of the theoretical values are most certain for hydrogen, and in this case the new theoretical value is within experimental error of the observed value. In discussing stopping powers, values for β-rays recently obtained by Mr. Nuttall and the author are used. These are free from errors arising from scattering. The relation between the atomic stopping powers for α-rays and those for β-rays are discussed. Bohr's theory does not represent the facts. Allowance for the motion of the atomic electrons decreases the discrepancy between Henderson's theory and the observations, about 80 per cent. of the stopping power being thus accounted for. The residual discrepancy is probably real and it may be greater for α-rays than for β-rays.

PARIS.

Academy of Sciences, Jan. 4.—Gaston **Julia**: The means of the moduli of analytical functions.—Jean **Thibaud**: The various crystalline forms of long-chain organic compounds and the difficulties of interpretation of their X-ray spectra. The interstice d of an organic substance capable of orientation, taken as an analytical character, is subject to variation, depending on its origin, mode of preparation, and its degree of purity. When the substance to be analysed is a mixture of similar substances with nearly the same number of carbon atoms in the molecules, the use of the interstice loses part of its analytical value.—A. **Henne** and G. L. **Clark**: The spectrography of flames in an explosion motor. Photographs were taken of the complete explosion and also of the four quarters of the explosion separately, with special reference to the phenomenon of knocking. The influence of the addition of such antidetonants as lead tetra-ethyl is to regularise the explosion in such a manner that the amount of energy liberated per unit of time varies only slightly throughout the course of the explosion.—Nicolas **Perrakis**: The specific heats of a sufficiently cooled non condensed phase. J. Perrin, from Eucken's experiments, arrived at the conclusion that all gases sufficiently cooled take the same molecular heat as the monatomic gases. The same conclusion is now obtained from simple theoretical considerations.—Mme. **Ramart-Lucas** and Mlle. **Amagat**: Molecular transpositions. The preparation and dehydration of some α-alkyl-α-phenyl-ethanols.—G. **Darzens** and A. **Heinz**: p-Xylyl-allylacetic acid and its conversion into cyclic tetrahydronaphthalene derivatives. The preparation of a new dimethyl-naphthalene. This synthesis is carried out in the following stages: ethyl p-xylyl-malonate, ethyl p-xylyl-allyl-malonate, dimethyl-tetrahydronaphthalene carboxylic acid, dimethyl-naphthalene carboxylic acid, dimethyl-naphthalene.—Itizo **Kasiwagi**: The action of nitromethane and its homologues on benzil.—G. **Kempp**: The modification of a frequency curve brought about by the superposition of a sinusoidal variation with accidental variability. A mathematical discussion of the temperature variations at Spitsbergen.—Pierre **Lesage**: The persistence of precocious character (in plants) at different periods of the year.—Henri **Humbert**: Two types of unifacial structure of the leaf in Madagascan Senecio.—G. **Guittonneau**: The microbial oxidation of sulphur in the course of ammonia production from peptone.—J. **Sabrazes**: The spirochæte of yaws (*Spirochæta pertenuis*): its coloration.

COPENHAGEN.

Royal Danish Academy of Science and Letters, Nov. 11.—O. B. **Boggild**: The meteoric iron block from Savik at Cape York. Occurrence and history; form and surface; composition of the interior; researches of the structure of the octahedrites.

Dec. 17.—Niels **Bohr**: Atomic theory and wave mechanics. The quantum theory of atomic constitution contains an essential element of discontinuity contrasting with the classical theories of mechanics and electrodynamics. In view of the recent promising results of the modification of classical mechanics known as the wave mechanics, the problem has arisen as to the possibility of avoiding any element of discontinuity in the description of atoms. This possibility, however, would seem excluded in the present state of science, where we meet with difficulties regarding fundamental concepts common for the classical theories and wave mechanics.

GENEVA.

