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Team Work.

WE welcome the appearance of another report of the Committee of the Privy Council for Scientific and Industrial Research, that for the year 1926–27, which will doubtless be received as an encouraging document in progressive political circles. For one thing, it represents the credit side of a balance sheet on the debit side of which there stands an item of some £450,000 of public money. In these days of necessary economy—and of even more necessary judgment in its incidence—a recital of the kind of goods that an outlay of half a million pounds will buy in the scientific market is an education by itself. For another, it gives some indication of the dimensions of the quarry in view. The Department performs the dual function of taking a part in assuring a supply of trained and experienced research workers, capable of applying themselves in their respective spheres to the solution of problems confronting British industry, and of instituting and co-ordinating the researches themselves for the benefit of the community.

It is, of course, unfashionable, almost indecent, to scoff at research in this twentieth century; the devotion and skill of the pioneers may have been taken for granted, but there have at least been enough of the more spectacular kind of successes in one branch or another not only to attract the popular attention, but also to awake a genuine concern for the vigorous prosecution of scientific researches with a view either to the amelioration of the conditions of life or to ultimate commercialisation. What is not so fully realised is the enormous amount of untiring, expensive, fundamental team work which must precede the successful completion or application of a discovery; the amount of minute and often apparently inconsequent detail which must be accumulated in order to fashion a single signpost of progress. The ten per cent. of inspiration in genius is readily acclaimed, but the ninety per cent. of perspiration is little appreciated, because undisclosed in the ordinary non-technical report. The labours of the less prominent members of the research community, moreover, although normally receiving due recognition at the hands of those who afterwards make use of them, are often more in the nature of fuel for the furnace than the heat itself.

Our contention, however, is not that the prizes are unequal, or even that the opportunities are equal, but merely that every honest contribution to the advance of our knowledge, provided it is accurately reported and adequately indexed,

possesses a potential relative value which may far exceed its actual intrinsic value. In particular, the major problems of national concern lend themselves to organised team-work, and the Department of Scientific and Industrial Research, together with the laboratories and associations working under its ægis on co-operative lines, are effectively and unobtrusively 'delivering the goods.' The backing of the State puts selected investigators in the position of being able to spend both energy and money on an exploration of the foundations of industry to an extent which would be impossible were the rise of a superstructure the immediate and sole concern. Thus there is a solidity, as well as a catholicity, about the work done under such auspices.

Another important aspect of the Department's activities is the part which it takes, in conjunction with the universities, in making it possible for specially promising students to devote themselves to the preparation for and the practice of a career of research. It is recognised that such support is a means—possibly only a temporary means—and not an end ; it is not of the nature and quality of a prize, but rather of an insurance. As we consider that, despite the enormous advances of the past decade, Great Britain has scarcely left the threshold of the scientific development of industry, we realise how necessary a policy this is. The premium costs but five per cent. of the expenditure.

Much thought has been devoted to the question of the propriety of giving or continuing maintenance grants to students. It is satisfactory to find that inquiry shows the number of cases in which the award proves unjustified to be negligible ; it is equally satisfactory to find that, even in the chemical profession, where there is a superfluity of aspirants, 66 per cent. of the former recipients are now employed in research in industry, in Government laboratories, or in the universities. It seems clear that the policy of the Department in this respect, although it may require some modification from time to time to meet the changing aspect of industrial and scientific affairs, has proved both economic and fruitful ; it is evident that some such opportunity for training in the application of academic knowledge and of academic methods in the industrial arena, whether it be carried out under public or private direction, is an essential link in the chain.

Probably the weakest link is here, in the use which we make of scientific knowledge, scientific potentialities, and particularly of scientific method. We hear much of the lack of appreciation of industrial conditions evidenced by young university graduates, of their unpractical equipment and the like, but too little of the new directions in which the methodical, critical, analytical, and finally synthetic processes of thought and of action in which they have been trained can be brought to bear on the difficulties and the opportunities of the work-a-day world. This application is by no means an automatic process, and the Advisory Council emphasises its significance. Britain, it declares, is not behind others in purely scientific work ; what she lacks is the application of scientific discoveries, and above all of scientific method, to industry. It is to such organisations as the research associations that we look specially to hold fast to both partners, and to make their co-operation both possible and profitable. "New industries," says the Report, "may spring up from individual discoveries and by individual effort, but as a new industry grows or merges into a staple industry it will depend more and more on co-operative effort for its health and progress. In this co-operative effort, which is needed to preserve and develop our great industries, the scientific man must take his share ; he must be concerned with the necessity for improvement in detail no less than with more spectacular endeavours to strike out into new paths."

These considerations bring us fairly and squarely in view of the main business of the Department, namely, to accumulate, either by assembly or direct inquiry, scientific results of a character suitable for immediate application in support of industry, and to lay sure foundations for its further development. No one who knows anything about the subject nowadays disputes the contention that organised research is, broadly speaking, a paying proposition, although there may be a considerable lag between the expenditure and its profitable return. Individual researches may, and often do, lead to no practical advantage, whereas others realise a handsome profit out of all proportion to the cost ; in consequence, only the larger industrial concerns can support capital charges adequate to ensure a profitable proportion of commercially successful results of major dimensions, whilst the smallest firms can share in the rewards of such investigation by supporting the work on a co-operative basis. There are twenty-four such associations, and the majority are in receipt of financial assistance from the Department. It is surprising, however, to find that the Research Association of British Motor and Allied Manufacturers receives so little support from the now prosperous industry — substantially less than an amount

represented by sixpence per motor vehicle produced annually by the industry—as to render it ineligible for a grant from public moneys. We cannot claim to know all that is necessary for maintaining a world-wide supremacy in this direction, so that it would appear that we are more afraid of our competitors at home than abroad. If this is in fact the case, or if the attitude of the industry is determined by some other reason, our hopes for the future must rest entirely on the experimental work which individual firms are able to carry out. This work, of course, is a very long way from being inconsiderable.

The existence of a National Research Council in Canada, a Commonwealth Council for Scientific and Industrial Research in Australia, a Department of Scientific and Industrial Research in New Zealand, and technical boards in South Africa and India, is one of the most encouraging premonitions of a reawakening Empire prosperity. Team work on a national scale can scarcely fail to be as productive of results as team work on an individual basis. The Empire Marketing Board rightly advises us to spend our money in such a way as to keep as much as possible "in the family"; the duty is also laid upon us as members of that family to advise one another concerning the use of our diverse opportunities in the common weal, and to explore our heritage in concert with a view to the efficient exploitation of the family estates. In such a case not only wealth, but also better health and greater happiness are unlikely to be denied us.

The Electronic Theory of Valency.

The Electronic Theory of Valency. By Dr. Nevil Vincent Sidgwick. Pp. xii + 310. (Oxford: Clarendon Press; London: Oxford University Press, 1927.) 15*s.* net.

WHEN the electronic structure of matter had been demonstrated, and the electrons in the atom had been not only counted but also classified by means of spectroscopic data, it was inevitable that attempts should be made to correlate the new data in reference to atomic structure with the commonplace facts of chemistry. In the case of metallic salts, which have been shown by X-ray analysis to be ionised completely even in the solid state, the application of physical data has been comparatively easy, since the attractive forces in an aggregate of ions can be calculated, and the principal unknown quantity is the compressibility or deformability of the ion. This can be expressed as a repulsion varying inversely as the nth power of the distance, the value of n being about 9 for crystals of the sodium chloride type, in which each ion is surrounded by *six* atoms of opposite sign; in crystals of the cæsium chloride type, however, where the envelope includes *eight* ions of opposite sign, the value of n is greater, whilst the *four* ion envelopes of the zinc sulphide type require a smaller index. These simple considerations are complicated by the mutual polarisation of the ions, which introduces another independent constant in the calculations; but, by assigning an arbitrary value to this constant, it has been possible in a considerable number of cases to calculate, by means of data derived from independent sources, the physico-chemical properties (*e.g.* the heat of sublimation, and the molecular volume) of crystalline compounds of this type.

On the other hand, when atoms are united into molecules by means of 'bonds,' the problem at once passes beyond the present scope of physical calculations, since the nature of these bonds cannot yet be defined in terms of known physical quantities. An interesting situation has thus been created. On one hand, physicists have yielded only too readily to the temptation to ignore these inconvenient linkages, and have assigned ionic structures to compounds in which the chemical evidence points clearly to the existence of molecules, held together by real bonds. Thus, since water at 25° contains only one ion-pair for each 500,000,000 molecules (and this proportion decreases as the temperature falls), chemists will view with profound scepticism the suggestion that ice is ionised to the extent of 100 per cent. and contains no molecules at all; and they may even regard this suggestion as a *reductio ad absurdum* of the physical method of attacking chemical problems. On the other hand, when once the electrical structure of the *atom* has been accepted, chemists cannot avoid making mental pictures of the electrical structure of *molecules*; and these pictures have a definite value even when they cannot be reduced to precise physical forms.

Thus, although the idea of 'shared electrons' as an explanation of the chemical bond was introduced by Sir J. J. Thomson before the nucleus atom was invented, we are indebted to Prof. G. N. Lewis for exploiting the general proposition that it takes two of these shared electrons to make a bond; and this general proposition is now so firmly established that physicists may look upon it as a chemical fact for which a physical explanation must ultimately be devised, although at present we do not know in what way a pair of electrons can come

under the control of two atomic nuclei, or why a binuclear orbit should be occupied by two electrons.

Dr. Sidgwick's book is an attempt to review the ordinary facts of chemistry in the light of the electronic structure of matter. It differs from previous books on the same subject, mainly in that attention is paid to the classification of the electrons into groups and sub-groups having a common principal or subsidiary quantum number. The most characteristic feature of the book is therefore a tentative classification of the *shared* electrons of chemical compounds, on the lines of the well-established spectroscopic classification of the *unshared* electrons of free atoms and ions. Such a classification must be mainly speculative, since it has at present no clear physical basis; but it may nevertheless prove to be of real value as an essential stage in the development of a combined attack by chemists and physicists on a problem which is of vital interest to both. In particular, the interpretation of chemical facts in terms of a purely empirical electronic theory of valency (and theories of valency have always been empirical) may be the only way in which the overwhelming array of chemical facts can be collected and masticated with the view of ultimate digestion. Thus, a very elementary static theory enabled Prof. G. N. Lewis to demonstrate the dual character of chemical affinity (typified by the *transfer* and the *sharing* of electrons) which the earlier chemical theories of valency had persistently sought to unify, and thus made it possible to harmonise the antagonistic valency theories of van 't Hoff and Werner.

This dual classification of *single bonds*, which is still the most important contribution made to chemistry by the electronic theory of matter, leads logically to the conception of polar, non-polar, and semi-polar *double bonds*, and a corresponding series of *triple bonds*, and in this form appears to cover all the main facts of chemical combination. It therefore seems likely to provide a permanent basis for all future theories of valency, with perhaps a grudging admission of a limited number of exceptions.

The most important of these possible exceptions are the *one-electron bonds* which Sugden has used as a means of maintaining Lewis's octet rule in compounds where groups of 12 electrons would otherwise be called for to represent the six 2-electron bonds of a 6-co-ordination compound. Sugden's very large group of exceptions, however, is narrowed down by Dr. Sidgwick to a few conspicuously unstable compounds, comparable with the 1-electron system, H_2^+, which can be detected in high vacua by means of the mass spectrograph. Dr. Sidgwick therefore admits the existence of 1-electron bonds amongst the unstable hydrides of boron; but even these exceptions to the general rule are only made necessary by the assumption that, since spectroscopic evidence proves that a large amount of energy is required to remove the *K*-electrons from an atom of elementary boron, the sharing of these electrons with a second atom of boron in the molecule of a boron hydride is impracticable. This assumption is open to question, since the balance of energy required can at present only be set down as the difference of a large known quantity and a similar unknown quantity, which may perhaps also be large.

The *three-electron bonds*, used in Thomson's formula for benzene, represent another type of exception, which appeals strongly to many chemists as supplying a physical basis for certain theories of residual affinity; but, since the parachor of benzene is in harmony with Kekulé's formula, it is doubtful how far even this very attractive exception is justified when the static condition of chemical molecules is under consideration, as contrasted with the possible existence of transient 'activated' forms.

Dr. Sidgwick's own principal contribution to the electronic theory of valency has been in connexion with the 'co-ordination compounds' which formed the subject of his presidential address to Section B (Chemistry) at the Leeds meeting of the British Association. These compounds were (and still are) widely known as 'molecular compounds,' *i.e.*, as compounds formed by the union of integral molecules, instead of free atoms. The rules and many of the facts of co-ordination, culminating in the development of a new type of optical activity, were discovered by Werner; but they were associated with a confused (although definitely dual) conception of valency, which he would have been the first to clarify if he had lived to read G. N. Lewis's (1916) paper on "The Atom and the Molecule." These molecular compounds do not obey the ordinary rules of valency, although they conform to the rules of co-ordination. They were first brought into the general scheme of the electronic theory of valency in 1919, when Langmuir suggested that, in the platinum ammonia compounds, such as $PtCl_2$, $4NH_3$, the "NH_3 radicals are held directly to the platinum, each sharing a pair of electrons," so that "all these compounds should be looked upon as typical primary valence compounds," that is, as compounds in which a quadrivalent atom of nitrogen is united to the metal by two shared

valency-electrons. In 1921 he applied the same ideas to the metallic carbonyls, $Ni(CO)_4$, $Fe(CO)_5$, $Mo(CO)_6$, which can be regarded as molecular compounds of carbon monoxide with a metal; he therefore assigned to these compounds valency formulæ, which have recently received a remarkable vindication from the discovery of chromium carbonyl, $Cr(CO)_6$, by Prof. Job in the laboratories of the Sorbonne.

Langmuir's suggestion that co-ordination depends on the sharing of a pair of electrons, derived wholly from one of the components, has been adopted by Sidgwick as the fundamental feature of the theory of co-ordination with which his name is now sometimes associated. In order to illustrate that theory, he suggests that the union of ammonia with a metallic chloride may be compared with the action of ammonia on methyl iodide,

$$[CH_3I] + NH_3 = [CH_3 . NH_3]^+I^-,$$

since in each case the molecule of ammonia can only enter the inner sphere of affinity by displacing an atom of halogen from it in the form of a halide ion. The process of co-ordination therefore involves: (i) *the formation of a real bond* between the molecules or ions that are undergoing co-ordination, just as a bond of the ordinary kind is formed between carbon and nitrogen when methyl iodide and ammonia unite to form methylamine hydriodide; and (ii) *the transfer of an electron* from one atom to another, just as (in the same interaction) the nitrogen of the ammonia gives an electron to the iodine of the methyl iodide, and thereby acquires a positive charge to balance the negative charge of the iodide ion.

Whilst, however, Dr. Sidgwick has done much to clarify our conception of co-ordination, and to bring it into line with other forms of chemical combination, he is doing a real disservice by attempting to extend the use of the word to include not only all the main types of molecular compounds to which it is commonly applied, but also a large proportion of the oxidation products known to chemistry. For this extension there does not appear to be any warrant in current literature, since the burning of carbon monoxide to carbon dioxide, the electrolytic oxidation of potassium chloride to potassium chlorate or perchlorate, and the conversion of a sulphide to a sulphone, all lie outside the scope of existing definitions of co-ordination; and only ambiguity and confusion can result from an attempt to alter the meaning of so well-established a term. None of these oxidation products is in fact a co-ordination compound in the generally accepted meaning of the term, and the only analogy is found in the fact that, when an atom of oxygen is added to a chloride ion (or indeed to any system carrying a complete octet or shell of electrons), the two shared electrons which provide the bond of the oxide are both derived from the complete octet, whilst the half-molecule of oxygen contributes only a sextet to the final system.

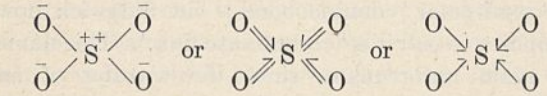
If these two electrons are shared equally by the two atoms which they unite, the oxidation must be accompanied (as I pointed out in 1923) by the development of a negative charge on the oxygen and a positive charge on the other element, exactly as in the process of co-ordination. The atoms are then united, on one hand by a non-polar bond or co-valence, and on the other hand by an ionic linkage or electrovalence, similar to that which unites the sodium and chloride ions in common salt or the ammonium and chloride ions in sal-ammoniac,

e.g. $NMe_3 + O \longrightarrow \overset{+}{N}Me_3 - \overset{-}{O}$ (compare $\overset{+}{N}H_4 + \overset{-}{Cl}$).

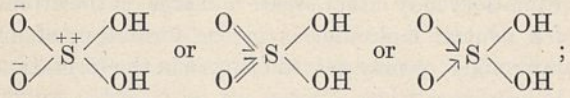
This dual linkage, which was first described as a 'mixed' double bond, is described by Sugden as a 'semi-polar' double bond; but Sidgwick now proposes to call it a 'co-ordinate link.' This name is again unfortunate, since the transfer of an electron, which accompanies the process of co-ordination, may either create a charge on the atoms of a neutral molecule, as in the formation of an ammoniate, or may get rid of it, as in the formation of a platinichloride, $2\overset{+}{K}\overset{-}{Cl} + PtCl_4 = \overset{++}{K_2}[PtCl_6]^{--}$, where the chlorine atoms in the product are regarded as neutral (just as in CCl_4), since the electric changes which they formerly carried have been transferred to the metal. In the product, therefore, Sidgwick's own theory indicates that the co-ordination compound is held together by ordinary non-polar bonds, which are abnormal only in that the anion carries a negative charge. Since one of the two main groups of co-ordination compounds does not contain the type of union which it is proposed to describe as the 'co-ordinate link,' this new term appears to break down, not only by covering too much ground when including the oxides, but also by covering too little ground in excluding the co-ordination compounds of ionised salts.

Finally, reference may be made to the symbol which Dr. Sidgwick uses to represent the 'mixed' or 'semi-polar' bond, or the 'co-ordinate link' of his own nomenclature. Since a single arrow has been used extensively by Robinson and others to represent a process of 'electron drift' in a single bond, there is a real risk of confusion in Dr. Sidgwick's use of this same symbol to represent a

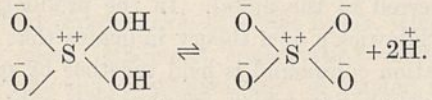
homopolar single bond on which an electrovalence has been superposed, as in the oxide $\overset{+}{N}Me_3-\overset{-}{O}$, especially as Robinson's electron drift would ultimately have the effect of *breaking* or ionising the homopolar bond, whilst the electron transfer represented by Dr. Sidgwick's symbol has the converse effect of *making* a bond between two molecules or ions which were previously quite free from one another. In this respect, Sidgwick's symbol is definitely inferior to the symbol $\rightleftharpoons$ introduced by me in 1922, which Sugden has used so extensively for this purpose. Both symbols are, however, inferior to the alternative (which is expressed by Sir Joseph Thomson's phrase 'intermolecular ionisation') of showing by means of plus and minus signs the charges on the individual atoms, or (more accurately) the relationship between the nuclear charge of the atom and the number of its quantum orbits which are occupied by electrons. Thus we may write the sulphate ion as :



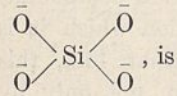
and sulphuric acid as



but the first of these symbols is the only one which shows that there is no direct change in the single bonds between sulphur and hydroxyl when sulphuric acid is ionised



In the same way, the analogous formula for the orthosilicate ion,



, is the only one which shows that the negatively charged oxygen cannot form a true 'semi-polar' bond with the silicon atom, since this atom is neutral and no longer carries a surplus positive charge.