Physical and Natural History Society, Dec. 16.—E. **Briner**, G. **Lunge**, and A. **Mirimanoff**: The reaction of nitrogen peroxide with sulphurous anhydride. The reaction is $2SO_2 + 3NO_2 = S_2N_2O_9 + NO$. The substance $S_2N_2O_9$ was obtained by La Provostaye, who, however, supposed it to be formed by another process.—E. **Briner** and O. **Agathon**: On the combinations of the phenols with ammonia, and the formation of higher ammoniates. Besides the mono-ammoniates formed by the addition of one molecule of ammonia to the phenols, the authors found, in operating with higher pressures, a production of ammoniates containing several molecules of ammonia.—A. **Jayet**: The Albian of the Reposoir (Haute-Savoie).—L. W. **Collet** and R. **Perret**: A supplement to the geology of the Col d'Anterne and the Cirque des Fonts.—E. **Bujard**: Action of repeated injections of ovalbumin upon the testicle of the white rat. Lesions are produced similar to those produced by alcohol and iodine.—E. **Cherbuliez** and R. **Wahl**: The hydrofluoric hydrolysis of the proteids. This does not eliminate the formation of humic substances any more than does hydrochloric or sulphuric hydrolysis.—A. **Pictet**: Synthesis of lactose. Glucose is transformed into glucosane, and this into diglucosane. The latter is condensed with β-galactose, giving a lactose anhydride, which is then hydrolysed.—E. **Paréjas**: Bone deposit of the Doldenhorn. The fragments can be with certainty ascribed to a reptile.—E. **Paréjas**: New observations on the base of Mont Joly (Haute-Savoie). A correction of tectonic interpretation; the coal strata are triassic and not carboniferous.

SYDNEY.

Linnean Society of New South Wales, Nov. 24.—Miss Lesley D. **Hall**: The physiography and geography of the Hawkesbury River between Windsor and Wiseman's Ferry. A detailed description is given of the physiography of the main river and the lower portions of its tributaries. Man's dependence on

physiographic factors is traced from the beginnings of settlement to the present day.—G. H. Hardy: A reclassification of the Australian robberflies of the Cerdistus-Neoitamus complex (Diptera-Asilidæ). The status of several genera, for which no scheme of classification hitherto evolved has met with general acceptance, is discussed. The generic name Cerdistus is adopted for the group, and under it Neoitamus, Cerdistus, and Stilpnogaster are ranked as subgenera, each of which is well represented in Australia.—A. H. S. Lucas: Notes on Australian marine algæ. (iii.) The Australian species of the genus Nitophyllum. *N. erosum* extends on the west coast so far north as the Houtman's Abrolhos, and *N. sinuosum* up to Port Stephens on the east coast, but the genus is only abundantly represented in the south, with its headquarters in Bass Straits, where multifarious forms occur which may be regarded as varieties or species.—M. Aurousseau: Analyses of three Australian rocks. Analyses are presented (*a*) of the well-known rock from One Tree Point, Sandy Bay, Hobart, Tasmania, a supposed fayalite basalt or melilite basalt, but actually a nephelite basanite; (*b*) of a micrographic granite from Ashford, N.S.W., that shows complicated graphic intergrowth; (*c*) of a peculiar amphibolite from Bunker Bay, Cape Naturaliste, W.A.—G. H. Cunningham: Gasteromycetes of Australasia. (vi.) The genus Lycoperdon. A critical revision of the members of the genus in Australia and New Zealand.

Official Publications Received.

BRITISH AND COLONIAL.

Canada. Department of Mines: Mines Branch. Investigations in Ore Dressing and Metallurgy (Testing and Research Laboratories) 1925. (No. 670.) Pp. ii+123+4 plates. Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1925. (No. 672.) Pp. 35. (Ottawa: F. A. Acland.)

The Quarterly Journal of the Geological Society. Edited by the Permanent Secretary. Vol. 82, Part 4, No. 328, December 31st. Pp. 489-677+xx+17 plates. (London: Longmans, Green and Co., Ltd.) 7*s.* 6*d.*

Aeronautical Research Committee: Reports and Memoranda. No. 1041 (A.3): Accidents to Aeroplanes involving Flutter of the Wings. Report of the Accidents Investigation Sub-Committee. (D.1. Special Technical Questions, 161.—T. 2168.) Pp. 19+12 plates. 1*s.* 3*d.* net. No. 1045 (E.21): On the Equivalence between the Dynamical System of a Multi Crank Flywheel System and a certain Electrical Circuit, with some Suggestions for Measuring Critical Speeds and Shaft Stresses by Analogy. By E. B. Moullin. (T.V.C.9.) Pp. 9. 9*d.* net. (London: H.M. Stationery Office.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1926. Pp. 24+5 plates. (Bristol.)

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Nineteenth Annual Report, 1925-26, presented by the Council to the Court of Governors on the 22nd October 1926. Pp. 50+6 plates. (Cardiff.) 6*d.*

County Borough of Reading: Museum of Economic Botany. Catalogue. Pp. 31. (Reading.)

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 52, Part 1, January. Pp. 152+lxxvi+40 plates. (London.) 7*s.* 6*d.*

Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 29: Responses of Plant Tissues to Electric Currents. By Prof. H. H. Dixon and T. A. Bennet-Clark. Pp. 351-372. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2*s.*

The Journal of the East Africa and Uganda Natural History Society. No. 27, November. Pp. 197-245+plates 15-34. (Nairobi.) 10*s.*

Journal of the Chemical Society: containing Papers communicated to the Society. January. Pp. vi+iv+281. (London: Gurney and Jackson.)

Hull Museum Publications No. 145: Record of Additions, No. 70. Edited by T. Sheppard. Pp. 47. (Hull.)

FOREIGN.

Department of Commerce: U.S. Coast and Geodetic Survey, Terrestrial Magnetism. Serial No. 353: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1925. By Daniel L. Hazard. (Special Publication No. 125.) Pp. 37. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of the Interior: U.S. Geological Survey. Bulletin 785C: Borate Deposits in the Kramer District, Kern County, California. By L. F. Noble. (Contributions to Economic Geology, 1926, Part 1.) Pp. ii+45-61. Bulletin 785D: Note on a Colemanite Deposit near Shoshone, Calif.; with a Note on the Geology of a Part of Amargosa Valley. By L. F. Noble. (Contributions to Economic Geology, 1926, Part 1.) Pp. ii+63-75. Bulletin 786A: The Geology of the Ingomar Anticline, Treasure and Rosebud Counties, Montana. By K. C. Heald. (Contributions to Economic Geology, 1926, Part 2.) Pp. iv+37+2 plates. (Washington, D.C.: Government Printing Office.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 8, Part 1: Botany of Porto Rico and the Virgin Islands. Mycology. By Fred J. Seaver and Carlos E. Chardon; with Contributions by Rafael A. Toro, F. D. Kern and H. H. Whetzel, and L. O. Overholts. Pp. 208. (New York City.) 2 dollars.

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 9: Statistics of Public, Society and School Libraries, 1923. Pp. 179. (Washington, D.C.: Government Printing Office.) 25 cents.

Department of Commerce: Bureau of Standards. Miscellaneous Publications, No. 74: Weights and Measures. Nineteenth National Conference of Representatives from various States held at the Bureau of Standards, Washington, D.C., May 25, 26, 27 and 28, 1926. Pp. xv+172+6 plates. (Washington, D.C.: Government Printing Office.) 60 cents.

Sveriges Geologiska Undersökning. Ser. C, No. 334, Årsbok 19 (1925), No. 1: Hydrologiska undersökningar av åkerjord inom Örebro län. Av Gunnar Ekström och Herman Flodkvist. Pp. 48. 1 kr. Ser. C, No. 335, Årsbok 19 (1925), No. 2: Södra Sveriges torvtillgångar, 1. Av Lennart von Post och Erik Granlund. Pp. 127+15 tavlor. 8 kr. Ser. C, No. 336, Årsbok 19 (1925), No. 3: On the Differentiation of the Alkalies in Aplites and Aplitic Granites. By N. Sundius. Pp. 43. 1 kr. Ser. C, No. 337, Årsbok 19 (1925), No. 4: Einige Aufgaben der regionalen Moorforschung. Von Lennart von Post. Pp. 41. 1 kr. Ser. C, No. 338, Årsbok 19 (1925), No. 5: Mullmalmer i Svenska järngruvor. Av Per Geijer och Nils H. Magnusson. With a Summary: The Occurrence of 'Soft Ores' in Swedish Iron Mines. Pp. 53+2 tavlor. 1 kr. Ser. C, No. 339, Årsbok 19 (1925), No. 6: Ravinbildningen i Gustavs. Av Carl Czon Caldenius. Pp. 26+3 tavlor. 1 kr. (Stockholm.)