Whilst a large part of Dr. Sidgwick's book is necessarily concerned with co-ordination and its various applications, the other forms of chemical combination are also adequately discussed. Thus the physical evidence for the nuclear atom, with its quantised electron orbits, forms the subject of two preliminary chapters; and the nature of the chemical evidence which led Main Smith to anticipate Stoner in re-arranging the quantum groups in the periodic classification of the elements is indicated much more clearly than in Smith's own book. General rules are also given whereby the author not only proposes to distinguish the physical properties of an ionised salt from those of a non-ionised compound, but also claims to be able to distinguish a covalent compound from a chelate co-ordination compound. In many cases these distinctions can be made with some confidence, as in the case of mercurous iodide, where the colour of the compound agrees with the X-ray analysis of the crystals in showing that the compound is not a mere aggragate of univalent ions, $\overset{+}{H}g\overset{-}{I}$, but must consist of covalent molecules, probably of the structure I . Hg . Hg . I. In other cases, however, the evidence is much less clear and the conclusions arrived at are less certain. Thus, in the rather difficult case of tellurium, the diagnosis appears to be based on a somewhat incomplete study of the symptoms, and will almost certainly have to be reconsidered as further knowledge becomes available.

The possibility that drastic revision of some of these preliminary conclusions may be called for does not, however, destroy their value, since, if they succeed in provoking further experimental work, they will have fulfilled one of the principal functions of a theory. At the same time, the reader would be well advised not to let the attractiveness of the picture obscure the tenderness of many of the threads of the canvas on which it is painted, since the author does not always emphasise sufficiently the reservations underlying his statements. If, however, when the author writes "it has been proved" the reader will mentally substitute the more accurate phrase "it has been suggested," and if when he writes "this must be due" the reader will read "this is generally believed to be due," no great harm will be done by the rather over-confident way in which the author's very fascinating views are put forward. There is also a risk that injustice may be done to earlier workers, owing to the fact that the origin of the views adopted by the author is not always indicated clearly. In particular, the section on the "Electronic Interpretation of Co-ordination" does not contain any reference to the paper, published in 1919, in which Langmuir anticipated the essential postulates of the theory of co-ordination advanced by the author in 1923. In the same way, the sections on the co-ordination of hydrogen might be strengthened by including a reference to the very clear statements on this subject which were made by Pfeiffer so long ago as 1913, and by Dimroth in 1921.

The last chapter of the book is devoted to a preliminary survey of the families of elements which make up the periodic table, with the view of finding an electronic interpretation of the chemical data, based on the known structure of the atoms and the known behaviour of the valency electrons. This survey is intended to foreshadow the contents of a new volume, in which these problems can be discussed more fully; but the value of that volume, when it appears, may be enhanced considerably by the fact that the author has been bold enough to put his first impressions into print, perhaps with the expectation that they may form a target for constructive criticisms.

Since the work of interpreting chemistry by means of physics may be one of the main tasks of the next decade, Dr. Sidgwick's book will be welcomed by workers in both branches of science, and all the more so from the attractive form in which it is presented. It is not an easy book to read, but (with one exception) the chapters are short, averaging less than 20 pages, so that they can be studied, one unit at a time, without undue effort; and the publishers have done their share in contributing to the pleasure of reading the book.

T. M. LOWRY.

Phosphatic Fertilisers.

Phosphoric Acid, Phosphates, and Phosphatic Fertilisers. By Wm. H. Waggaman. Assisted by Henry W. Easterwood. (American Chemical Society Monograph Series.) Pp. 370. (New York: The Chemical Catalog Co., Inc., 1927.) 7.50 dollars.

THIS book is the thirty-fourth publication of the American Chemical Society Monograph Series, the purpose of which is to present to chemists as a whole the collected information on a chosen subject in a readable form and to show the problems that still await investigation. Exceedingly numerous are the references to the literature, and these will be of the greatest value to those readers who wish to pursue the subject still further.

Ever since the value of artificial fertilisers in agriculture was established, phosphoric acid has been considered mainly in this connexion. While in the past this essential plant food was given in the form of superphosphate, basic slags, rock phosphates, guano, and bones, only the first three of these are now available to any extent as fertilisers. The reserves of guano are becoming exhausted and the supplies are consequently limited. Bones are of importance in other industries. The ideal phosphatic fertiliser should combine good 'availability' with cheapness and be at the same time a high-grade product, for freightage has to be taken into account.

Judging the three fertilisers now in use by these standards, the water-soluble phosphate has the greatest possibilities, for by development and improvement of methods of manufacture the grade can be increased and price reduced. Basic slags are the by-product from steel works and of comparatively little value to the makers; the chances of improving their agricultural value are very remote. With regard to rock phosphates, though both high-grade and attractive in price, they are slower in action. Of recent years they have undoubtedly been used to a larger extent, but this would appear to be due to the fact that price and proximity of supply—they are well distributed over the world, so freightage is reduced—are important factors. Even now, however, the world consumption of superphosphate is greater than that of either rock phosphate or basic slag. Thus if any advance—which is long overdue—can be made in the phosphate industry similar to that which has taken place in the manufacture of nitrogenous fertilisers, the future would seem to be with the water-soluble phosphates. This is a topic of much general interest. In consequence, Messrs. Waggaman and Easterwood's book should be valuable to many, for in the main it deals with this subject. In addition, the growing importance of phosphoric acid in other industries is shown very convincingly. Of the relative merits of the phosphatic fertilisers now in use it has little to say, for there is still much controversy on the subject. Nevertheless, information on that matter from one so well qualified as Waggaman would have been welcome.

The book as a whole describes (1) the importance of phosphoric acid in bio-chemical and industrial processes, and (2) the sources and types of raw phosphatic material available, (3) methods for converting these into commercial products, (4) the economic production of phosphoric acid. Part I. is a general outline, but its value is greatly enhanced by the numerous references to the literature; an expansion of this part, the inclusion of references to some of the more recent work, and omission of the section on elemental phosphorus and its compounds would have been preferable. The sources and types of raw phosphate material, their conversion into fertilisers, etc., are treated in considerable detail,

and to those in any way connected with this trade it should be valuable. With regard to basic slags, their agricultural value in Great Britain and Ireland, at least, is not in full agreement with the results, taken from 1911 experiments, quoted in this book. Of the economic production of phosphoric acid the authors have much to say. The senior author has taken an active part in the development of the pyrolytic process and other problems, so that the conclusion that phosphoric acid will be a serious rival to other inorganic acid comes from a very authoritative source.

"Phosphoric Acid, Phosphates, and Phosphatic Fertilisers" fulfils admirably the purpose of this series, giving a clear and full account of the subject, especially the industrial side. The authors' views on the future development are supported by a veritable mass of data, while the numerous illustrations make the book attractive.

Geography and Anthropology.

Environment and Race: a Study of the Evolution, Migration, Settlement, and Status of the Races of Man. By Dr. Griffith Taylor. Pp. xv + 354 + 6 plates. (London: Oxford University Press, 1927.) 21*s.* net.

THE racial history of man cannot be elucidated by the physical anthropologist alone. The most that he can do is to describe the physical characters of large or small groups of men, recent and extinct, and to indicate their inter-relationships. The historian, or collector of legendary history, may throw some light upon past movements of the population, and the contemporary observer can record what movements are in progress or took place in the immediate past. The biologist, using that term in its widest sense, may make suggestions as to the factors of evolution, physiological, psychological, and others; as to the phenomena of miscegenation, heredity; and various other influences and processes.

Some of these aspects of anthropology are conditioned by the physical environment of a given people, but even an environmental study does not suffice, since it is necessary to understand the former geographical and climatic conditions which were operative upon the ancestors of that people. We know that practically all peoples have been subjected not only to an environment different from that in which they now live, but also that their environment continually varied, land was raised or submerged, and there were major and minor fluctuations of climate. Also, it is necessary to know the relief of the land, the rainfall, and other data, in order to learn what areas were favourable for human existence, those that served as corridors and those that acted as barriers, and so facilitated or inhibited human movements.

These studies are the province of the geographer, and although partial studies of this kind have been made, which have been published in various books and journals (some of which are likely to escape the notice of anthropologists), they have never previously been assembled in a single book; thus a general survey of the world on these lines has been beyond the scope of the anthropologist. If only for this effort, anthropologists owe a great debt to Prof. Griffith Taylor for his "Environment and Race." In considerations of this kind, a time scale is necessary, and it is mainly to the geologist that anthropologists must turn, and our author, naturally, has not neglected this aspect. Although culture has nothing to do with race, we do find that certain languages, customs, ideas, and objects have a particular range in space, and doubtless some of them were restricted in their origin to a definite group of people; here the linguist, the sociologist, and the technologist come to our aid; the subject of fossil technology, or archæology, for example, is invaluable in tracing the movements of ancient cultures; but the diffusion of cultures in some cases may to a large extent be independent of racial migrations, a fact which the author seems to have overlooked.

For the past and present setting of the stage for mankind, Prof. Griffith Taylor provides a most admirable survey. Within the compass of a small book it was obviously impossible for him to go into that detail which a student of a given area might require, but the broad lines here sketched out will prove an invaluable preliminary to more intensive research—it may here be noted that the loess belt of Europe has been overlooked, though it formed an important migration route.

The book is an amplification of suggestive articles that have appeared in the *American Geographical Review*, 1919, 1921, 1922. The thesis is maintained that man originated in central Asia and thence Neanderthal (with which Proto-Australian, *e.g.* Talgai, etc., are associated), Negrito, Australoid, Negroid, Iberian, Nordic, early and late Alpine (*i.e.* Mongolian) stocks debouched in this order and passed, but not necessarily all of them, along the corridors of the peninsulas of central Asia—Europe, Africa, Australia, and America; the earlier propulsive forces being the climatic thrusts of the four main ice ages. This theory presupposes that increase in

the cephalic index (C.I.) took place only in the centre of Asia, and though it is worked out with ingenuity it is unlikely to receive the support of anthropologists.

The argument is based on averages, and does not take into account the considerable fluctuations that occur in the groups. Thus the Lower Negroes, "Peoples of Guinea and Upper Nile," are credited with a C.I. of 71 (parallel with the South Melanesians and New Guineans); the Wolofs of Senegal are said to have a C.I. "as low as 69," but Struck gives it as 74·3; and the author credits the Higher Negroes, "Bantu-speaking Negroids," with a C.I. of 73 (parallel with the Australians). B. Struck has prepared a well-documented "Karte des Kopfindex" of central Africa (*Z. f. E.*, 54; 1922), from which it is evident that the averages of peoples of Guinea and the Upper Nile Valley vary from 71 to 75, few being 71 or less, but also in the former region there are numerous peoples with average C.I. of 75-79, while in the Cameruns and Congo basin average indices of 77 to 81 are common, with patches of above 81. According to Griffith Taylor's scheme, these Negroes should be Hamites, Semites, Aryans, and early Alpines; but we are told that the "vast central and southern block of negroes has not been greatly affected by recent mixture" (p. 106). A similar objection applies to other areas.

From Appendix B, it is evident that the author still adheres to his previously published opinion that various customs, etc., characterise definite zones of cephalic indices. In 1921 he said, "the couvade occurs in the Hamitic-Iberian zone [C.I. 76-78] *and nowhere else*," but the Carib C.I. of 80·9 and the Arawak of 83 are hard to reconcile with this generalisation, and other cultural distributions are equally open to question. It is doubtful whether any ethnologist will accept this theory of zonal cultures. A new feature is the introduction of 'ethnographs,' in which certain physical characters are combined to form a hexagon, the proportions of which vary according to race. The book is illustrated by a number of racial types, and especially useful is the large number of distribution maps and block-diagrams.

The book concludes with valuable discussions on "the white race in the Australian environment" and "the control of the potential white settlement of the world by environment." In these sections Prof. Griffith Taylor speaks with authority based on solid facts, and they should be carefully studied by prospective emigrants and also by politicians.

A. C. HADDON.

Our Bookshelf.

Rules for Compositors and Readers at the University Press, Oxford. By Horace Hart. The English spellings revised by Sir James A. H. Murray and Dr. Henry Bradley. Twenty-eighth edition. Pp. 135. (London: Oxford University Press, 1928.) 2*s.* net.

THIS little book was not originally intended for publication. When it was begun the intention was simply to make a guide for compositors and readers at the Clarendon Press. But copies were also given to those who were interested, and, later, applications for copies were received from persons who had no absolute claim to be supplied gratuitously. Many such requests came from Home, Colonial, and Indian Government officials. That is a recommendation in itself, and the recommendation is heightened when we learn that, later, it became known that copies were on sale in London. Clearly there was no alternative but to publish the book for the benefit of all those who are interested in the technicalities of typography; and there can be no doubt that it confers great benefits not only on those engaged in the art of printing, but also on those whose business it is to write.

The book includes, of course, the ubiquitous (but none the less necessary) guide to proof correction. But there is also an alphabetical list of alternative and difficult spellings; there is a list of spellings for use in medical works, divided into words with, and words without, hyphens; there are rules for setting up French, German, and Greek works; there is advice on the question of spacing—a matter which is ordinarily full of annoyance for both printer and author; special signs and symbols are made clear; and sufficient attention is paid to the use of punctuation, O and Oh, a and an, to save much impending irritation. It is not possible here to indicate the full scope of the book. It is a work of reference, and, as such, may be expected to be a mine of *easily accessible* information; that expectation is certainly fulfilled.

The American Annual of Photography, 1928. Vol. 42. Edited by Frank R. Fraprie and E. J. Wall. Pp. 224+68. (Boston, Mass.: American Photographic Publishing Co.; London: B. T. Batsford, Ltd., 1928.) Paper, 7*s.* 6*d.*; cloth, 10*s.*

THIS annual has several distinguishing features. The "Practical Digest of the Year's Work in Photography," by Mr. Wall, is a readable and discriminative article with occasional valuable criticisms. The formulæ of developers, etc., are all tabulated on the same unit, and each table, which includes those of a like kind, has the average formula appended to it. There are more than ninety pictorial illustrations, and an article directing attention to their characteristics by Mr. Fraprie.

Of the sixteen other articles, the one of outstanding interest is on "Photography through the Microscope," by E. P. Wightman and A. P. H.

Trivelli. The authors not only describe modern developments in photomicrography, such as the use of ultra-violet light, modern methods of dark-ground illumination, and the application of the 'motion picture camera' to certain types of microscopic moving subjects, but also they give illustrations that are very little if at all inferior to the original photographs. Examples of the use of the ultra-microscope include pictures of *Pleurosigma angulatum*, collodion and gold films, a partial mirror of gold, normal blood platelets, soap crystals, and the germ of yellow fever. Those taken by means of ultra-violet radiations show remarkably fine definition, bearing in mind how difficult it is to find the focus in this method, and they clearly demonstrate the increased resolving power of the shorter wave-lengths. The kinematographic photomicrographs show the gradual development of silver bromide grains, the growth of silver sulphide specks on the surface of fused silver bromide, the absorption of water by a crystal of salt in butter, and the formation of colloidal bismuth and its subsequent coagulation. These and several other photomicrographs, of both high and low power, were supplied by experts in the various branches of work represented.

God is Love. Can this be True? An Old Man's Meditations. By Dr. James M. Wilson. (Affirmations: God in the Modern World.) Pp. 31. (London: Ernest Benn, Ltd., 1928.) 1*s.* net.

RELIGION is closely concerned not merely with the problem of the existence of God, but also with the even more pressing problem of His character. God might exist, and yet not be the kind of being man could worship. Canon Wilson clearly realises that the God of biological science scarcely resembles the God of Love whom we read of in the New Testament. How are we to reconcile these opposites?

Canon Wilson's method is to evacuate his God of transcendence and personality, and to present Him as purely immanent Spirit, in the conscious possession of which Spirit men may find sonship with God. This solution, while emphasising the, to religion, indispensable consciousness of union with God, has its dangers too. Indeed, what solution has not? If we divest God of transcendence and personality, the God of biology may wear a more tolerable aspect, since the sufferings He imposes are His own, and since (if He is impersonal) He does not really know what He is doing. But what we gain in one way, we lose in another; for the God of religion, divested of transcendence and personality, seems no longer worshipful. Personality is a supreme value, and whatever falls short of it seems unworthy of worship. As for the immanent God, the God within us, if we begin by worshiping *Him*, shall we not end by worshipping ourselves?

We may, however, be grateful to Canon Wilson for approaching this most difficult subject in a spirit of candour and deep religious faith.

J. C. HARDWICK.

Archimedes: or The Future of Physics. By L. L. Whyte. (To-day and To-morrow Series.) Pp. 96. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2*s.* 6*d.* net.

THIS little book appears at an opportune moment. It is generally acknowledged that the accepted principles of theoretical mechanics break down at the boundary of the atom, and some new system will have to be devised which will make the internal structure of atoms amenable to mathematical treatment. The main issue of the crisis is the subject of the controversy between Einstein and Eddington on one hand and Bergson and Whitehead on the other. The author tries to fathom the meaning of this modern duel and to forecast the manner in which it will be eventually settled. He directs attention to the fact that the laws formulated by Einstein deal with reversible phenomena. Real processes in Nature, on the other hand, are irreversible. "It may be that the reason why we cannot interpret atomic behaviour in terms of particle motions is that electrical and radiational processes are essentially irreversible. Particle motion and wave propagation—the two ideas on which all modern theories of matter are based—are both represented by mathematical expressions which are essentially reversible, since time enters only through the square of 'dt'. If the quantum processes should prove irreversible, we have already found a reason why the old conceptions of particles and waves must be inadequate."

The author draws a suggestive analogy between radiation and life processes, both of which are essentially irreversible.

La géométrie non euclidienne. Par Prof. P. Barbarin. Troisième édition suivie de notes sur la géométrie non euclidienne dans ses rapports avec la physique mathématique, par Prof. A. Buhl. (Collection Scientia, No. 15.) Pp. 176+7 planches. (Paris: Gauthier-Villars et Cie, 1928.) 15 francs.

AN interesting and brightly written introduction to non-Euclidean geometry, with an appendix of notes dealing with its relations to the theory of relativity. There are plenty of references and several plates, including portraits of the heroes of the subject, Bolyai, Lobatschewsky, Riemann, and a fascinating picture of Beltrami's pseudosphere. It is an extremely good half-crown's worth.

Les bases de la géométrie et de la physique: l'invariance de l'espace euclidien. Par Clément Laurès. Pp. iii+125. (Paris: Albert Blanchard, 1928.) 15 francs.

THE author claims to have proved Euclid's postulate of parallels and to have pointed out the errors and contradictions of Lobatschewsky. The book is an attack on non-Euclidean geometry and the theory of relativity, which M. Laurès describes respectively as "une des plus stupides inventions du XIX^{e} siècle," and "une autre stupidité, fille aînée de la première."

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.*]

The Production and Application of High Voltages in the Laboratory.

The importance of the application of high voltages to vacuum tubes is self-evident. Its possibilities in connexion with radioactivity have been emphasised lately by Sir Ernest Rutherford.[1] For the last two years we have been occupied in developing a laboratory method for the production of high voltages in a form suitable for application to vacuum tubes. Our problem divided itself into two parts: (*a*) The production of high voltages; (*b*) their application to vacuum tubes.

(*a*) The method for producing high voltages is based on old and well-known principles. A condenser of the order of 0·5 microfarad is charged to a potential of the order of 50,000 volts and suddenly discharged through a small inductance and a spark gap. The inductance is coupled to a resonance coil of the type usually referred to as a Tesla or Thomson coil. It was immediately obvious that very high potentials can be obtained with moderate means. Our coils were wound on pyrex tubing 3 inches in diameter and 36 inches long. The number of turns was in the neighbourhood of 7000.

The main difficulties to overcome were the insulation of the ends of the coil and of the turns from each other. We found ordinary transformer oil to be capable of insulating coils for 3,000,000 volts at atmospheric pressure, and for more than 5,000,000 volts at 500 pounds per square inch. No extraordinary precautions as to purity of the oil or otherwise were used, and do not seem to be necessary for these voltages. Spherical caps were mounted in the usual manner on the ends of the coil. By using the coil on half wave-length, the gradient at the caps corresponded to one-half of the total voltage. The coils were subjected to rough vacuum impregnation perhaps as a matter of prejudice. Our limitation at 5,000,000 volts was in the insulation between turns with this particular length of coil. Ordinary No. 40 silk enamel covered wire was used. The ends and the electrical efficiency are capable of giving considerably higher voltages with the present arrangement. Since 5,000,000 volts, when applied to doubly charged helium atoms, or particularly to α-particles, and still more to multiply charged ions (stripped atoms), should be capable of giving particles with energy much in excess of the swiftest α-particles so far observed, we temporarily transferred our efforts about a year ago to the problem of applying voltages of this order to vacua.

The method of measuring the voltages may be described as a capacity potentiometer. The apparatus consisted in an insulated metal 'pick-up' ball suitably placed in the field of the coil and connected to one terminal of a 10-inch sphere gap, the other terminal of which was earthed. By a preliminary calibration at the same frequency, the ratio of the coil potential to the pick-up potential was determined at low voltages on the latter (about 100 volts). This calibration involved a study of the voltage distribution along the coil, the details of which we will report later. A knowledge of this distribution made it possible to infer the voltage across the whole coil by measuring the voltage across a small section, thus eliminating capacity effects of the measuring instrument. We took care to ascertain experimentally the effect of the distance between the two balls of the gap. These calibrations have been performed under various conditions with entirely different set-ups, giving always consistent values for the voltage obtainable with a given input.

We have also performed rough calibrations in which the Tesla coil voltage was measured directly by means of a sphere gap and simultaneously by the capacity potentiometer. Due care has been taken in this case to reduce the effect of the leads to the direct gap on the potentiometer.

The order of magnitude of the voltage has also been ascertained by measuring the field strength at a distance by means of a cathode-ray oscillograph and applications of electrostatics.

The doubts which might be raised as to the correctness of our sphere-gap measurement seem to be two: The truthfulness of the sphere gap and the absence of conductivity in the oil. Our frequencies being of the order of 100,000 per second, the correctness of the sphere gap is proved by the work of Peek.[2] The extrapolation applied to the capacity potentiometer from low to high voltages we have tested in various ways. Thus the position of the pick-up was varied, giving always consistent results. The spark-over between turns on especially tested wire always leads to higher voltages than those measured. The voltage measured is proportional to the voltage applied to the primary circuit. At the same time, the direct effect of the primary circuit on the pick-up is negligible.

(*b*) After trying discharge tubes of ordinary design, it became obvious that limitations somewhat similar to those experienced at low frequencies apply to high-frequency voltages as well. The application of more than 400,000 volts in an ordinary way appears to be difficult, apparently due to the fact that methods of completely outgassing an entire electrode (including the part close to the glass) have not yet been devised.

However, we found it quite possible to apply several times the above voltage to a vacuum without electrodes inside the tube, making use, therefore, of the fact that our voltages alternate at high frequency. In this arrangement we have a 9-inch, well-baked and evacuated bulb placed, using approximately 1 mm. spacings between the end of the Tesla coil and an earthed plate. Fluorescence of long duration is caused on the sides of the bulb, but no volume discharge takes place and the bulb does not puncture. An ionisation gauge on a side tube does not give any difficulty. If the pressure in the bulb is raised, a bolt strikes through 2 inches of oil and makes a large hole in the bulb.

The question of the power available in a Tesla coil is of some importance. Experimental tests show that coils of our usual design with a given power input have their voltage reduced by a factor of 2 if a 16-megohm leak is connected across the terminals. If the coil is used on a 60-cycle synchronous gap, and if the energy dissipation only during 10^{-5} sec. for each spark is considered, the power which may be drawn from a coil operating at 5×10^6 volts is readily seen to be at least of the order of 1 kilowatt.

Even with one discharge a second considered as taking place effectively in producing high-voltage particles for 10^{-6} sec., *i.e.* for $\frac{1}{10}$ of a cycle, a number of electrons equivalent to 10 gm. of radium could be supplied by the Tesla coil without overstepping its electrical power limitations. On the same basis, a

[1] E. Rutherford, Nature, **120**, p. 809; Dec. 3, 1927.

[2] F. W. Peek, jun., *Jour. Franklin Inst.*, **197**, p. 1; 1924.

gap operated on 60-cycle current giving 120 sparks a second would enable the Tesla coil to deliver the equivalent of 2 lb. of radium.

It is clear that the outside electrode method of using vacuum tubes does not make it possible to use all of this power. However, a transfer of 2×10^{11} electrons would not puncture the glass. Estimates show that very considerable radium equivalents can be obtained even by the method of external electrodes.

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M. A. TUVE.

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Washington, D.C., Feb. 25.

An Optical Paradox.

SURELY there is nothing peculiarly 'optical' in the 'paradox' to which Mr. Smith refers in NATURE of Feb. 25. In respect of most measurable properties (for example, length and mass) systems can be arranged in a series such that each member, though indistinguishable from its immediate neighbours, is distinguishable from those more remote. In other words, the relations usually termed 'equality' in measurement are not transitive; though $A = B$, $B = C$, it does not follow that $A = C$.

That is a fact; paradox can enter only in describing it. Mr. Smith's description appears paradoxical, because the term 'identical' that he employs usually implies transitiveness. To determine whether a relation is transitive, at least three members of its field must be compared; accordingly, if 'identical' means a transitive relation, none of his comparisons, each involving two sensations only, can establish identity. It is *not* a 'quibble' to say that two sensations, A and B, indistinguishable when compared directly, are not identical; for they may be distinguished by the classes, C_A and C_B, consisting of sensations from which they are respectively indistinguishable. C_A and C_B always contain common members; but in general they are not coextensive, and each contains members foreign to the other. A and B are truly identical only if C_A and C_B are coextensive, and A is indistinguishable, not only from B, but also from every sensation indistinguishable from B.

In theory these considerations may be 'widely ignored,' but in practice they are not. Poincaré's suggestion that the theory of errors of measurement and of the adjustment of observations should be based on them has not been widely adopted. But, as I have tried to show in Chaps. xvi. and xvii. of my "Physics," it leads to practical rules for dealing with these matters closely resembling those in general use, which are more often based on the futilities of the Gaussian Gospel. Whenever we recognise the possibility of errors and take steps to avoid them, we are in effect giving full weight to Mr. Smith's considerations. Nobody experienced in photometry would actually compare lamps through a simple unidirectional chain such as he describes.

NORMAN R. CAMPBELL.

A PARADOX, resembling that which Mr. T. Smith describes in NATURE of Feb. 25, p. 281, was stated by G. F. Stout in his "Manual of Psychology" (1915), pp. 303 to 304, for senations in general.

For a particular sensation, that of weight lifted, the paradox was abolished by the experiments of F. M. Urban (*Archiv für gesamte Psychol.*, 5, 15, 16), for they showed that the threshold was not the definite thing that Mr. Smith assumes it to be, but that when one stimulus was kept fixed, the probability of the observer making the decision 'equal' varied with the other stimulus in a gradual manner.

Is the optical threshold unlike that for weight?

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Feb. 29.

DR. CAMPBELL seeks to demolish the paradox by applying to sensations an argument constructed to take account of the variability of our measurements of the properties, believed to be constant, of external objects. Besides differing in other important respects, the two applications are unlike in that the presence of errors in our measurements is readily demonstrable by intercomparison, whereas the view that indistinguishable sensations are not in fact equal sensations is an arbitrary assumption which it would be difficult to support by direct evidence. This view is perhaps derived from the wish that it were permissible to regard visual sensation and light stimulus as definite single-valued functions of one another.

Now there may be occasions when it is convenient to postulate an idealised system of sensations bearing such a relation to a series of stimuli; but the concept is essentially theoretical, and must not be confused with the sensations of experimental photometry. Experimentally, sensation denotes an impression individual to the observer, an impression, moreover, of so fleeting a nature that group intercomparison is impossible. The observer's verdict on his sensations at any given moment is the only one that matters: if he says that two sensations are indistinguishable, we ought either to accept that statement as final or bring forward evidence to justify our distinguishing between them.

I am inclined to think that the physicist has been handicapped in considering the photometric problem by his expectation of a close correspondence between sensation and stimulus. It is characteristic of the way in which he has grown accustomed to regard his experiments that he should, without question, ascribe the sensation he associates with the left side of the field solely to the lamp on his left, and to the lamp on his right the sensation he associates with the right side of the field. I have little doubt that he habitually presses too far the view that sensations may be isolated. In photometry, particularly when the two parts of the field are nearly or exactly matched, we ought to regard the sensation as a function of both the stimuli. On this view the argument of the paradox fails, not because the two sensations in a single observation differ, but because we are not justified in isolating the two halves of the system from one another or in assuming an unvarying connexion between the radiation on the unaltered side of the system and the sensation in the part of the field we link with it.

More generally the principle to which I wish to direct attention is that every sensation is a function of all the stimuli. The principle is illustrated by the fact that the introduction of peripheral illumination may enable us to discriminate between sensations when differentiation was previously impossible. Dr. Campbell would perhaps explain this result by saying that the introduction of the additional illumination in effect constitutes the replacement of the old comparator by a better one. That view is, I think, legitimate, but it is not consistent with the assumption of an unvarying connexion between stimulus and sensation.

T. SMITH.

The Soil 'Stratometer': A Method for the Examination of Deep-lying Soil.

In alluvial soils there are frequently large variations of soil texture, especially in a vertical direction. With deep-rooting crops like cotton, the soil at depths of more than two metres may be directly important to the plant, quite apart from its indirect importance by influencing drainage, or infiltration under irrigation. The study of such deep soil by soil-boring and sampling has certain limitations, while its complete disturbance by digging large holes is even more objectionable and tedious.

Some infertile areas of the Botanical Section Farm at Giza were being examined for the presence of 'pans' when it was noticed that the mechanical resistance of the soil varied greatly, whether such resistance was felt by a Frænkel borer or by the use of the digging tool. From this observation was developed a simple instrument which has been entitled a 'stratometer,' whereby the variable hardness of soil along vertical lines can be found, giving results somewhat analogous to the records of variability on the surface, in a horizontal plane, which have been made at Rothamsted with dynamometers attached to ploughs (B. A. Keen, Nature, Dec. 19, 1925, p. 905).

The present note is intended to put the actual method on record. Detailed studies of Egyptian soils by this method are being continued, and will be published later.

The method consists merely in driving a rod into the soil by repeated application of a uniform impact blow, as in pile-driving. The error which would otherwise be caused by increased friction on the sides of the rod as the depth increased is avoided almost entirely by the use of an enlargement like a spear-head at the point of the rod; this head is detachable to save trouble in removing the rod from hard soils, the head being left below and a new one fitted to the rod. The uniform impact blow is conveniently applied by a perforated weight through which the rod passes loosely; this weight rests and strikes on an anvil-stop clamped firmly to the rod, while the height through which the weight drops on to this anvil is fixed by a stop above it, also clamped to the rod.

The distance through which the rod descends at each blow is measured in any convenient way; a simple method is to fasten a tape just behind the head and to mark on the tape after each blow at the point where the tape passes through a zero level, indicated by a spiked plate driven into the surface soil with a hole through which the rod and tape both pass.

The tape-records may be afterwards computed and plotted in various ways, but usually it is convenient to show the hardness of successive strata, between 10 cm. or 20 cm. intervals, in terms of the energy required (*i.e.* number of blows) to traverse such intervals. The whole apparatus is very simple, can be made by any blacksmith, and a single set of observations down to two metres takes about ten minutes to make with two operators at work.

As an illustration of the information thus obtainable, the case of a 'pan' may be cited. The cotton plants in one corner of a field were stunted during mid-summer, recovering later. An exposure was made and showed that their roots found difficulty in penetrating a layer at 30-60 cm. deep. Less than 15 metres away they were quite healthy. Soil water-content samples showed the hard layer to be impermeable to water also. The digging of pits showed an exactly similar distribution of clay above and sand below in both spots, the hardness and impermeability of the lower edge of the clay in the panned spot not being obvious except to the feel of the tools used in boring or digging. On applying the stratometer the difference was most strikingly revealed as a four- to five-fold difference in maximum hardness (Fig. 1).

If the stratometer impinges on a stone this is readily indicated by the sound as the blow is given, and the *sudden* and persistent resistance to the rod.

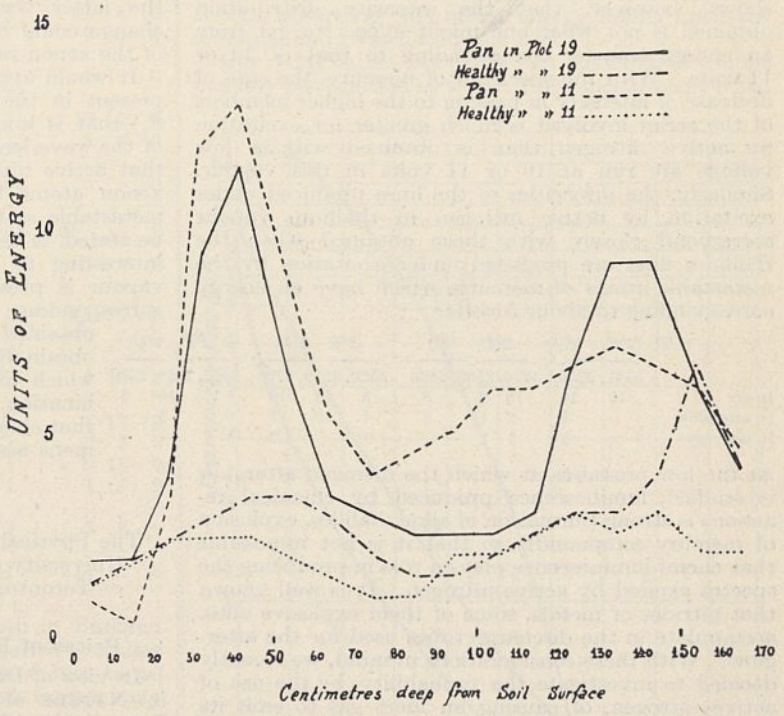

Fig. 1.—Graph of stratometer records.

The design of the rod for depths exceeding two metres needs care in order to avoid loss of energy by undue vibration, and the relation between water-content and hardness of soil is an obvious source of variability when comparisons over an interval of time are required. These are being investigated in conjunction with the direct employment of the stratometer for detailed survey of the deep soil and subsoil on particular areas.

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The Nitrogen Afterglow.

The phenomena connected with active nitrogen and its afterglow have recently received a great deal of attention. A view almost generally accepted now is that the afterglow is due to the recombination of nitrogen atoms produced in the discharge. Though it has not been possible hitherto to determine thermochemically the heat of dissociation of molecular nitrogen, a value a little above the equivalent of 11 volts has been found for it from the characteristics of its band spectrum. On the recombination of two atoms taking place to form a molecule this amount

of energy may be transferred to a second molecule, and it is just sufficient to excite the afterglow bands. This view, it may be stated, is based on the assumption that the initial states giving rise to the first positive group of bands are the same as the final states involved in the production of the second and fourth positive group. The vibrational levels seem to be identical; the rotational levels have not yet been analysed.

What appeared to be a confirmation of this hypothesis was the discovery that foreign vapours such as those of mercury, zinc, etc., when mixed with active nitrogen, emitted radiations that required for their production electronic excitation not greater than the equivalent of 10 volts.

A closer examination of the spectra thus excited shows, however, that the intensity distribution obtained is not what one might expect to get from an energy transfer corresponding to that of 10 or 11 volts. With the spectrum of mercury, the rate of decrease of intensity in passing to the higher members of the series involved is much greater for excitation by active nitrogen than is obtained with a low voltage arc run at 10 or 11 volts in this vapour. Similarly, the intensities of the lines produced under excitation by active nitrogen in thallium vapour correspond closely with those obtained when the thallium lines are produced under excitation by the metastable atoms of mercury, which have an energy corresponding to about 5 volts.[1]

Tl.	$(2^2P_2-{}^2S_1)$		$(2^2P_1-{}^2S_1)$			(2^2P-3^2D)			(2^2P-4^2D)		
	5351,	3230	3776,	2580,	2826	3529,	3519,	2768	2922,	2918,	2380
In arc	10	10	10	8	8	8	10	10	6	10	8
In afterglow		6	2	1	0	4	10	3	0	3	–
In mercury		5	3	1	–	9		2	1	–	–

At the low pressures at which the nitrogen afterglow is studied, luminescence produced by chemical reactions is strong (formation of alkali halides, explosion of mercury compounds), so that it is not impossible that chemi-luminescence plays a rôle in producing the spectra excited by active nitrogen. It is well known that nitrides of metals, some of them explosive ones, accumulate in the discharge tubes used for the afterglow. With these considerations in mind, we recently decided to investigate the probability, by the use of active nitrogen, of causing an inert gas to emit its characteristic radiations. In such a case chemical changes would, of course, be excluded. If the view expressed above be valid, xenon with an ionisation potential of about 11 volts ought to emit its complete spectrum when mixed with active nitrogen. With the use of krypton the low level spectral lines should be obtained. These inert gases were therefore introduced into the discharge tube, and the spectrum of the light from the afterglow was photographed by means of a quartz spectrograph of high light power specially built in the laboratory for this purpose.

In the first series of experiments a mixture of krypton and xenon prepared in the laboratory was used and an excess of nitrogen was added. In the spectrograms obtained the afterglow bands were present, but no spectral lines due to the inert gases were recorded.

When, however, a drop of mercury was introduced into the tube and the spectrum of the afterglow again photographed, it was found that the mercury lines came out strongly on the plate in addition to the nitrogen afterglow bands. Very short exposures were required to bring out these mercury lines.

In a second series of experiments, very pure xenon was added to the nitrogen until the mixture was about half and half of each gas.

When an electrical discharge was passed through this mixture, the xenon lines showed up strongly in the spectrum of the light from the discharge, and the first positive nitrogen bands were almost completely suppressed. With this mixture the afterglow obtained was intense, but no xenon spectral lines were obtained on the spectrograms even when an exposure of twelve hours duration was made.

An experiment was performed to see if xenon radiation of wave-length λ8819 A., which is known to be strongly weakened when sent through excited xenon (J. C. McLennan and R. Ruedy, *Trans. of Royal Society of Canada*, vol. 32, p. 15; 1928), was absorbed by the xenon present in the nitrogen when the latter was showing a strong afterglow. No change could be detected, however, in the intensity of the xenon radiation sent through the glowing gas.

It would appear, then, that no xenon atoms were present in the gas in the metastable state ($^3P_2$ or S_5) that is known to be involved in the absorption of the wave-length λ8819 A. It is evident, therefore, that active nitrogen is not an agent that can cause xenon atoms to pass from the ordinary into the metastable state. The energy of the latter, it may be stated, is the equivalent of about 8·4 volts. It is interesting to recall that when, for example, zinc vapour is present in active nitrogen, spectral lines corresponding to 8·4 volts excitation are readily obtained. What happens with zinc vapour is obtainable with the vapour of any metal with which nitrogen can enter into chemical combination. The conclusion seems to be justified that chemi-luminescence plays a rôle in phenomena associated with active nitrogen.

J. C. McLennan.
Richard Ruedy.
J. M. Anderson.

The Physical Laboratory,
University of Toronto,
Toronto, Feb. 9.