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1925. (Publication 2836.) Pp. xii+633+84 plates. (Washington, D.C.: Government Printing Office.) 1.50 dollars.

Proceedings of the United States National Museum. Vol. 69, Art. 18: Notes on the Age of the Continental Triassic Beds in North America, with Remarks on some Fossil Vertebrates. By F. R. von Huene. (No. 2644.) Pp. 10. (Washington, D.C.: Government Printing Office.)

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 16, Art. 3: Notes on Homoptera from Illinois, with Descriptions of New Forms, chiefly Eupteryginae. By W. L. McAtee. Pp. 127-136. (Urbana, Ill.)

U.S. Department of the Interior. Annual Report of the Commissioner of Education to the Secretary of the Interior for Fiscal Year ended June 30, 1926. Pp. iii+36. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES.

Catalogue méthodique des livres de médecine. Pp. 96. (Paris: Masson et Cie.)

Electric Furnaces at the British Industries Fair, Birmingham. Pp. 6. (London: Automatic and Electric Furnaces, Ltd.)

Origin of Mankind: being a Catalogue of Books relating to Anthropology, Folklore, Ethnography, Archaeology, Occult, Heathenism, Witchcraft, Native Races, Mythology, Magic and sundry other Subjects concerning Man. (No. 491.) Pp. 68. (London: Francis Edwards.)

Neue Bücher. Januar. Pp. 47. (Berlin: Julius Springer.)

Diary of Societies.

SATURDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: 'Atmosphere' in Fiction.

MINING INSTITUTE OF SCOTLAND (at Edinburgh).

MONDAY, FEBRUARY 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir Berkeley Moynihan, Bart.: Hunterian Oration.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr. R. T. Gunther: Certain Early Astronomical Instruments and their Makers, illustrated by the Exhibition of Instruments in the possession of the University of St. Andrews and by lantern slides (Address).—Sir J. R. Findlay: Exhibition and Description of certain Instruments from his Private Collection.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Lt.-Comdr. R. Gould: The Landfall of Columbus.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—E. W. Sisman: The Straight-Eight Engine.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Sopwith's Café, Newcastle-upon-Tyne), at 7.—Informal Discussion on The Problem of Rural Supplies.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 7.—W. M. Selvey: Power Stations and their Equipment (Lecture).

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—D. R. Tullis: Notes on Aluminium Alloys.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. R. F. A. Hoernle: Problems and Methods of Metaphysics.

ROYAL SOCIETY OF ARTS, at 8.—Prof. E. G. Coker: Photo-elastic Measurements of Stress Distribution (Cantor Lectures) (1).

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemistry, Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 8.—B. D. W. Luff: The Use of the Microscope in Qualitative Analysis.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 8.—Dr. Cloudesley Brereton: The Philosophical Basis of the Teaching of Literary Appreciation.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Botany School, Cambridge), at 8.45.—Prof. H. L. Hawkins: Some Problems in the Evolution of the Echinoidea.

INSTITUTE OF CHEMISTRY (Manchester and District Section).—Prof. R. Robinson: Electronic Theories of Valency in Organic Chemistry.

TUESDAY, FEBRUARY 15.

ELECTRICAL ASSOCIATION FOR WOMEN (at King's College for Women (Household and Social Science Department), Campden Hill Road), at 5.15.—Mrs. C. Frederick: How the American Housewife solves her Household Difficulties.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—G. H. Wood: An Examination of some Statistics relating to the Wool Textile Industry.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ROYAL SANITARY INSTITUTE, at 5.30.—Dr. W. Robertson and others: Discussion on Immunisation against Diphtheria.

ROYAL AERONAUTICAL SOCIETY, at 6.—W. M. Dyson and others: Informal Discussion on Materials, with special reference to Corrosion.