[1] *Jour. Opt. Soc. Am.*, **14**, p. 17; 1927. *Zeit. f. Physik*, **29**, p. 345; 1924.

Prices of Periodical Scientific Publications.

In view of Dr. Baini Prashad's letter on this subject in NATURE of Mar. 31; perhaps the following information with regard to physiological and biochemical periodicals may be useful.

The statistics in the list below show that the total cost per annum of seven of the most important German physiological and biochemical journals is between three and four times as much as that of seven leading English ones, and also that the same German journals cost considerably more than do the more important physiological journals *of all the other countries together*. These figures, like those of Dr. Baini Prashad, are for the year 1927.

1. British.

	Vols. per year.	Price per year.
Biochemical Journal (Biochemical Society)	1	£3 0 0
British Journal of Experimental Biology (Company of Biologists, Ltd.)	1	2 0 0
Heart (Shaw and Sons)	c. 1	1 17 6
Journal of Physiology (Physiological Society)	2	2 10 0
Physiological Abstracts (Physiological Society)	1	2 2 0
Proceedings of the Royal Society, B.	1½	1 10 0
Quarterly Journal of Experimental Physiology (Griffin and Co.)	2	3 12 0
	9½	£16 11 6

2. AMERICAN.

	Vols. per year.	Price per year.
American Journal of Physiology (American Physiological Society)	4	£7 4 0
Journal of Biological Chemistry (American Society of Biological Chemists)	4	6 0 0
Journal of General Physiology (Rockefeller Institute for Medical Research)	2	2 15 0
Physiological Reviews (American Physiological Society)	1	1 12 6
	11	£17 11 6

3. GERMAN.

Berichte ü. d. ges. Physiologie (Springer)	4½	£13 10 0
Biochemische Zeitschrift (Springer)	12	17 8 0
Ergebnisse der Physiologie (Bergmann)	1	4 12 6
Jahresbericht ü. d. ges. Physiologie (Bergmann and Springer)	1	4 18 0
Pflüger's Archiv f. d. ges. Physiologie (Springer)	3	9 12 0
Zeitschrift für Biologie (Lehmann)	1½	3 0 0
Zeitschrift für physiologische Chemie (de Gruyter)	10½	8 8 0
	33½	£61 8 6

4. OTHER EUROPEAN.

Annales de Physiologie (Doin)	1	£1 7 6
Archives italiennes de Biologie (Trade)	1	2 2 0
Archives internat. de Physiologie (Vaillant-Carmanne)	2	2 5 6
Archives néerlandaises de Physiologie (Société hollandaise des Sciences)	1	1 12 0
Archivio di Fisiologia (Niccolai)	1	2 2 0
Bulletin de la Société de Chimie biologique	1	*c.* 0 15 0
Journal de Physiologie (Masson)	1	1 5 0
Scandinavisches Archiv f. Physiologie (de Gruyter of Berlin)	3	3 3 0
	11	£14 12 0

The enormous output at present both in England and in Germany—still more so in America—renders it imperative that all published results should be as concise as possible, so that the research worker may be able to keep abreast of the material. One great difference between the British and German journals is that the former are edited far more rigorously than the latter. If the Germans followed our example in this respect, it is probable that they would be able to reduce their published biochemical matter by one-half.

If the Englishman finds the cost of German periodicals excessive, still more must the German physiologist himself find it so. When this matter was brought up at the International Physiological Congress at Stockholm the year before last, the suggestion was there made that the German physiologists should do their own printing: the Deutsche Physiologische Gesellschaft might well be utilised for this purpose, in the same way as the Deutsche Chemische Gesellschaft is used by the German chemists, thereby rendering German chemistry available to all at a very low price.

The only other remedy left for Great Britain is to discontinue subscriptions to the more expensive German journals. Dr. Prashad suggests that the Royal Society and similar bodies should take the matter up in the interest of workers. I am informed that the Council of the Royal Society at a recent meeting actually decided to discontinue a number of these journals, mostly published by Springer, and including Pflüger's *Archiv*, and the *Zeitschrift für Anatomie und Entwicklungsgeschichte*, thereby saving just under £100 a year, and setting an example which might well be followed by other societies and institutions, both in Great Britain and in the United States.

WILFRID BONSER.

Medical Sciences Library,
University College, London, W.C.1.

Woods and Wireless.

THE splendid paper read by Mr. Barfield at the meeting of the Institution of Electrical Engineers on Dec. 7 last, and referred to in NATURE of Dec. 30, 1927, p. 967, throws light upon the hitherto obscure mechanism of the damping by trees on the propagation of radio waves. In fact, every tree acts as a B.C.L., absorbing part of the energy falling upon the antenna, and re-radiating the rest.

May I lay stress upon the fact that a tree cannot possibly be regarded as a pure resistance, except when

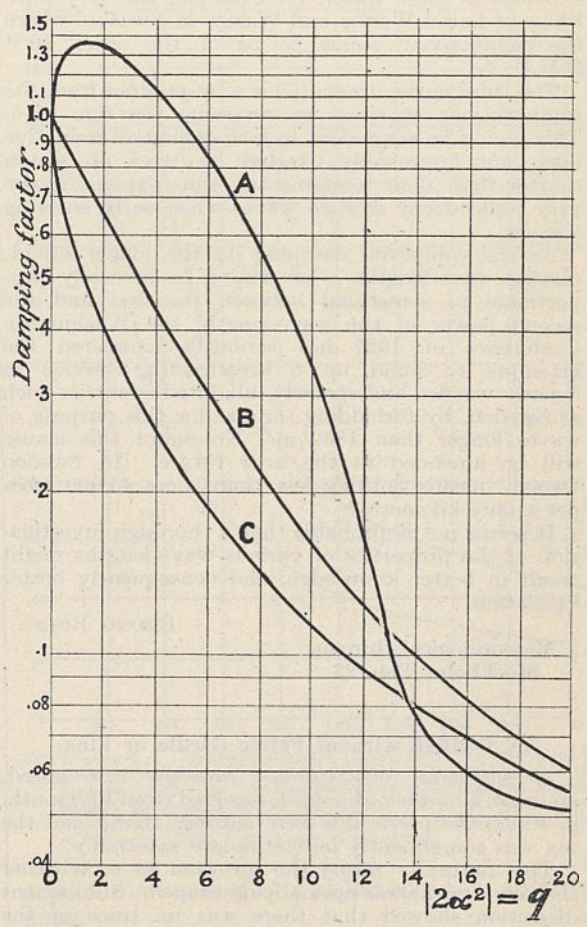

FIG. 1.

emission takes place on the resonant frequency of the tree. As, generally, the natural wave-length of the tree is shorter than the wave-length of the broadcasting transmitter, its action is that of a condenser with big losses. Translating to the language of Prof. Sommerfeld's beautiful solution, this means that the 'numerical distance' is not a positive real number, but a complex one. Writing his a^2 in the form $2a^2 = q\ (\cos b + i \sin b)$, we get, approximately, $q = 2\pi r/2c\lambda^2\sigma$, $\tan b = (\epsilon + 1)/2c\lambda\sigma$, the symbols having their usual meaning, and with σ in E.M.U., ϵ in E.S.U.

The computation of the damping is in this general case a trifle more tedious than when the soil is a pure conductance, but surely pays for the trouble taken. In the special case when $\cos b = \sin b = 1/\sqrt{2}$, *i.e.* the capacity effect just as great as the conductivity effect, we have the damping curve A drawn in full in the accompanying diagram (Fig. 1); for comparison the trivial case of $\cos b = 1$, $\sin b = 0$ is also shown (B).

The former curve explains the very remarkable feature, first revealed by Mr. Barfield himself on the Daventry station, and amply confirmed by Mr. Lemoine on the Swedish stations at Karlsborg and Motala, namely, that the damping is *negative* for the first 20 or 30 kilometres. This is nothing but a feint on the part of the woods, which soon revenge themselves by an almost catastrophal damping farther away. It is a happy coincidence on certain wave-lengths that, in day-time, reflection sets in at the right moment to reinforce the vanishing direct ray. The same effect ought also to be shown by great expanses of fresh water, for example, the very pure water of Lakes Wetter and Wæner in Sweden, where the conductivity seems to be of the order 10^{-14} E.M.U.

The third curve drawn (C) is a by-product from the computations obtained by reversing the sign of b. This should be equivalent to introducing an inductive load, not improbably exerted by trees on waves shorter than their fundamental, thus explaining the very rapid decay of such waves when early entering a wood.

As the composite damping on the longer broadcasting wave-lengths is shown to be inversely proportional to something between the first and the second power of the wave-length, the Washington Conference of 1927 has seriously hampered the attempts to build up a broadcasting service in densely wooded and sparsely inhabited countries such as Sweden, by forbidding the use for this purpose of waves longer than 1850 m. No doubt this clause will be amended in the near future. In Sweden 'wood' means nothing less than some 40,000 trees per square kilometre!

It seems not improbable that a thorough investigation of the properties of various wave-lengths might result in better knowledge, and consequently better legislation.

BRUNO ROLF.

Meteorological Bureau,
Stockholm, Feb. 23.

A Dogfish without Pelvic Girdle or Fins.

A SPECIMEN of *Scyllium canicula* was noted, amongst a number of dogfish received from Plymouth, in which the pelvic fins were entirely absent and the sex was consequently indeterminate externally.

This naturally raised the question as to whether the pelvic girdle was normally developed. Subsequent dissection showed that there was no trace of the girdle. The dissection also showed that the animal was a fully mature male with the internal urino-genital organs normally developed, but, correlated with the absence of pelvic fins, there was no trace of claspers.

The urinogenital papilla was situated somewhat nearer the vent than is usually the case.

Abdominal pores were present on each side of the cloaca, but they did not open internally to the cœlom.

E. M. SHEPPARD.
J. H. LLOYD.

University College,
Cardiff.

Functional Differences between Left and Right Splanchnic Nerves.

STIMULATION of the peripheral end of the divided right splanchnic nerve in the abdominal cavity has revealed several marked differences in the resultant effect upon the blood-pressure from the well-known results obtained by similar stimulation of the left nerve. If the right nerve be stimulated by successive stimuli of sufficient strength at frequent intervals, a rapid exhaustion of the nerve occurs. Using a rapidly interrupted current with the secondary coil 10 cm. from the primary and 2-volt accumulator, it is found that there is a rapid diminution in the pressor response, and after about four or five stimulations no further rise of blood-pressure can be elicited with the same strength of current.

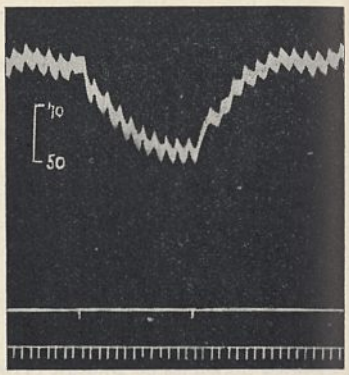

FIG. 1.—Mechanical stimulation of the peripheral end of the right splanchnic nerve by means of a glass rod producing a fall of blood-pressure. Time in 5 seconds.

I have obtained this effect with cats under various anæsthetics, and in the decerebrate and pithed conditions. Repeated attempts have failed to produce these results in the left nerve.

Coincident with the diminution of the rise of blood-pressure, a curious after rise becomes increasingly apparent. It occurs immediately after cessation of stimulation, and is very rapid in its formation. Ligature of the adrenal glands does not alter it, nor does ligature of the superior mesenteric or portal veins.

Continuation of the series of stimulations after exhaustion has taken place causes a *fall* of blood-pressure to be manifested, and eventually a condition is reached when even the strongest stimuli evoke falls of blood-pressure. The falls are most easily elicited by mechanical stimuli (Fig. 1).

Such results indicate that the right splanchnic nerve contains a considerable number of vaso-dilator fibres.

My thanks are due to Prof. Swale Vincent, without whose assistance and advice much of the work would have been impossible.

J. H. THOMPSON.

Department of Physiology,
Middlesex Hospital Medical School, W.1.

Dug-out Canoe in Algoa Bay.

THE origin of the dug-out canoe, over which there was so much controversy, has now been finally settled. I have ascertained definitely that the canoes are in use in the East Indies, mostly at Celebes and the Malacca. At the latter place there are men who actually make them for sale.

The blocks with holes in them, at the sides of the canoe, are five in number. Three are for supports for plank seats on which the paddlers sit. The other two are for the purpose of securing the bamboos to which the outriggers are attached. The slot at the bottom of the canoe is for the insertion of the base of a pole for a sail.

F. W. FITZSIMONS.

Port Elizabeth Museum,
Port Elizabeth, Feb. 18.

Some Modes of Mechanical and Animal Locomotion.

By A. Mallock, F.R.S.

SUCH questions as how do birds fly, how do fish swim, how do ships steer, or snakes crawl, have been subjects of interest from very early times.[1] The present note is concerned with these and some other forms of locomotion, all of which may be placed under the heading of motion in fluids and motion on solids. Motion in fluids includes ships, airships, flying machines, birds, winged insects, fish, whales, and various swimming insects and Crustacea. Motion on solids refers to various legless creatures such as snakes, molluscs, and microscopic organisms.

Motion in Fluids.

A very general proposition applicable to all cases may be stated with regard to motion through a fluid; namely, if a body moves with a velocity v and experiences a resistance R, momentum is generated (either by pushing, pulling, or rubbing) in the direction of the motion such that $d(MV)/dt = R$. Here MV is an abbreviation for the integral of the mass of each element of fluid $\times$ velocity imposed on it by the progress of the body. If the source of power is contained in the moving body, an equal variation of momentum in the opposite direction must be generated in the fluid to overcome the resistance.

For the present purpose the source of power, whether screw, wing, paddle, or jet, may be called the accelerator, since its purpose is merely to accelerate the fluid in a direction opposed to R. The ideal accelerator may be taken as an area placed broadside to the stream, supplied with means of increasing the potential of the fluid passing through it, and experiencing therefore a reaction equal to the accelerating force. To determine what total flow and what velocity is required to produce a given reaction, let A be the area of the accelerator, v the velocity of the fluid, and ρ its density. The flow of mass is ρAv. If R is the given reaction and F the accelerative force acting on the fluid, and if $R = Mg$, then M is the mass of fluid which weighs R and occupies a volume Av. Thus $\rho AvF = Mg$. M is a constant, so that $F/g = 1$ and $A = \text{volume} \div v$. Take, for example, the case where the fluid is air and let $R = 1000$ lb. and $A = 1000$ ft.^{2}. A thousand lb. of air has a volume of about 12,800 cubic feet, and this volume per second will, starting from rest, acquire a velocity of 32 ft./sec. in passing through the accelerator when acted on by a force equal to its own weight. If the area is halved the velocity must be doubled and $F = 2g$, and so on.

The power required to produce the velocity is vR. In the diagram (Fig. 1), curves are given showing, in term of the area of the accelerator, the velocity of the air current necessary to cause a reaction of 1000 lb., and also the horse-power required to maintain it. A curve is added showing the diameter of the stream if the cross-section is a circle.

In this diagram it is assumed that the accelerator itself is stationary and that therefore all the work goes in creating currents in the air. If, however, the pressure drives the accelerator forward at a velocity v_2, then, in the absence of any acceleration, the flow of mass through the accelerator will be ρAv_2 per sec., and if v_1 is the velocity which must be added to this flow to maintain the reaction R, the power required will be $R(v_1+v_2)$, and the requisite accelerating force will be less than that indicated in Fig. 1 in the ratio $v_1/(v_1+v_2)$, *i.e.* a smaller force acting at a higher spead on a greater mass.

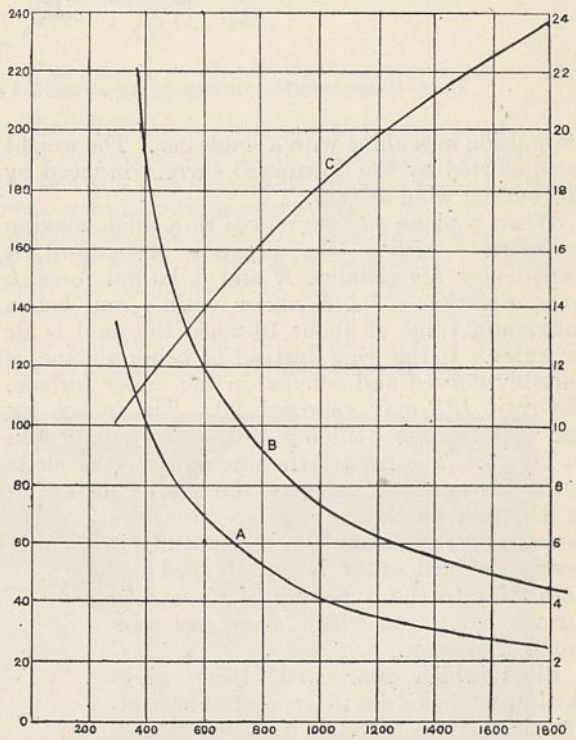

Fig. 1.—Curve A. Ordinates show the velocity in ft./sec. which must be given per sec. to a volume of air weighing 1000 lb. (in terms of the area over which the volume extends) in order that the reaction against acceleration should be 1000 lb. Curve B. Horse-power required to maintain the stream. Curve C. Radius of a cylinder of the same section area as that of the stream.

A somewhat similar case is that of a barge being poled along at a speed v_1 against a resistance R. If the bottom of the canal is hard and the pole does not slip, the bargee walks aft at the speed v_1 and does useful work at the rate v_1R. If, however, the pole slips at the speed v_2, he has to walk at the rate of v_1+v_2, expending power $R(v_1+v_2)$, of which Rv_2 is wasted.

For bodies the weight of which is borne by the fluid (such as airships, fish, etc.), the stream emitted by the accelerator is in the direction of the fluid resistance, but for flying machines, birds, and

[1] See Proverbs xxx. 18, and Epistle of James iii. 4.

winged creatures in general, whose weight has to be supported dynamically, the stream must have a downward momentum component Mv_y, giving $d(Mv_y)/dt = W$, while the horizontal component Mv_x makes $d(Mv_x)/dt = R$.

In flying machines, the horizontal component, corresponding to R, is supplied by a screw, and the weight is supported by the inclined surface of the wing. With flying animals, however, the wings have to propel and also to support the body.

Fig. 2 shows diagrammatically the attitude of the wing during one complete beat. The propulsion effect is dependent on the change of wing angle during the up-and-down stroke, and is similar to the propulsion in sculling with a single oar. The weight is supported by the downward current induced by the curved wing section.

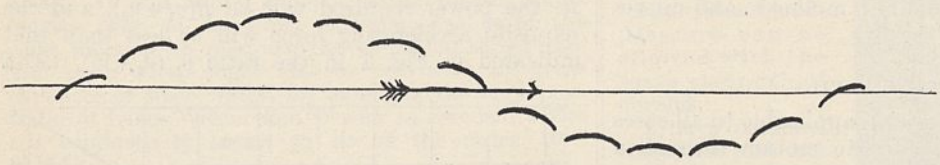

FIG. 2.—Diagram showing the attitude of the wings of a bird during one complete beat.

When a plane surface moves in a fluid, making an angle α with x (the direction of motion), it experiences a resistance R and a lateral force L in a direction y. L/R varies with α and has a maximum value of about 10 when the fluid is air or water. If the wing, instead of being a plane, is suitably curved and convex on the upper surface, the ratio L/R may approach 20. The reason for the approximate doubling of the lift is indicated in Fig. 3. The flow of the stream past the plane surface is as in (a), and past the curved surface as in (b), from which it may be seen that the downward component of momentum is nearly doubled in the latter. I need not here refer to the dynamics of these two forms of flow, on which there has been much discussion.

Birds which soar with their wings stationary make use in general of ascending air currents, though it is possible, as was shown by the late Lord Rayleigh, that when the velocity of the wind is different at different levels, they may soar by passing alternately into strata of quicker and slower wind speeds, provided that the speed gradient is sufficiently steep. I do not know, however, of any observations proving that this method is actually used. Ascending currents are formed in many ways, such as by the ascent of heated air, or by the configuration of the ground or waves on a water surface. With their long experience, birds have probably learnt to make use of any conditions which give the desired result.

Dr. Hankin, in India, made many observations on the soaring of birds, and found that none of the birds on the plains began to soar until the sun had risen for some time, and I myself have noticed that, on a hilly tropical island, soaring does not begin until the sea breeze has been established. From this it seems probable that ascending currents are the chief agents in soaring flight.

Hovering, that is, keeping the body stationary in still air by the working of the wings, is only found in Nature in small birds and insects. The heaviest bird which I have known to hover is our English kingfisher, but humming-birds are the typical vertebrate hoverers. More striking examples are to be found amongst insects, such as hawk-moths and hover-flies, but the best of all is a dipterous fly (Bombylius), like a small humble-bee, which when feeding on a flower will insert and withdraw its proboscis as steadily as if it were controlled by a fine adjustment screw.

The kestrel hawk has the power of keeping its position for short intervals with wonderful exactness. This, however, is not true hovering, but merely flying against the wind at the speed of the wind. In all true hovering the attitude of the body is nearly vertical, and the mean plane of motion of the wings approaches the horizontal.

The limitation of the size of hovering animals is, as may be gathered from Fig. 1, the small power to weight ratio in muscular action. From the diagram also it may be seen how futile it is to attempt to construct hovering machines, using as accelerators screws of size common in aeroplanes.

If inventors or designers could develop a machine which, with 1000 lb. total weight, could carry a 100 h.p. engine with an accelerator of any kind of an effective area of 600 ft. to 1200 ft. (which in the form of a screw would imply a diameter of 40 ft. to 60 ft.), a hovering machine would become a possibility.

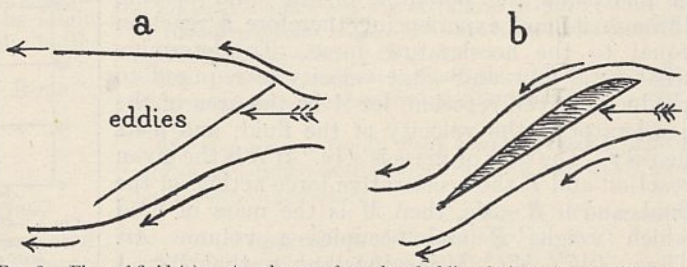

FIG. 3.—Flow of fluid (a) past a plane surface placed obliquely in a stream; (b) past a surface plane on the upstream surface but with a convex back.

There are many examples in Nature of the use of oars and paddles. The chief paddlers are the swimming and diving birds with webbed or partially webbed feet. The general action of paddling is indicated in Fig. 4, which shows the position of the foot and the opening and closing of the toes during one complete stroke. When referred to a fixed point in the body, the foot describes a nearly circular path, and the successive positions of the web are not unlike those of floats in a feathering paddle-wheel.

The contrast between acceleration by paddles and wings may be well observed at the Zoological

Gardens when the diving birds are fed, for the penguin uses its short wings to fly under water, and I think that anyone would give the prize for speed and manœuvring power to the wings.

It is worth noting that these under-water wings, not having to support the weight of the bird (and therefore not having to give a downward component to the fluid on which they act), are nearly plane surfaces, and not, as in the case of air wings, convex on top.

The most familiar examples of the use of natural oars are found in the Dytiscus family and in the water-boatmen (Notonecta). Here one pair of legs greatly exceeds the other in length, and the last joints are bordered by a row of stiff bristles which stand vertically up and down during the backward or propelling stroke, but collapse in a horizontal plane as the leg is moved forward, thus in effect forming an oar which feathers under water.

Another and very curious example is found in the Gyrinidæ beetles. Here the tarsi are expanded into long paddle-shaped blades capable, when not in use, of folding within an enlarged upper joint. See illustrations *a*, *b*, *c* in Fig. 5. I do not know whether these blades are used as oars or as wings, but it would be possible, and certainly interesting, to take moving photographs of their action with the lens focused on the underside of the water surface.

In upright-swimming fish and whales the accelerator is the tail fin or flukes, and to some extent the tail end of the body, the action being that of sculling with a single oar. The greater part bulk and weight of both these classes consists of the muscles working the accelerators. The outstanding difference in the mechanism in Pisces and Cetaceæ is that in the first the muscular action bends the spine into a curve alternating to the right and left, while in the latter similar motions are caused up and down (Fig. 6).

Flat fish (soles, etc.) have two modes of progression: one for moving slowly in contact with the ground, the other being kept for quicker travel. In these fish the dorsal and anal fins are greatly developed, extending from head to tail. For slow movement these fins are bent into a waved surface (Fig. 7), the waves, with the water between the fins and the ground, travelling in a backward direction.

When higher speeds are desired the body is raised from the ground and the main series of muscles, which are connected with the spine and ribs, act in the same way as in the upright-swimming fish, but the flexure of the spine is now up and down, instead of from side to side.

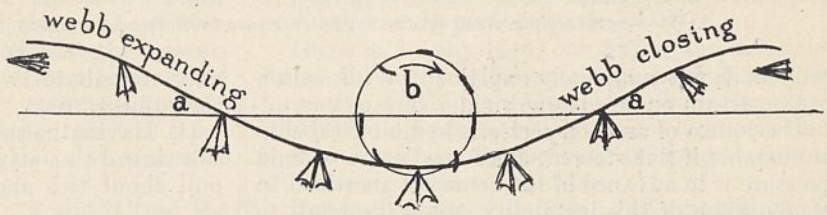

FIG. 4.—Diagram showing the action and position of the webbed feet of a swimming bird (*a*) with reference to a fixed point, (*b*) with reference to the body of the bird.

Among the rays the ribs are almost wanting, and the whole width of the body is occupied by the greatly developed pectoral fins. The fin-rays are very numerous, and each of these is connected with a muscle rather similar in form to the muscles which in other fish are attached to the ribs.

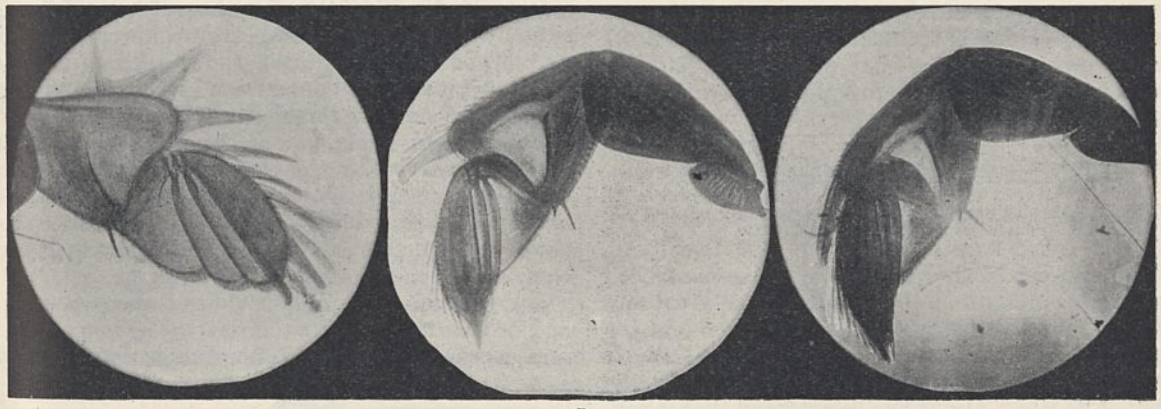

FIG. 5.—Swimming legs of Gyrinus, showing paddle-shaped tarsi (*a*) fully extended, (*b*), (*c*) partly closed.

I have had no opportunity to observe the way in which the rays use their pectorals, but it seems likely that it is similar to the action of the dorsal and ventral fins in flat-fish.

Flying-fish when submerged swim as the other upright-swimming fish, and must for a short time at least be able to travel very fast, for I have seen them rise close to the side of a ship going 15 knots and pass ahead at perhaps 4 or 5 knots faster. While in the air the pectoral fins act as glides only, as may be shown by the small size of their muscular attachments, but where the water is smooth they can prolong their flight by sculling with the tail fin,

keeping its lower half in the water, so that the weight is supported by the air and the propulsion given by the sea. It is interesting to notice the increase in the speed of the fish after the tail is immersed.

The steering of ships, especially those with small rudders, is not completely explained by the action of the stream on an oblique rudder surface.

FIG. 6.—Showing the position of tail fin of an upright-swimming fish during one complete cycle.

The course of an even perfectly symmetrical ship is unstable if not steered, since the centre of fluid pressure is in advance of the centre of inertia. In consequence of this instability, the wake tends to make an angle with the line of the keel, and thus to exert a turning movement on the ship. Even a small rudder, however, is sufficient to determine the direction of the instability, that is, whether the wake shall deviate to port or starboard, and a large part of the efficiency of the helm is dependent on this cause.

The unstable wake gave a great deal of trouble in some of our earlier warships, and there was a class of small gunboats (meant originally, I believe, for service in the Chinese rivers) which were notorious for their erratic steering. There was a story of a captain of the *Excellent* entering Portsmouth Harbour on one of them being hailed by the master of a sailing barge beating out with: "Now, sir, if you will tell me what part of the harbour you want to get to, I'll try to squeeze into the rest."

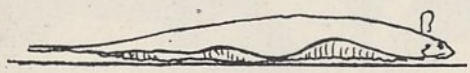

FIG. 7.—Showing wave-like form given to the dorsal and anal fins of flat-fish when moving slowly.

The manner of the progress of snakes has been much misrepresented. In Prof. Owen's "Anatomy of Vertebrates" there is a figure of a snake in the attitude of a looper caterpillar, like a Greek Ω. It has been said also that a snake 'walks' on the ends of its ribs; also it has been stated that it can, without any curvature of the body, move in a straight course by the ratchet-like action of the large ventral scales.

So far as my own observation goes, a snake on a flat smooth surface is in a very helpless condition, and can only progress by slightly raising the curved body on the right and left sides of the course alternately and straightening the raised portions. The track left by a snake in crossing a dusty road looks like a succession of horse-shoe marks such as are represented in Fig. 8. If there are any projections on the surface—grass, sticks, stones, branches, or in fact anything against which the body can get a 'purchase'—the snake bends itself into a curve to fit one or more of the projections and causes the curve to travel backward along the body, so that, with reference to the projections, the curve remains stationary and the body passes through the shape (Fig. 9).

The coefficient of friction between the body and the projection is involved in this, and here no doubt the edges of the scales on the under surface are of use in preventing backward slip.

The crawling of molluscs has not, I think, ever been satisfactorily explained, and I can only contribute two observations which bear on the subject.

(1) Having harnessed a large *Helix aperta* by a silk thread to a spiral spring, I found that it could pull about two and a half times its own weight

FIG. 8.—Track of a snake on a flat dusty surface.

before the foot began to slip on the surface on which it was crawling.

(2) Taking young specimens of the same snail, which are translucent, and examining the foot by transmitted light, it was seen that, so long as the animal was in motion, dark waves were passing in a forward direction through the substance of the extended foot. There were two or three of these waves visible at the same time. Whether they indicate muscular contraction or regulate the secretion of mucus remains to be determined.

That there is some periodicity in the secretion of mucus is proved by the intermittent tracks with which snails mark garden walks, leaving patches of mucus separated by clear ground. The intervals between the marks are very constant so long as the character of the ground does not change.

On dry ground more mucus has to be expended, and where there is dust it is not uncommon to find a snail has died from exhaustion. On a dusty road having on one side a drying ditch and on the other a wet one, I once saw the tracks of a number of young Limax which had tried to cross. Not one had succeeded. The tracks, in parallel lines a few inches apart, extended from 6 inches to 2 feet over the dust,—a dead snail at the end of each.

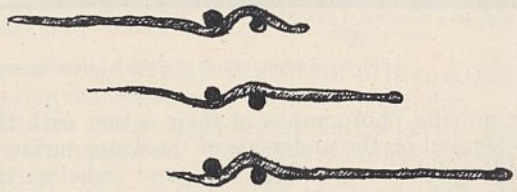

FIG. 9.—Showing mode of progression of a snake.

Many microscopic forms of life are capable of

moving slowly by the action of cilia. The action of cilia seems to be that each individual hair is capable of extension and retraction as well as of lateral bending, and that in the extended state the extremities are all moving in the same direction, thus causing a flow of fluid over, or giving motion to, the ciliated surface when in contact with a fixed body, an action which is not unlike that of the fire-bars in an automatic grate.

I know of no explanation of the mechanism by which the cilia are actuated or of the conditions which determine their periodicity.

Nova Pictoris as a Double Star.

A RECENT note in our astronomical column stated that observations in January at La Plata and Johannesburg showed that Nova Pictoris was surrounded by a nebulous ring. About Mar. 26 the La Plata observers noted that the appearance of this ring had altered; they telegraphed to Johannesburg, asking for an examination to be made with the 26-inch refractor; this was done, and revealed the fact that the star appeared double.

A Reuter telegram on Mar. 28 added that the position angle was 70°, the components were about equal in magnitude, that each was nebulous, and that the distance between their centres was half a second. It was added that separation of two stellar points at this distance would have been easy, and that under the actual conditions a darker band could be detected between the nebulous discs. On the other hand, Dr. Spencer Jones, His Majesty's Astronomer at the Cape, in a statement quoted in the *Times* for Mar. 29, gives the distance between the stars as one-fifth of a second. The Johannesburg estimate is probably to be preferred, the telescope there being larger, and the observers having much practice in measuring difficult binaries.

Dr. Spencer Jones adopts the view that the outburst was due to an actual collision of two stars, which have now drawn apart sufficiently to enable them to be seen separately; this is the theory that Mr. Bickerton has advocated for the last forty years, but most astronomers have decided that there are far too many Novæ for this explanation to be tenable in general. It would be expected to happen only once in many million years. Nova Pictoris, however, differed in several respects from the average Nova, so the possibility of a collision need not be immediately dismissed; an opportunity will be afforded to test the suggestion when measures of the pair have been taken for some months. The rate of angular separation would not be uniform; it would slow down owing to the mutual gravitation of the stars, which would pass each other on hyperbolic paths.

There is, in any case, one important difference from Bickerton's theory; he postulated the formation of a third body between the stars, which would be for some time more luminous than them; but the Johannesburg telegram mentions a darker region in the middle.

Harvard College Bulletin 852, published in November last, quotes Mr. Davidovich's spectroscopic parallax 0·006″ (giving a distance of 540 light-years) and derives a proper motion of −0·042″ in R.A. (great circle) and −0·018″ in declination. This is from comparison of old plates with recent ones, both taken with the 24-inch Bruce refractor, the time-interval being 24·2 years. The original magnitude of the star was 13 (absolute magnitude 7); if there were two stars on the old plates, their images would probably be blended. The above motions give position angle 247°, which is very nearly in line with the angle 70° now reported.

The outburst occurred on May 25, 1925, so that the interval up to the detection of duplicity is 2 years 10 months; assuming that the stars were then together, this gives 0·18″ as the average annual rate of separation; but it would have been much more rapid at first, and would now have sunk to perhaps a third of this, so that a trustworthy measure of the rate cannot be expected for several months.

The occurrence is unprecedented in the history of Novæ, and is of great interest; the similarity of the two stars in magnitude and appearance leaves little doubt that they are at the same distance from us, and that the phenomenon is not to be explained by the motion of the Nova revealing an independent star that previously was hidden in its rays.

Obituary.

Mr. E. W. Maunder.

THE death of Mr. Edward Walter Maunder on Mar. 21, at seventy-six years of age, will be regretted by astronomers in many parts of the world. Mr. Maunder was for many years a member of the staff of the Royal Observatory, Greenwich, and his appointment indicated the beginning of the change in the character of that establishment that has occurred in the last half-century. In his report, read on June 1, 1872, the Astronomer Royal, Airy, put to the Board of Visitors the proposition that a continued series of observations of the solar spots, and perhaps some solar spectroscopic work, of which he spoke with less certainty, might fitly be undertaken at Greenwich, though the Observatory would then become *pro tanto* a physical observatory, and hinted that its operations might be extended in that direction in the future. This resulted in the appointment of Maunder as photographic and spectroscopic assistant on Nov. 6, 1873, and in the first half of the following year a spectroscope by Browning was attached to the 12¾-inch equatorially mounted telescope, then known as the Great Equatorial, and a photo-

heliograph that had been used at Kew was installed in the Observatory grounds, both of which were given into Maunder's charge.

Thus began the forty-year series of photographs of the sun that was made under his direction. The first decade of the period was before the general use of the gelatine dry-plate, and the task of taking photographs by the collodion process daily, as weather permitted, was somewhat arduous. Maunder was partly relieved of this by the appointment of a skilled helper, and was able to devote some time by day to spectroscopic examination of the chromosphere and prominences, whilst at night the instrument was used for measuring the displacement of lines to determine velocities in the line of sight, occasionally for mapping the spectra of planets and stars, or, sometimes the telescope was used without the spectroscope for visual examination of, or for micrometric work on, the planets. Notes on the spectra of two Novæ, with others on similar subjects, are to be found in the *Monthly Notices of the Royal Astronomical Society* under Maunder's name, and for the most part the observations here mentioned are in the volumes of that publication. After the accession of Christie to the office of Astronomer Royal, the work of photographing and recording the sunspots was developed in several ways. The photo-heliograph was adapted so that (from April 4, 1884) the solar image had a diameter of 8 inches instead of 4 as hitherto, and the Greenwich photographs were supplemented by others taken at Dehra Dun and elsewhere to make the series complete.

This naturally made more demand on Maunder's time, and the personnel of the department was increased, but about the time of the sunspot maximum of 1894, the spectroscopic work at Greenwich was given up that he might devote himself wholly to the sunspots. The record of their positions and areas was kept by him with care and skill until his retirement in November 1913, and beyond the bare record, his ingenious tabulations and diagrams are of much value. A re-determination of the position of the sun's axis, published in 1912 and 1913, and a diagram showing the distribution of spots in latitude during three or more cycles, known as the 'Butterfly' diagram, may be mentioned, but his papers that received most attention were those on the association of terrestrial magnetic disturbance with the appearance of sunspots. A diagram in the *Monthly Notices* of November 1904, which displayed the solar longitude of the centre of the disc that was contemporaneous with the occurrence of magnetic disturbances in the years 1882 to 1903, showed unmistakably that magnetic storms are of solar origin. The idea of a short period in magnetic phenomena was not new, but it is doubtful whether it had been before exhibited so vividly.

It does not belittle Maunder's actual astronomical work to say that his greatest service to the science was the founding of the British Astronomical Association. In his early years at Greenwich he had formed a large circle of astronomical acquaintances, and in the year 1890 he was led to conceive the idea of an Association of amateur astronomers for mutual help, who because of their sex, or by other circumstances, might be precluded from joining the Royal Astronomical Society. Mainly by his efforts such an Association was formed, and the position of the organisation to-day, with its roll of a thousand members, many of whom are contributing observations of unique character and importance to astronomy, testifies to its success.

Maunder went abroad on six occasions to observe a total solar eclipse—twice as a member of a British official expedition; once as a guest of the Canadian Government, and three times he was a member of a party organised by the British Astronomical Association. On four of these occasions he was favoured with fine weather.