CHILD-STUDY SOCIETY (at Caxton Hall), at 6.—Hon. Bertrand Russell: Nursery Schools.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—H. Spooner: The Natural Regeneration of Woodlands.—R. W. Hale: The Little Owl.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Institution of the Rubber Industry) (at 39 Elmbank Crescent, Glasgow), at 7.—B. D. Porritt: The Milling of Rubber.—T. R. Dawson: The Hardness Testing of Vulcanised Rubber.—J. T. Strachan: Demonstration of a New Piezo-micrometer.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. C. Dollman: Good Taste, Bad Taste, and No Taste at all.

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineering and Scientific Club, Birmingham), at 7.30.—A. H. R. Fedden: The Supercharging of Aircraft and Motor Vehicle Engines.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES.—Prof. J. S. Huxley and Dr. M. Ginsberg: The Claims of Eugenics.

WEDNESDAY, FEBRUARY 16.

SOCIETY OF GLASS TECHNOLOGY (jointly with Yorkshire Section of Society of Chemical Industry) (at Sheffield University), at 2.30.—General Discussion on Silicate Analysis:—W. H. Withey: A Critical Survey of Methods for the Analysis of the Simpler Glasses.—Violet Dimbleby: Notes on Methods Used in the Analysis of Glasses.—W. J. Rees: The Analysis of Refractories.—T. P. Colclough: Notes on the Analysis of Silicate Slags.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Prof. J. F. Dobson: Erasistratus.—W. R. Dawson: Contribution to the History of Mummification.—Dr. C. Singer: An Example of the Egyptian God Bes Exhibiting Symptoms of Spina Bifida.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. E. M. Cowell: Recent Advances in the Surgery of Hernia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (3).

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—R. F. Legget: Some Considerations of our Power Resources.

INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—E. W. Sisman: The Straight-Eight Engine.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (jointly with Liverpool Engineering Society) (at The Temple, Dale Street, Liverpool), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—P. Dunsheath: 33,000-Volt Cables with Metal-Sheathed Cores, with special reference to the S.L. Type.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—E. Hinchliffe: The Experiment Tank in Ship Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (jointly with Institute of Metals—Sheffield Local Section) (at Sheffield University), at 7.30.—Dr. V. E. Pullin: The Application of X-Rays to the Examination of Metals (Lecture).

EUGENICS SOCIETY (at Hotel Rembrandt), at 7.30.—Dr. A. F. Tredgold: Mental Disorder in relation to Eugenics (Galton Lecture).

MERSEYSIDE AQUARIUM SOCIETY (at Liverpool Museum), at 7.30.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Dr. J. Glasspoole: The Variability of Average Monthly Rainfall throughout the Year.—Dr. L. F. Richardson and D. Proctor: Diffusion over Distances ranging from 3 km. to 86 km.

ROYAL SOCIETY OF ARTS, at 8.—C. C. Paterson: Some Studies in Electric Lamps and Valves.

FOLK-LORE SOCIETY (Annual Meeting) (at University College), at 8.—Presidential Address.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Dr. W. E. Cooke: The Life History of the Neutrophil Polymorphonuclear Leucocyte.—Dr. A. S. Parkes, Dr. F. W. R. Brambell, and F. Melville: The Effect of X-Ray Sterilisation on the Development of the Accessory Organs of Reproduction in the Mouse.

INSTITUTE OF CHEMISTRY (London Section).

ROYAL MEDICO-PSYCHOLOGICAL ASSOCIATION (at Cheshire County Mental Hospital, Parkside, Macclesfield).—Prof. T. H. Pear: Recent Investigations on Visual Imagery, with special reference to Hallucinations.

THURSDAY, FEBRUARY 17.