Maunder had a ready pen, considerable command of language, and wrote much. He was acting editor of the *Observatory* magazine from 1881 until 1887. At one period he contributed the Astronomical Column to this journal, and at another did similar office for the now defunct *Knowledge*. He edited the *Journal of the British Astronomical Association* from its foundation until the end of the fourth volume, and from 1896 until 1900; and the complete series contains many articles by him on topics of varied nature, archaic astronomy being one of them. His book, "Astronomy without a Telescope," has found many readers, as has his "History of the Royal Observatory," whilst his elucidation of certain scriptural passages in his work "Astronomy of the Bible" elicited commendation from ecclesiastics in high position, the book itself being in keeping with the devoutness that was a marked feature of his character.

Maunder was twice married. His first wife died in 1888, leaving a family of three sons and two daughters, who survive him. In 1895 he married Miss A. S. D. Russell, who was formerly on the staff of the Royal Observatory, and is not unknown in the astronomical world. He joined the Royal Astronomical Society in 1875, and was a member of its council for several years, serving as honorary secretary from 1892 until 1897. He retired from his post at the Royal Observatory at the end of the year 1913, but was recalled during the years of the War to carry on the sunspot record.

PROF. THEODOR CURTIUS, emeritus professor of chemistry in the University of Heidelberg, died at Heidelberg on Feb. 9 in his seventy-first year. Curtius, who was well known as the discoverer of hydrazine, hydrazoic acid and the azides, discovered also the method of obtaining aliphatic diazo-compounds. Lead azide, which he first prepared, soon became an important substitute for mercury fulminate as a detonator.

WE regret to announce the following deaths:

The Right Hon. Viscount Cave, G.C.M.G., who had just resigned from the office of Lord High Chancellor, and Chancellor of the University of Oxford since 1925, on Mar. 29, aged seventy-two years.

Dr. William C. L. Eglin, vice-president of the Philadelphia Electric Company and president of the Franklin Institute, on Feb. 7, aged fifty-eight years.

News and Views.

In September next an important meeting of the International Illumination Commission, which was formed in 1900 and includes both the gas and electrical interests, is to be held in America. The objects of the Commission are the study of all subjects bearing on illumination and its cognate sciences, and the establishment of international agreements in illumination matters. There are at present National Illumination Committees in Austria, Belgium, France, Germany, Great Britain, Holland, Italy, Japan, Switzerland, and the United States of America. For the first time in the history of the Commission, a British president has been elected, namely, Mr. C. C. Paterson, Director of the Research Laboratories of the General Electric Co., Wembley. The Commission has already established an international standard of light, and is now dealing with such subjects as definitions and symbols, factory and school lighting, automobile headlights, heterochromatic photometry, photometric accuracy, fundamental research on glare, colorimetry. The British National Illumination Committee, which is closely associated with the Sectional Illumination Committee of the British Engineering Standards Association, the membership being practically identical, will be responsible for nominating delegates to represent the British viewpoint and British interests, and is anxious to secure adequate representation at these meetings. It is hoped that the delegates will include representatives of the Government departments, municipalities, the National Physical Laboratory, the electrical industry, the gas industry, and the principal associations interested in illumination matters. Mr. Buckley, of the National Physical Laboratory, Teddington, who is the secretary of the British National Illumination Committee, will gladly furnish full particulars.

The Report on Scenery-Preservation for 1926–27, issued by the Department of Lands and Survey, New Zealand, makes pleasant reading. Among many interesting reservations recently added is the Te Koru Pa in the Taranaki District. The pa, which was at one time the headquarters of the Ngamahanga Hapu of the Taranaki Tribe, is situated in a horse-shoe bend of the Oakura River, and, apart from its historic interest, has long been held in high regard as a favourite picnicking-ground. It forms one of the very few remaining examples of a pa with stone-faced glacis or parapets surrounding the tiki or citadel. The narrow neck connecting the pa with the mainland was in the old days defended by a very deep trench backed by three terraces, all of which were faced with stone to a height of 15 feet in places. This area was a gift to the Crown from the native owners. Mr. Wilkinson's report on Kapiti Island, which is in his care, contains much that will appeal to the naturalist. For example, he writes: "Nearly all over, or at least in places where the forest-roof is open, the *Uncinia riparia* is becoming a pest and is a menace to bird-life. . . . Not only does it hold small birds, but even the morepork is not able to extricate himself when once he is properly caught. The unfortunate part about it is that the plant is seeding, and therefore in its dangerous stage, just when the young birds are beginning to fly about. I have several times rescued birds, and in nearly every case they were adult birds, so that young birds caught must eventually die of starvation or be taken by the wekas."

The Report also notes the improvements effected by an Amending Act of 1926. This gives permission for the destruction of certain troublesome animals under stringent provisions. Power is conferred on local authorities to contribute towards the cost of acquiring scenic reserves and towards their improvement and maintenance. So far as possible, the control of reservations is vested in local authorities or special boards, and honorary inspectors are appointed. This affords enthusiasts an opportunity of performing useful service of value to the State, and encourages among the general public a regard for natural beauty. In England we have to protect our downs from the seaside bungalow. In our antipodes, "The advent of the seaside dwelling in the Sounds has proved an important factor in the improvement to the scenery during the past few years. Most of the owners of these are enthusiastic nature-lovers, and, besides protecting the remnants of native bush on their properties, have extended these by planting more native or introduced trees. In this way many hundreds of acres which a few years ago were in bracken or burnt bush are rapidly becoming reafforested, and prove a welcome addition to our efforts in conserving what we can of the original native bush that beautified the Sounds."

The Ministry of Agriculture and Fisheries has issued a statement of the measures taken to prevent the introduction into Great Britain of foot-and-mouth disease from South America. Epidemics of this disease have been traced to carcases imported from Europe, and the research committee investigating the subject has determined that the virus, if present, remains active in frozen carcases for 76 days. Negotiations were conducted with the Governments of Argentina, Brazil, and Uruguay, and the Ministry's Senior Veterinary Inspector, Mr. J. L. Frood, visited those countries and conferred with the officials there. Finally, Lord Bledisloe agreed to undertake a mission to the three countries to modify, if necessary, and to ratify agreements awaiting final approval. Agreement was reached respecting the measures necessary to prevent the importation of the foot-and-mouth disease virus with the frozen meat which comes from the three countries named. The two principal clauses institute veterinary inspection of the animals before removal from the *estancias*, and of the animals at the freezing establishments before and after slaughter, with isolation of herds in the event of symptoms of contagious disease appearing among them.

The Folkestone Natural History Society, which was founded on April 4, 1868, has been celebrating its diamond jubilee. On Saturday, Mar. 24, a visit was

paid to Snowdown College. At a public meeting held on the following Wednesday, short addresses were delivered by Mr. A. H. Ullyett on the history of the Society, by Dr. Walcot Gibson, on the value of local natural history societies, and by Mr. C. A. B. Garrett, on natural history in schools. During the evening especial attention was directed to the part the Society has played in the inception of the excellent Town Museum now under the able curatorship of Captain Moody-Foster. Occasion was also taken to present a set of silver-plate to Mr George Chapman Walton, in recognition of his long services to the Society as honorary secretary and as president—an office which he has filled since 1905. A lecture by Prof. Julian Huxley on the progress of biological science during the past sixty years, delivered on Friday evening; and a conversazione with exhibits and demonstrations, held on Saturday, Mar. 31, terminated a very successful anniversary of one of the oldest natural history societies in Great Britain.

A MEETING for the discussion of geophysical surveying was held at the Institution of Civil Engineers on Mar. 28, under the chairmanship of Sir John Flett, Director of the Geological Survey of Great Britain. The chairman, in his introductory remarks, emphasised the value of geophysical methods in the study of geology and mining, and indicated that the results recently obtained by the Geological Survey have proved entirely satisfactory. Dr. W. E. P. M'Clintock described a survey with the Oertling torsion balance over the Swynnerton Dyke in Staffordshire, by the Geological Survey, and showed the closeness with which the position of the intrusive dyke had been located and its features investigated. Not merely could the limits of the dyke be established, but also it was shown that the dyke was inclined slightly to the vertical. He stressed the convenience of the Oertling protecting hut, and the general convenience and portability of the apparatus. Mr. E. Lancaster-Jones outlined the evolution of a new instrument recently constructed for the measurement of gravity gradients. This instrument, termed a 'gradiometer,' is unaffected by curvature, and may be readily transported by one man. In speed of operation it is a considerable advance on previous instruments, and it should enable both reconnaissance and detail gravity surveying to be effected with greatly increased economy and efficiency. An account of field work with this instrument was given by Captain H. Shaw, who showed results that have been obtained in tidal areas. In one case an important fault showed up prominently, and was located with accuracy and interpreted in detail. In a second area, a noticeable subterranean feature was revealed, and by means of a dense station network it was possible to delimit this anomaly, and to give a complete interpretation of its characteristics. The sensibility and reliability of the instrument were shown to be quite up to standard, while the resulting gravity gradients were unusually consistent, and conformed completely to those previously obtained in adjacent areas. Captain W. H. Fordham spoke on the magnetometer and its applications to geology and mining, and described a new type of magnetometer recently produced by Messrs. Oertling Ltd., on the lines of the earlier Thomson-Thalen instrument.

SEMI-DESTRUCTIVE earthquakes occurred in north-eastern Italy near Udine (about 40 miles north-west of Trieste) on Mar. 26 and 27. The later and more violent shock was recorded at Kew at 8 hr. 34 min. 56 sec. A.M. (G.M.T.); the other at 2 hr. 43 min. 1 sec. P.M. The district visited by them is one in which earthquakes are of moderate strength and frequency. About 50 miles west of Udine is Belluno, a small town that almost coincided with the epicentre of the strong earthquake of June 29, 1873. This earthquake was studied by Prof. H. Höfer (Wein, *Ak. Sber.*, vol. 76, pt. 1, 1877, pp. 819-856) and is probably the first attributed to an origin in two distinct foci. Höfer suggested that two faults were then in action simultaneously, one running south-east, the other east, from a point near Belluno. The latter, as traced by him, passes close to Udine and Tolmezzo, places at which much of the damage caused by the recent earthquakes occurred. A further earthquake, described as violent, was recorded at Kew Observatory on Mar. 31 at 0 hr. 35 min. 2 sec. G.M.T. The epicentre is estimated to have been 1620 miles away, probably between Greece and Crete. The disturbance recorded at Kew was considerably more violent than that produced by the recent earthquake in the Italian Alps.

BY the provisions of an enactment about to be introduced in the Federal Council of the Federated Malay States, it will be made an offence to take fire-arms or other apparatus for killing animals or birds into a game sanctuary or reserve. Game rangers will be given power to seize animals, birds, trophies, or fire-arms, etc., which have been used in the commission of an offence. A notification in the *Federated Malay States Government Gazette* announces that rewards for the destruction of 'noxious animals' will be paid on the following scale: Tigers, full grown, 25 dollars each, cubs, 10 dollars each; leopards, full grown, 15 dollars each, cubs, 5 dollars each; crocodiles, up to 2 feet in length, 25 cents each, more than 2 feet long, 3 cents an inch; crocodiles' eggs, 25 cents each; hamadryads and conras, 5 cents per foot. Claimants for rewards are required to produce the carcase or fresh skin in the case of tigers or leopards; in the case of a crocodile, the unbroken vertebral column will suffice.

THE Perkin Medal was instituted by the Society of Dyers and Colourists in commemoration of Sir William Perkin, who died in 1907 during his presidency of the Society. It is awarded at intervals of two or three years for discoveries of outstanding importance in connexion with the tinctorial arts. Previous recipients of the medal have been Profs. Graebe and Liebermann, for their synthesis of alizarin (1908); Prof. Adolf von Baeyer, for his synthesis of indigo (1911); Comte Hilaire de Chardonnet, for his pioneer work on artificial silk (1914); Prof. A. G. Green, for

his discovery of primuline (1917); M. R. Vidal, for his work on sulphur black (1919); Mr. H. Lowe, for his work on the production of permanent lustre on cotton (1921); Mr. C. F. Cross, for his discovery of viscose (1923); and M. M. Prud'homme, for his work on aniline black and alizarin blue (1925). At the annual dinner of the Society, held in Manchester on Mar. 23, the Perkin Medal was presented to Dr. R. E. Schmidt, of Elberfeld, for his remarkable work on anthraquinone and allied bodies, which has led to the discovery and commercial production of a whole series of fast dyestuffs. The medal, which was struck in gold, was modelled by the late F. W. Pomeroy, R.A., and is an excellent presentation of Perkin's head in profile.

THE protection from lightning flashes of petroleum tanks, which are often assembled over a large area, is a problem of considerable importance. The flames arising from burning oil often reach great heights, and in some cases the burning oil can only be prevented from spreading over the adjoining land by digging up trenches round the blazing area. In the *Electrical Review* for Mar. 9, a method is described which has been installed in America for protecting such areas. Colonel Wilcox claims that it secures absolute immunity. Steel towers are connected round the area and are connected at the top by a ring of wires in a horizontal plane. When the atmosphere is electrified, brush discharges take place from points on this ring. This undoubtedly minimises the danger. We agree with Sir Oliver Lodge, however, in thinking that it fails to give absolute protection. There is no reason why a flash of the 'impulsive rush' or *B* type should not strike an object inside the ring. The experiments carried out in America on a small model of this protective device produced only *A* flashes, and in this case almost absolute protection would be secured. St. Paul's Cathedral in London is protected by a horizontal loop encircling the dome and by other conductors. Six-point aigrettes are jointed at intervals to the loop and similar aigrettes are used at Westminster Abbey. K. Hedges, who designed both systems, recognises the powerful effects of points in levelling down excessive stresses, but he does not claim that they give absolute protection. The accident at Tunbridge Explosive Works in 1918, when hermetically sealed drums of nitro-glycerine were detonated, although the lightning conductors were of the most modern type and in excellent condition, proves how difficult it is to guard against a *B* flash.

THE decision of the eastern associated submarine cable companies to co-operate with Marconi's Wireless Telegraph Co., Ltd., in developing 'world-radio' is a wise one. They have successfully overcome many difficulties during the last eighty years, but the rapid development of the beam system of radio and possible competition in world-radio by foreign companies at last induced them to see that co-operation was the wisest policy. The recent Imperial conference of representatives of the Dominions discussed the question of cable-radio, and both the cable companies and Marconi's gave evidence, but so far the discussions at the conference have been kept secret. Until the Imperial government has notified its decisions, the Marconi-eastern combination is handicapped by not knowing what powerful interests will have to be considered and consulted. In the *Electrician* for Mar. 23, R. Belfort lays stress on this aspect of the problem. He points out that the virtual arbitrators of the situation may themselves be formidable competitors, as they can own and exploit both cable and radio enterprises. The Americans also have a vast organisation of radio, telephone, and cable companies which are continually developing their methods and extending their operations. It seems probable that the Commercial Cable Co. of America will soon possess a complete round-the-world cable-radio service. A similar girdling of the earth will probably also soon be accomplished by the Western Union Telegraph Co. Those and other competitive developments make it difficult to prophecy how profitable the new enterprise will be. America occupies a fortunate position, as its communication companies are all under private control. Mr. Belfort thinks that just as the Eastern company was unable to resist Marconi competition, so it is possible that a Marconi-Eastern combination may not be strong enough to confront American and other foreign competition. In our opinion, however, the improved service will increase the revenues, and this increase should be sufficient to satisfy the legitimate claims of all the competitors.

BY the Protection of Lapwings Act, 1928, which received the Royal Assent on Mar. 28, and is now in force, the sale, or possession for sale, for human consumption of lapwings' eggs and also of the bird itself between Mar. 1 and Aug. 31 in each year, is absolutely prohibited. The Act applies equally to native and to imported eggs and birds.

THE Gold Medal of the Institution of Mining and Metallurgy has been awarded to the Right Hon. Sir Alfred Mond, "in recognition of his scientific and industrial services in the development of the mineral resources and metallurgical industries of the British Empire." The Medal will be presented to Sir Alfred Mond at the annual general meeting of the Institution to be held at Burlington House on Thursday, May 17.

THE Council of the Royal Anthropological Institute has awarded the Huxley Memorial Medal for 1929 to Baron Erland Nordenskiöld of Göteborg. He has also been invited to deliver the Huxley Memorial Lecture in November of that year. Baron Nordenskiöld's researches in the archæology and ethnology of South America hold a deservedly high place in the estimation of anthropologists, and the award will be welcomed as a merited recognition of many years' valuable work.

IT was announced in the House of Lords on Mar. 29 that a committee of inquiry had been set up to inquire into the possible danger arising from the use of lead tetra-ethyl in motor spirit, composed as follows: Sir Frederick Willis (chairman), Sir George Buchanan, Dr. Bridge, Mr. Pye, Sir Charles Martin, Sir Robert Robertson, Major Galwey, Dr. C. H. Lander, Prof.

A. C. Chapman, Sir William Willcox, and Prof. Dixon. The secretary to the committee is Mr. S. F. S. Hearder, Ministry of Health, Whitehall, S.W.1, to whom all communications should be addressed.

FRIDAY evening discourses after Easter at the Royal Institution include: "Heirlooms of Industry in the Science Museum," by Sir Henry Lyons; "Carriers of Electricity in the Atmosphere," by Prof. A. M. Tyndall; "Life's Unsuspected Partnerships," by Prof. Doris L. Mackinnon; "Engine Knock and Related Problems," by Mr. A. C. Egerton; "The Results of the further Excavations at Ur," by Mr. C. Leonard Woolley; and "The Waves of an Electron," by Prof. George P. Thomson.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Temporary assistant quantity surveyors and temporary architectural draughtsmen under the Mines Department——The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (April 14). An assistant pathologist in the Laboratories of Pathology and Public Health, 6 Harley Street, W.1—The Secretary (April 20). A teacher of engineering subjects at the Cheltenham Technical School—The Secretary, County Education Office, Shire Hall, Gloucester (April 20). A lecturer in electrical and mechanical engineering at the Forest of Dean Mining School, Cinderford—The Secretary, County Education Office, Shire Hall, Gloucester (April 20). A secretary to the delegacy of the University of London for co-operation with Training Colleges in the London District in accordance with a Scheme approved by the Board of Education—The Principal Officer, University of London, South Kensington, S.W.7 (April 21). A test assistant in the Chemical Department of the Royal Aircraft Establishment—A.273, Chief Superintendent, R.A.E., South Farnborough, Hants. A head of the Mechanical and Structural Engineering Department of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, S.E.1.

Our Astronomical Column.

THE RECENT TRANSIT OF MERCURY.—*Circular No. 75* of the Union Observatory, Johannesburg, contains a discussion of the observations of this phenomenon made at several observatories. In the mean, the phases were 23 seconds earlier than the predicted times, as compared with 30 seconds in 1924. It will be remembered that the lunar errors are also slightly diminishing. The view is now largely held that these fluctuations indicate variability in the earth's rate of rotation, the periods of the oscillations being somewhat irregular, but considerable fractions of a century. Dr. Benjamin Boss (*Daily Science News Bulletin*, Science Service, Washington, Feb. 28) suggests that there are in addition fluctuations of much shorter period (days or hours) in the rate of rotation; he thus explains the puzzling anomalies found in the meridian determinations of time and Right Ascension at most observatories. He suggests as an explanation that the solid surface of the earth, when raised by lunar and solar tides, may not completely settle back, but remain raised for some time, and then at last reach a breaking point and return abruptly. Such settling back would sometimes reach the magnitude of an earthquake, and in fact Dr. Boss notes that his time variations show relationships with the frequency of earthquakes.

STELLAR PARALLAXES FROM ALLEGHENY OBSERVATORY.—The excellence of the numerous parallax determinations made at this observatory is well known, and regret will be felt that the latest instalment (*Yale University Transactions*, vol. 6, Pts. 1 and 2) is the last with which Prof. Schlesinger will be personally concerned. There are three stars of special interest in the list. The parallax found for Barnard's star of record proper motion is 0·550″. It is noted that this is the best determined stellar parallax, the mean of seven good determinations being 0·538″. For ϵ Hydræ the value found is 0·026″, in good agreement with 0·025″, found spectroscopically from the radial velocities of the close components. Betelgeuse is interesting from the large angular diameter given by the interferometer. The value found for its parallax is 0·013″; the trigonometrical determinations range from 0·011″ (Mount Wilson) to 0·024″ (Yale heliometer). The mean of seven spectroscopic determinations is 0·011″; but the spectroscopic scale must be a little uncertain for such extreme giant stars, the means of graduation being restricted. The well-known binary 70 Ophiuchi has a parallax of 0·184″. The probable errors of these parallaxes are about 0·01″ or less.

THE SPECTRA OF COMETS.—Several important papers on this subject have appeared recently, including discussions by N. T. Bobrovnikoff, of various Yerkes photographs taken during the period 1908–1927 (*Astrophysical Journal*, vol. 66, pp. 145 and 479). The first of these treats of Halley's Comet in considerable detail. The spectra were studied photometrically with a self-registering microphotometer and compared with direct photographs. A variation in size and brightness of the principal monochromatic images of the head indicates the development of the CN and C + H, rather than the Swan, bands as the comet recedes. Two types of continuous spectrum were discovered—one due to reflected sunlight, and the other the comet's own spectrum with a maximum intensity at λ4000. The existence of the latter depends on the comet's heliocentric distance, only appearing at distances greater than 1·2 astronomical units.

The second paper deals with the spectra of 22 comets, all of which resemble Halley's in the above respects and in the existence of sudden changes in their spectra. The change from solar to cometary type of continuous spectrum takes place usually at a distance of about 0·7 astronomical units from the sun. Bredichin's theory of cometary tails is not supported by these observations, and fluorescence is suggested as a probable origin of cometary spectra.

A third paper on comets comes from Meudon, by M. F. Baldet (*Annales de l'Obs. d'Astr. de Paris*, tome 7). In this paper a historical survey is given of our present knowledge of the subject, with various tables of wave-lengths which should be of considerable value in the identification of cometary lines. Detailed discussions follow of the spectra of eight comets, and of laboratory researches into the spectra of relevant sources. It is to be regretted that the author does not always follow the recommendations of the International Astronomical Union in the printing of his photographs.

Research Items.

Avokaiya Fishing.—In *Man* for March, Mr. E. E. Evans-Pritchard, who has visited the Moro tribes of Mongalla Province on behalf of the Sudan Government and with the financial assistance of the Royal Society and the Laura Spelman Rockefeller Trust, describes the interesting methods of dry-season pool-fishing employed by the Avokaiya tribes. They use fish scoops made in a few minutes from millet stalks, tied together with cords of fibre. The mode of procedure is as follows: a line of boys is formed across the pool or stream, who draw the scoops all together across the pool or push them in front of their bodies. When the end of the pool is reached the boys form a semi-circle around the bank. When the number is insufficient to form a continuous line, they cover the distance as best they can, and small boys swim and splash on the open side of the pool. Small boys also swim about to frighten fish into the scoops, while the boys at the end of the line feel under the banks with the same object. Simple as the process looks from the bank, it is more difficult than it seems, as is shown by the difference in the catch when experienced fishers take part. A great deal depends upon the celerity with which the mouth of the scoop is closed when a fish has entered. Both the Avokaiya and the Moro are agricultural peoples, and the fish form a welcome addition to the food supply. The mode of fishing here described seems to be more of a play activity than a method of economic utility. The Moro Meza use fish poisons, but the Moro Kodo also use nets and large hand-worked hooks.

India and the Pacific.—In the *Ceylon Journal of Science*, vol. 1, pt. 4, Mr. A. M. Hocart publishes some supplementary notes on his studies of the Indian and Fijian caste systems. He now states that in addition to the absence of the fourth caste in Fiji, the absence of the third caste in Samoa is to be noted. The power is divided or contested between the nobles and the masters of ceremonies, just as a tendency in this direction is to be observed in India, where traditions show the Vaisyas dropping into obscurity and the aristocracy resolving itself into two rival castes, Brahmins and Kshatriya. India retains, however, the fourth unitiated caste, whereas the Samoans have assimilated their fourth caste to the nobility. The existence of the four-caste system is preserved in the history of the Four Brothers of Upolu, who each went out to seek a country for himself and his people. When they divided up their possessions, Sana received the staff and fly-whisk, the insignia of the public orator or master of ceremonies, the spear and club were given to Ana, the digging stick with which yams are planted to Tua, but Tolufale received nothing. The fact that the orator is mentioned first may have a bearing upon the question whether the original position of the Kshatriya was first as is generally assumed. In both India and Samoa and Tonga, a nobleman may be a priest. In Samoa and Tonga chiefs may assume the orator's title if they have an ancestress of that caste. It is also suggested that the Indian barber caste may have to be identified with the caste known in Fiji as *mbouta*, who are exempt from the consequences which follow when anyone touches the sacred body, and especially the head, of the chief. Epithets employed of them suggest they may be of noble descent or a clan of noble bastards. The Indian barbers may in the same way be derived from priests, *i.e.* descendants of a Brahmin father and a Sudra mother.

Russian Zoological Studies.—The *Annuaire du Musée Zoologique*, Leningrad, which has been very late in appearing, is now coming out very regularly, three parts of the vol. 27 and one of the vol. 28 having been published during 1927. These publications contain a very long series of zoological papers on different groups. P. Schmidt gives revisions of two genera of fishes, Icelus and Gymnacanthus, while B. Iljin published a critical list of Gobiidæ of the Black Sea. On mammals there are papers by B. Vinogradov (on the mechanism of gnawing and mastication in some burrowing rodents); Flerov, on mammals of the Tchorokh district in Transcaucasia, and on a new subspecies of *Ochotona hyperborea* from the Polar Ural; M. K. Serebrennikov describes the fauna of rodents of the Samara province, and S. S. Ognev gives a description of a new genus and species of cat (*Eremælurus thinobius* Ogn.) from Transcaspia. On birds there is only one paper, by B. Stegmann, on birds of the Alai steppes, but there is also a paper by C. A. Kurova on trematodes of the family Echinostomatidæ from birds in Turkestan. Papers on invertebrates include, to mention only a few, a list of Acarina of the Kamtchatka, by S. Thor; revision of two genera of Polychæta, by N. Annenkova; a list of the Orthoptera of Crimea, by E. Miram; descriptions of Solifugidæ from Africa, by A. Birula; list of Hydroidea and Alcyonaria from the Barents Sea, etc.

The May-flies of India.—The study of May-flies is so little advanced in tropical regions that a description of the material contained in the Indian Museum and other Eastern institutions is especially welcome. In *Records of the Indian Museum*, vol. 29 (1927), Dr. B. Chopra provides the first part of a general account of the Indian species and their biology; this contribution, which occupies pp. 91-138, is illustrated with three finely executed plates. In his prefatory remarks on the wing venation, the author points out that the homologies of certain of the veins are still far from definitely established, and he provides a useful tabular comparison of the various systems of nomenclature that have been advocated. In view of the present position of the subject, the Comstock-Needham system is followed, and it has the advantage of having been more widely adopted than the schemes that have aimed at emending it. In the general classification of May-flies the work of Ulmer has been adopted almost completely, and in the present contribution certain of those species falling in the group Ephemeroidea are discussed and, where necessary, described at length. Of the new species discovered, one belongs to the genus Palingenia and two to Polymitarcys.

Modification of Development by Temperature Gradients.—Prof. Julian Huxley (*Roux Arch. f. Entwick. der Organ.*, Bd. 112, pp. 480-516) has subjected frog's eggs and embryos and chick embryos to temperature gradients in various directions (*a*) with the main axial gradient of the organism and thus adjuvant, (*b*) against the main axial gradient and thus antagonistic, and (*c*) lateral to the main axial gradient. The results seem to show that, during segmentation, at the higher end of the temperature gradient, division of cells is accelerated, with the result that adjuvant gradients accentuate the normal size differences between animal and vegetative cells, while antagonistic gradients diminish them. These alterations in segmentation have little effect on subsequent development. Lateral gradients applied to frog embryos in the neural plate to tail-bud stages produce

marked asymmetries which, however, do not always persist in subsequent development. Lateral gradients applied to chick embryos produce acceleration of development of the heated side with marked increase in the tissues and in the size of organs on that side. Antagonistic gradients applied to chick embryos cause enlargement of the primitive streak posteriorly, retardation of brain development, reduction in the head size in the later embryos, and precocious development of the hind limb buds. Adjuvant gradients produce opposite results on head size and limb bud development.

NEMATODE SPERMATOGENESIS.—N. A. Cobb (*Jour. Washington Acad. Sci.*, **18**, No. 2, Jan. 1928) records observations on spermatogenesis in a free-living nematode, *Spirina parasitifera*, common an inch or two deep in sand between tide marks on both sides of the North Atlantic. Four spermatids are formed from a spermatocyte, but instead of metamorphosing into spermatozoa, each spermatid undergoes further changes and divisions and gives rise to a 'spermatidian tissue' of 64 and finally 128 cells. The male passes the spermatidian tissues into the uteri of the female. Fertilisation is preceded by an increase in size of that cell of the spermatidian tissue adjacent to the ovum next to be fertilised; this spermatidian cell is transformed into a 'spermule,' which fertilises the ovum. Whether every one of the 128 spermatidian cells metamorphose in this way is as yet undetermined. The author says that he knows of a large number of other species of nematodes belonging to numerous and varied genera in which the general appearances in the gonad of the male so closely resemble those described as to leave no doubt that their spermatogenesis follows a similar course.

FORM VARIATIONS OF THE BRITISH FRESHWATER PEARL MUSSEL.—H. H. Bloomer gives an account of the variation of the British and Irish forms of *Margaritifera margaritifera* in *Proc. Malac. Soc. Lond.*, vol. 17. 'Form' in this paper is defined as "the external shape of the shell when observed from a lateral point of view without any regard to the shape of the teeth, muscular impressions, or other internal characters." Twelve different 'forms' are figured on photographic plates, including one from the River Wye which presents "a general conformity with certain characters which seem to justify making it a new local variety," var. *siluriana*. Local distribution is discussed river by river, and brief diagnoses of the dimensions and appearance of the contained pearl shells given.

TRAVERSE METHODS.—The United States Coast and Geodetic Survey has issued as *Special Publication No. 137*, a small manual of first order traverse which, in spite of its slender bulk, is a useful summary of the methods employed in traverse work in the American surveys. Field methods and office computation are both covered. The manual is a useful companion volume to that on first order triangulation recently published.

PERIODICITIES IN THE NILE FLOODS.—From a long series of Nile flood records, extending from A.D. 641 to 1451, taken from the original Coptic records and corrected to the modern calendar, Dr. C. E. P. Brooks has investigated the question of periodicity and gives his results in a paper in the *Memoirs of the Royal Meteorological Society*, vol. 2, No. 12. The method employed for analysing the data is that known as the difference-periodogram. The result was the discovery of 19 periodicities of lengths varying from 1·91 to 76·8 years, some of them well established and others of doubtful validity. Some of these periodicities bear a simple relation to one another, as the series 5·52, 11·06, 22·12, 33·49, 66·0, 76·8 years. In fact, eleven of the periodicities agree within 1 per cent. with a simple multiple or sub-multiple of 22·12 years. One of the remaining periodicities could not be determined accurately, but another has a discrepancy of so much as 3·5 per cent. A few of these periodicities fit with those recorded from other data, especially the 33·49, which agrees fairly well with the variable Brückner periods. The more difficult task of finding a cycle of variation in the length of the periodicities led to no conclusive results, but there were indications of a 500-year period.

THE OUTER SHELLS OF THE EARTH.—A stimulating discussion by Prof. R. A. Daly of recent evidence bearing on the structure of the lithosphere appears in the *Amer. Jour. Sci.*, Feb. 1928. The disagreement between the results of A. Mohorovičić, Gutenberg, and Jeffreys on the thickness of the sial of the continents is pointed out, and it is shown that owing to the absence of any generally accepted solution, there is still uncertainty as to wave velocities at different depths in the crust. It is thought that, under the low stress conditions of seismic waves, the rocks may have higher effective elastic moduli than under the high pressure conditions of laboratory investigations. Corroboration of this idea is found in an analysis of the hysteresis curves of Adams and Coker. Thus the data of seismology do not as yet forbid belief in a basaltic substratum. It is thought that the velocities of earthquake waves in holocrystalline basalt and glassy basalt would be nearly identical at the contact, and therefore that the latter, if it exist, will be difficult to detect. Thus the substratum below a certain depth may be rigid but glassy. The postulate of an earth shell of peridotite *near* the crust is considered to be both unnecessary and unjustified by evidence. A new interpretation of the intermediate layer is offered. Jeffreys regards this as tachylyte and Holmes as diorite and quartz-diorite. Daly suggests that it may represent a quartz-bearing rock at a temperature beyond the transition point of α-quartz to β-quartz (575° C.). The sudden change of elastic properties at the inversion temperature indicates that Daly's view has much to commend it.

THUNDERSTORMS AS SOURCES OF HIGH POTENTIALS.—In *Forschungen und Fortschritte*, of Feb. 20, there is an interesting article by A. Brasch, F. Lange, and C. Urban on a project for obtaining extremely high potential differences, for use in such experiments as Rutherford's on atomic disintegration, from thunderstorms. It is estimated that within practicable heights above the earth's surface, of a few hundred metres, there are available at times potential differences of 5-30 million volts. For this purpose a cable 660 metres long has been stretched across a valley near Lugano, carrying near its middle point, 80 metres above the ground, a collecting network. Details are given of the arrangements for insulation of the cable and for the measurement of the potential differences. Preliminary measurements made during the only suitable thunderstorm which occurred during the period of observation indicated a potential difference of above one million volts, causing a spark across an air gap more than 4 metres long.

MAGNETIC THEORY.—In volume 4, No. 4, of the *Proceedings of the Imperial Academy* of Japan for 1928, Prof. K. Honda puts forward in a short paper a new theory of the origin of magnetism based on the structure of the atom. In present theories, magnetic properties are attributed to the outer

electrons of the atoms, but Prof. Honda attributes diamagnetism only to these electrons, his explanation of the property being along the usual lines. Para- and ferro-magnetism he attributes to the nuclear electrons, which revolve in the nucleus with speeds approaching that of light, and produce magnetic moments of the requisite magnitude. In order to endow this atom with the power of turning towards a magnetic field, he supposes that a certain number of the protons revolve in the opposite direction to the electrons. In ferro-magnetic substances the angular momentum of the nucleus is supposed small, so that a magnetic field easily turns them, while in paramagnetic substances the momentum is great. According to the author, a quantitative examination of the theory leads to the explanation of many observed facts in magnetism.

TOTAL REFLECTION OF ELECTRONS.—An interesting suggestion has been made by O. Klemperer, in the *Zeitschrift für Physik* of Feb. 24, to the effect that electrons, which are known to act under appropriate conditions as if they were diffracted, can also be totally reflected. If a particle entering a solid from a vacuum is retarded, the speed of its associated phase wave must be increased, when the corresponding index of refraction becomes less than unity, and for sufficiently oblique incidence, penetration of the surface cannot take place. This idea receives a certain amount of support from some experiments that were done several years ago on the secondary emission of electrons from the surfaces of various bodies bombarded at different angles by homogeneous beams of primary electrons. For electrons which had been accelerated through a fall of potential of a few kilovolts, the retardation in glass and some other insulating substances was equivalent to between one and two kilovolts, and although this is admittedly higher than would be expected from thermionic and photo-electric phenomena, its value for metals is much smaller, and of the order of what is required to account for the apparent contraction of the spacing of the atomic planes in a crystal of nickel indicated by the diffraction experiments of Davisson and Germer.

ISOMORPHISM OF AMMONIUM AND PHOSPHONIUM HALIDES.—Although a tendency to isomorphism is evident between ammonium and phosphonium halides in which all the hydrogen atoms are replaced by alkyl radicles, for example, tetra-ethylammonium bromide and tetra-ethylphosphonium iodide, the absence of isomorphism among non-substituted ammonium and phosphonium salts has resulted in the view that the resemblance between the groups NH_4 and PH_4 was merely formal. In a paper published in the volume for 1927 of the *Rendiconti dell' Accademia delle Scienze e Matematiche* (Naples), Congilio and Caglioti show, however, that crystallisation of a solution containing ammonium and phosphonium iodides gives rise to mixed crystals of the ammonium iodide type, containing phosphonium iodide in proportions varying to a maximum of 1·92 per cent.

PREPARATION OF LEAD TETRA-ETHYL. — *Report No. 29, Aeronautical Research Institute, Tokyo Imperial University*, by T. Tanaka and T. Kuwata, contains a study of the preparation of lead tetra-ethyl from ethyl chloride, using Grignard's reaction. Lead tetra-ethyl was obtained by the action of lead chloride upon ethyl magnesium chloride below 5° C. The crude product was purified by treating the ethereal solution with oxygen in the presence of dilute hydrochloric acid until it was colourless and crystallising out the triethyl lead chloride present in the solution. The lead tetra-ethyl had an unpleasant odour and boiled at about 82° C. under 11 mm. pressure. It decomposed on heating to 400° C. and at ordinary temperatures became turbid on exposure to air and sunlight.

THE CO-ORDINATION VALENCY OF ALUMINIUM IN ITS SALICYLATO DERIVATIVES.—In its complex compounds, the co-ordination number of aluminium is either four as in the alkali aluminates, or six as in cryolite. The two stable hydrates which are apparently formed by aluminium oxide, may accordingly be regarded as $H[Al(OH)_4]$ and $H_3[Al(OH)_6]$. In one case aluminium resembles boron with a low co-ordination number, and in the other it shows its resemblance to iron and chromium. In the January number of the *Journal of the Chemical Society*, G. J. Burrows and I. W. Wark describe an investigation of the salicylato derivatives of alumium. Various derivatives of aluminosalicylic acid $H_2[(C_7H_4O_3)_2Al\begin{matrix}OH\\OH_2\end{matrix}]$ were prepared in which the co-ordination valency of aluminium is six, indicating, therefore, its resemblance to iron and chromium. An unsuccessful attempt was made to resolve the alkaloidal salts of the above acid into optical isomerides.

COMPLEX ETHYLENETHIOCARBAMIDO-SALTS OF UNIVALENT AND BIVALENT METALS.—Owing to the presence of two amino-radicals as well as a thiocarbonyl group, thiocarbamide forms polynuclear as well as mononuclear derivatives with metallic nitrates. The co-ordinating properties of the amino groups may, however, be inhibited by incorporating the two nitrogen atoms in a five-membered ring as in ethylene-thiocarbamide, $\begin{matrix}CH_2-NH\\|\\CH_2-NH\end{matrix}\!\!>C=S$, represented by *etu*. The preparation of a large number of the complexes formed between this compound and various metallic salts is described by G. T. Morgan and F. H. Burstall in the *Journal of the Chemical Society* for January. Each molecule of the base is considered to contribute two electrons from its sulphur atom to the co-ordination complex and, thus, in the compound [Cu, 4 *etu*]NO_3 the cuprous ion acquires eight additional electrons, thereby becoming equivalent to the rubidium ion. Similarly, silver and cadmium complexes are electronically equivalent to cæsium and barium ions respectively. Such analogies are supported by the fact that these complex nitrates give rise to neutral solutions and by the electrical conductivities of these solutions.