ROYAL SOCIETY, at 4.30.—G. U. Yule: Wolfer's Sunspot Numbers considered as a Disturbed Periodic Series.—Dr. G. M. B. Dobson and D. N. Harrison: Measurements of Ozone in the Earth's Atmosphere and its Relations to other Geophysical Conditions—Part II.—H. Horrocks: Meteorological Perturbations of Tides and Currents in an Unlimited Channel Rotating with the Earth.—*To be read in title only:*—Prof. H. Levy and A. G. Forsdyke: The Stability of the Vortex System in the Rear of a Moving Body.—A. Fage: The Flow of Air and of an Inviscid Fluid around an Elliptic Cylinder and an Aerofoil of Infinite Span.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: Acoustical Problems treated by Lord Rayleigh (3): Bells.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—S. Marks The Educational Aspect of the Model Theatre.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—F. H. Clough: The Stability of Large Power Systems.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Major R. H. Mayo: The Design and Operation of Commercial Aircraft.

CHEMICAL SOCIETY, at 8.—H. O. Askew: The Production of Fog in the Neutralisation of Alkali with Hydrogen Halides.—F. H. McDowell: Constituents of Myoporum Laetum Forst. (The "Ngaio.") Part II. Hydrogenation of Ngaione and Ngaiol, and Dehydration of Ngaiol.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Lt.-Col. W. P. MacArthur: Old-Time Typhus in Britain.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Meeting).

INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section) (at Liverpool).—H. C. Young: Production Methods in a Rubber Factory.

FRIDAY, FEBRUARY 18.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Dr. Vaughan Cornish: The Propulsion of Waves in Granular Material by Winds and Currents. Other speakers, Dr. T. E. Stanton, Dr. H. Jeffreys. Chairman, Sir Frank Dyson.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. H. Southam: The Pathology and Treatment of the Retained Testis in Childhood.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Col. Sir Frederick L. Nathan: Fuels for Internal Combustion Engines.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Fuel Lecture.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—Mrs. C. Frederick: Household Engineering and Efficiency Tests.

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

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. L. Eavestaff: The Graphic Eye and the Photographic Eye.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—L. Turner: Modern Concrete Construction: A Review of Recent Progress and Problems.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Josiah C. Stamp: The Laws of Monetary Science.

SATURDAY, FEBRUARY 19.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: The Supernatural in Fiction.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB (Exhibition Meeting), at 8.15.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 12.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. Edith Durham: Some Old Montenegrin Customs.

SUNDAY, FEBRUARY 13.

GUILDHOUSE (Eccleston Square), at 3.30.—N. C. Sen: Brahmo Somaj.

MONDAY, FEBRUARY 14.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. P. Geyl: Dutch Society and Dutch Politics in Spinoza's Time.

ST. THOMAS'S HOSPITAL (Sherrington School of Physiology), at 5.—Prof. W. Storm van Leeuwen: Allergic Diseases caused by Factors of Climate. (Succeeding Lectures on February 15 and 16.)

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.15.—Prof. J. Garstang: The Songs of Birds.

TUESDAY, FEBRUARY 15.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Sir Frank W. Dyson: Conceptions of the Cosmos from the Times of Copernicus to Galileo.

KING'S COLLEGE, at 5.30.—C. E. M. Joad: Vitalism and Theory of Knowledge.

WEDNESDAY, FEBRUARY 16.

BIRKBECK COLLEGE, at 5.45.—Major R. F. Wall: The Care of Domestic Animals. (Succeeding Lectures on February 23 and March 2.)

THURSDAY, FEBRUARY 17.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. G. H. Hardy: Trigonometrical Series. (Succeding Lectures on February 24 and March 3.)

KING'S COLLEGE, at 5.30.—Rev. Dr. W. R. Matthews: The Mind: Philosophy.

UNIVERSITY COLLEGE, at 5.30.—Dr. E. Deller: 'The University Idea' in the United States.—Prof. E. A. Stenso: The Ostracoderms, their Organisation and Relationships. (Succeeding Lectures on February 18, 22, and 24.)

NORTHAMPTON POLYTECHNIC INSTITUTE, at 7.—R. Genders: Steel and its Thermal Treatment (6): Cast and Malleable Cast Iron.

SATURDAY, FEBRUARY 19.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. T. Calman: The Shipworm, a Pest of the Seas.

SUNDAY, FEBRUARY 20.

GUILDHOUSE (Eccleston Square), at 3.30.—C. Bailey: The Religious Experiences of Ancient Rome.