AN ELECTRICAL INDICATOR FOR HIGH-SPEED ENGINES.—J. Obata and Y. Yosida describe in the *Reports of the Aeronautical Research Institute of the Imperial University of Tokyo* (No. 28, December 1927) an electrical indicator for high-speed engines which gives excellent results. The principal difference between this instrument and the usual mechanical or optical one lies in the use of a steel disc 2 mm. thick and 5 mm. in diameter. Compared with ordinary discs, its thickness is very great. The minute motions of this disc caused by the pressure in the cylinder are recorded by an exceedingly sensitive electrical method called the 'ultra-micrometer' method, which utilises a generating valve circuit. Using two small engines, several records of actual engine pressure were obtained by an Einthoven string galvanometer, a Lutz-Edelmann string electrometer and a Duddell oscillograph. The results show that this electrical indicator gives correct diagrams for high-speed engines for which ordinary indicators cannot be used. The calibration of the indicator was made statically, a standard pressure gauge of the Bourdon type and compressed air being used.

Scientific and Industrial Research.

PROMOTION and co-ordination of scientific research by the State on any widespread scale is still novelty enough to invest the recently published Report of the Committee of the Privy Council for Scientific and Industrial Research for 1926–27, accompanied by the Report of the Advisory Council for the same period, with a special degree of interest. To the reports are attached a summary of work conducted by the various research organisations functioning under the auspices of the Department, and appendices containing tabulated information of a statistical and bibliographical nature, together with references to the development of organised research in other parts of the Empire.

In addition to the work of the research associations, the activities of the National Physical Laboratory, the Geological Survey, the Fuel Research Station, the Building Research Station, and the Forest Products Laboratory are described, and much information is given concerning the progress of work on food storage and transport, water pollution, and chemotherapy. It is satisfactory that important investigations at the Low Temperature Research Station, which have been delayed for lack of funds, can now be proceeded with in view of the receipt of a substantial grant from the Empire Marketing Board. There is, however, still urgent need for a coastal station devoted to the study of the preservation of fish and the utilisation of fish by-products. The magnitude of some of the issues at stake can be adjudged by reference to work in progress demonstrating the successful conversion of coal into liquid fuels; it still remains to be seen whether the new industry will be firmly established before existing sources of petrol begin to fail. The Advisory Council makes some pertinent remarks on the conditions under which the Geological Survey and the Museum of Practical Geology are housed. It is earnestly to be hoped that the scheme for a new building, once authorised by Parliament but still suppressed on the grounds of economy, will soon be put into effect.

A glance at the summary of work in hand during the year demonstrates the great diversity of the interests involved. The study of chemical reactions at high pressures is being carried on both at the Chemical Research Laboratory, Teddington, and at the Imperial College of Science and Technology; the Aerodynamics Department has dealt with a very full programme, including tests of airship models and the elimination of wing-flutter, in the investigation of which mathematical analysis has afforded a large measure of success. Considerable progress has been made in fuel research, despite hindrance due to the stoppage in the coal industry. The keeping qualities of apples are believed to be concerned with the protoplasm content and the extent of the sugar reserves, and the possibility of a precise prediction of the duration of life of the fruit under any set of conditions by means of chemical examination at harvesting is predicted. Radio observations made during the solar eclipse are mentioned; 'wireless' enthusiasts will also be interested to note that differences in wave attenuation are attributed largely to the absorbing effect of trees, greatest attenuation being observed in the most densely wooded parts of the country, and that the large number of receiving aerials in the London area appears to have a considerable energy-absorbing effect. The number of specific problems submitted to the British Museum Laboratory tends to increase; the work specially referred to in the report includes the mounting, cleaning, and preservation of delicate materials, the identification of early porcelain, and the unrolling of brittle manuscripts on leather.

The report would have been incomplete without some reference to the work of the National Research Council of Canada, the Australian Commonwealth Council for Scientific and Industrial Research, and the New Zealand Department of Scientific and Industrial Research, to the activities of the South African Departments of Mines and Industries, Agriculture, and Forests, and to those of various Indian Departments.

Origin and Development of Portion of the Australian Flora.

IN the second part of his presidential address before the Australasian Association for the Advancement of Science at Hobart, delivered on Jan. 16, Mr. R. H. Cambage discussed the "Origin and Development of Portion of the Australian Flora." The position was summarised as follows:

There appear to be more genera common to Africa and the eastern half of Australia only, than to Africa and the western half of Australia only, so that evidence of a direct land connexion between these two countries is meagre.

It is thought that many genera which are common to Africa and Australia have reached these countries from the same source in the north, and have then developed in response to environment.

From available evidence it would seem that, at least since Cretaceous time, the northern hemisphere has had a greater land mass than the southern, and, as a result, there has been more room for plant development in the north than in the south. Probably the Pleistocene and even earlier glacial periods have been instrumental in permitting many genera to pulsate across the tropics from temperate northern regions, and in the process, and after arrival in the south, there have been much radiation, development, and evolution. Although there probably has been more migration to Australia from the north, there is evidence in some cases of secondary radiation from the south, especially in the genus Eucalyptus.

It seems undoubted that some genera common to Australia and New Zealand have reached both countries from the north, some species coming down the east coast of Australia, while others have gone by way of New Caledonia and adjoining islands to New Zealand.

Except for a land connexion between north-eastern Australia and islands to the north, perhaps so late as Pliocene time, Australia has long been isolated from the rest of the world.

There appears to be more evidence in favour of a former land connexion between Antarctica and South America, and perhaps New Zealand and Australia, than between Africa and Antarctica.

Studies of the many changes which have taken place in the history of the world's flora, of its adaptability to environment, its response to change of climate and soil, its ability to overcome many adverse conditions, all combine to impress one with the conviction that the marvellous act of creation not only embodied the initial giving of life, but also provided inherent power and initiative for the necessary development and evolution required for the persistence of that life, in harmony with its varying surroundings and dominating influences.

Past and Present Peoples of Chinese Turkestan.

AT a meeting of the Royal Anthropological Institute on Tuesday, Mar. 27, Sir Arthur Keith gave an account of a people who lived in the eastern part of Chinese Turkestan in the earlier centuries of our era. His account was based on five skulls which were obtained by Sir Aurel Stein during his third expedition (1913–15) to central Asia. The explorer found these skulls in sites within the eastern and southern fringe of the Taklamakan desert—sites now dried up and forsaken, but irrigable and inhabited when the Tarim basin of Chinese Turkestan formed part of the corridor along which in past times Chinese trade flowed towards the west.

The people from these ancient cemeteries show a mixture of characters, some of which are Mongoloid, others of which are Caucasoid (or Iranian), but on the whole the Mongoloid traits are the more evident. Amongst the Lopliks and other peoples still inhabiting the eastern and south-eastern fringes of the Tarim basin are found individuals which come very near to the Loulan type found in the ancient cemeteries. From data collected by Sir Aurel Stein and collated by Mr. T. A. Joyce, it is apparent now that the peoples at the eastern end of the Tarim basin—the floor of which is formed by the Taklamakan desert—are transitional in type. When traced towards the north and towards the east they rapidly become Mongolian; when traced along the south side of the Tarim basin towards the west the Iranian type prevails more and more and becomes pure when the Pamirs and the valley of the Oxus are reached. The Loulan people who lived in the eastern part of the Tarim basin more than 1500 years ago were of a transitional type. Sir Aurel Stein's discoveries show that the racial frontier between Mongolian and Caucasoid types in this part of the world has not greatly altered its position since the Christian era began. The Loulan people were probably true Huns.

Intermarriage and migration do take place across racial frontiers, and most anthropologists explain a mixed type, such as the Loulan, as a result of intercrossing. In Sir Arthur Keith's opinion such an explanation leaves the most important facts of the problem unexplained. We have, in the first place, to explain the origin of the primary types—the Mongoloid and Caucasoid. We have to explain the greatest racial divide in the world, one many thousand miles in length, which crosses the Old World and separates peoples of a Mongoloid type in the east and north from others of a Caucasoid type in the west and south. This divide is traceable from the north-west corner of Europe to beyond the mouth of the Ganges in Asia. The great divide crosses the Taklamakan from west to east; the Loulan people lived on it. We cannot explain the origin and distribution of peoples of Mongoloid stock and the existence of the great racial divide unless we presume that evolution is true and that the stocks which we find on one side of the divide and on the other have come into their present states of body and brain in the areas where we now find them. If, as we presume, Mongoloid and Caucasoid stocks have in the course of time become differentiated from a common type, then between the extreme forms there ought to be, or to have been, transitional types occupying intermediate zones. If evolution is true we ought to find intermediate types on frontier zones, and that is what we do find. In Sir Arthur Keith's opinion the Loulan people should be interpreted, not as products of hybridity, but as of a natural evolutionary process.

In unravelling the Mongoloid from peoples of Caucasoid affinities, head form is not decisive. Mongoloid peoples are of all degrees of long-headedness and of all degrees of round-headedness. So are Caucasoid peoples. The Loulan people, who had heads of medium size, were intermediate between long and round. As a rule the Mongoloid peoples of central Asia had the larger heads and brains; the Iranian peoples of the Pamirs were small headed and not big-brained. The main points which serve for the discrimination of Mongoloid peoples are hair, skin colour, and facial form. A considerable part of Sir Arthur Keith's paper was devoted to Mongolian characters of face and the methods which should be applied for their analysis and measurement. In conclusion, he thanked the Government of India for the benefits which have been conferred on science through the expeditions led by Sir Aurel Stein who, in Sir Arthur's opinion, has done more than anyone to clear up the racial constitution of the peoples of central Asia.

Water Movements in the Straits of Gibraltar.

PROF. RAPHAEL DE BUEN publishes an account of the oceanographical investigations which have been carried out by Spain in the Atlantic and Straits of Gibraltar, in the *Journal du Conseil International pour l'exploration de la mer*, vol. 2, No. 3, December 1927.

Periodic fluctuations in the depth at which particular temperatures occur have been noted by the *Dana* Expedition in 1921 and by the various Spanish expeditions in this area. They were attributed to tidal phenomena (NATURE, **109**, 45; 1922), but Prof. de Buen goes a step further. Since the periodicity does not correspond with that of the Atlantic tide, he considers that they owe their origin to deep-seated Mediterranean tidal waves.

The author does not consider that a sub-surface current of Mediterranean water wells out into the Atlantic over the ridge between Gibraltar and the African continent, such as has been shown to take place by Danish and Norwegian oceanographers (*loc. cit.*).

Prof. de Buen writes: "It may be seen in all the series of observations made during the campaign of the *Almirante Lobo*, as also in my maps (published in the *Rapport Atlantique*, 1926), which are based on the observations made during the campaigns of the *Dana* and the *Thor*, that at no time do the Mediterranean waters penetrate to the Atlantic. This must not, however, be accepted as an established fact until further investigations have been carried out, having as their object to discover whether at any time, at the moment when the bottom waters approach most nearly to the surface, some quantity of Mediterranean water does not find its way into the Atlantic. The Mediterranean influence in the Atlantic was found in all the observations to be nil. It is therefore necessary to seek some other explanation of the existence of warm dense water to the south-west of Ireland, in which some experts have considered that they could see a markedly Mediterranean character."

Somewhat inconsistently, "the layer of Mediterranean water which penetrates into the Ocean through the Straits of Gibraltar" is cited a few pages later as a possible explanation of the migration of sardines in the neighbourhood of Cadiz.

University and Educational Intelligence.

LONDON.—Dr. W. W. Jameson has been appointed as from Jan. 1 to the University chair of public health tenable at the London School of Hygiene and Tropical Medicine. Dr. Jameson received his medical education at the University of Aberdeen, the Rotunda Hospital, Dublin, and University College, London. From 1914 until 1919 he was assistant and lecturer in the Department of Hygiene at University College, London, and since then he has been Medical Officer of Health of different London boroughs. In 1926 he was appointed lecturer on public health and preventive medicine at Guy's Hospital Medical School. He is the author of "A Synopsis of Hygiene" (Churchill), of which a second edition has been published, and of papers on public health matters.

Dr. E. E. Turner has been appointed as from Sept. 1 to the University readership in chemistry tenable at Bedford College. Dr. Turner was educated at Coopers' Company's School, London, at East London College (1910–14), and Sidney Sussex College, Cambridge (1916–19); he obtained the degree of D.Sc. (Lond.) in 1920. After holding posts at the Goldsmiths' College, London, and at the Technical College, Huddersfield, he worked during 1919–21 as lecturer in organic chemistry, University of Sydney. For the period 1921–23 he was chemist in the Research Department at the Royal Arsenal, Woolwich, and since 1923 has been senior lecturer in chemistry at East London College. He has published numerous papers independently and conjointly in *Proc. Roy. Soc.* and in the chemical journals.

The title of reader in physical chemistry in the University has been conferred on Dr. Samuel Sugden, in respect of the post held by him at Birkbeck College. Dr. Sugden studied at the Royal College of Science from 1912 until 1914. Later he became a research chemist in connexion with explosives in the Research Department of the Royal Arsenal, Woolwich. In 1924 he obtained the degree of D.Sc. (Lond.). He has been lecturer in chemistry at Birkbeck College since 1919. His published work includes papers on the determination of surface tension and its variation with temperature and some related functions, on the parachor and chemical constitution, and on molecular volumes at absolute zero, published in the *Journal of the Chemical Society*, and a translation of Stock's "Ultrastrukturchemie," under the title "The Structure of Atoms" (Methuen).

ST. ANDREWS.—A scholarship of £100, tenable for three or four years at the United College, St. Andrews, by a student who is resident in the University Residence Hall, has just been established by the gift of Dr. David Russell of Markinch. The new Russell Scholarship is available to candidates who have spent at least two years in a secondary school under the Fifeshire Education Authority, or whose parents or guardians are resident in Fifeshire, and preference will be given to a candidate from Markinch district.

THE Ramsay Memorial Fellowships Trustees will consider at the end of June applications for fellowships, one or more of which will be limited to candidates educated in Glasgow. The value of each fellowship is £250 annually, plus a grant for expenses. The fellowships are held normally for two years, but may be extended for a third year. Applications must be received by June 5 by the Secretary, Ramsay Memorial Fellowships Trust, University College, Gower Street, W.C.1.

THE Ministry of Agriculture and Fisheries is prepared to receive, up to May 15 next, applications for grants in aid of scientific investigations bearing on agriculture, to be carried on in connexion with a university, university college, or other approved institution or society in England and Wales during the academic year beginning Oct. 1, 1928. Particulars of the conditions on which these grants are offered are set out in form A.53/T.G., obtainable from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

AN appeal for a capital sum of £50,000 for the extension of the Ramsay Laboratory of Chemical Engineering at University College, London, and for its equipment, was made recently by the Chemical Engineering Building and Equipment Fund Committee, of which Sir Alfred Mond is chairman. The response up to the present time has produced £23,555. Among the subscribers are: Imperial Chemical Industries, £10,000; The Shell Group, £5000; The Gas Light and Coke Company, £5000; Dunlop Rubber Company, £1000; Messrs. Reckitt and Sons, Ltd., £1000. In addition to the capital fund for the building and equipment, an income of £6000 a year is required for the maintenance of the Laboratory. Towards this £3191 has already been promised for the first five years and £2600 for the second five years. The Committee is anxious to complete both funds as speedily as possible in order that the new building may be proceeded with. Donations and subscriptions may be sent to Sir David Milne-Watson, at University College, London (Gower Street, W.C.1), who will be glad to supply any further particulars.

THE Royal Technical College, Glasgow, records in its report on the work of the session 1926–27 an increase from 4149 to 4169 in its total enrolment. This followed four sessions of decreasing numbers, reflecting the depressed condition of the engineering and shipbuilding, mining and metallurgical industries with which the College is closely connected. Of the 934 day students, 245 pursued degree or diploma courses, and 136 other day students attended twenty or more hours a week. University degrees, including one D.Sc. and three Ph.D., were obtained by 36 students. Experimental and research work carried out for local industrial firms, much of it having reference to problems arising out of the use of very high temperatures in steam engines, continued to grow. In the Department of Chemistry, a special laboratory was equipped for the use of the Scottish Coal Survey Committee, and the whole of the analytical work and most of the research in connexion with Scottish coals will henceforth be centred in the College buildings. With the aid of a grant from the Iron and Steel Institute much new apparatus was acquired. In the engineering laboratories a series of investigations on the creep of metals approached completion. The School of Navigation, now the largest of its kind in Great Britain, arranged a course of study for cadets serving on board ship. This pioneer effort in continuation class work for youths at sea attracted attention in other countries. The School of Pharmacy was recognised by the authorities concerned as providing complete facilities for candidates for the B.Pharm. degree of the University of London and the higher qualification of the Pharmaceutical Society of Great Britain.

ERRATUM.—The announcement of the appointment of Dr. J. C. Earl to be professor of organic chemistry in the University of Sydney in our issue of Mar. 31, p. 519, was placed incorrectly under St. Andrews. Dr. Earl is a graduate of St. Andrews, but has been lecturer in organic chemistry in the University of Sydney since 1922.

Calendar of Customs and Festivals.

April 8.

EASTER DAY: the greatest of the three great festivals of the Christian Church. It is generally agreed that it coincided with and replaced a pagan festival. Traces of such a festival are to be seen in both ecclesiastical and popular observance. The form of morning greeting, "Christ is risen," with the reply, "Christ is risen indeed," which was formerly the rule, and is still observed in the Greek Church, might be held to imply, in the light of other customs, the survival of a belief in a real and annually recurring resurrection, such as that which was the cardinal doctrine in the Eastern cults of Adonis and Attis.

A brief account of the observance of Easter among a modern peasant population serves to bring out the essential elements in the festival pointing to the survival of ideas belonging to an earlier stage of religious belief. In Macedonia the Resurrection is celebrated twice. The first occasion is at a midnight mass on Easter Eve, when the service begins in the open. When the Gospel of the day has been read and the hymn "Christ is risen" has been sung, Lent is considered to be over. Guns are fired amid shouting, the eggs and cakes which have been brought by the worshippers are eaten, and the priest lights a candle, calling upon the congregation to light their tapers from his candle. This they hasten to do. The church doors are then thrown open after a challenge and reply, and the congregation troops in to the service. The second mass takes place on Easter Day, when the worshippers repair to church, each with a lighted taper. After the service, general greetings and the reconciliation of any enmities take place before entering upon the three days' feast, in which the exchange of presents of eggs coloured red and the eating of lambs roasted whole are the principal features. The Paschal fire is kept alight during the whole of the Paschal week.

The representation of the Crucifixion by an image is a common feature in the Roman as well as the Greek Church, and in the southern parts of Europe it is a custom for this representation to be carried in procession on Good Friday. A period of general lamentation and mourning follows until Easter Day, when there is firing of guns and fireworks or a bonfire, and a feast of a lamb. Frazer notes the resemblance of this custom in particular to the mourning for the death of Adonis and the rejoicing at his resurrection. The parallelism with the death of Attis on the tree is, as he notes, also especially close.

Early churchwardens' accounts indicate that English practice, in addition to the Paschal candle, included a representation of the Crucifixion, and in one case a figure of Judas is mentioned.

LENTEN AND EASTER FIRES.—The ceremonial extinction of all lights in church on Easter Eve and rekindling them from the Paschal taper preserves the idea of purification which underlies the custom of kindling bonfires at Easter and at various other times during Lent, but especially on the First Sunday, which was widely spread among the European peasantry. The custom was purificatory and protective. The larger the fire, the wider the area over which it brought prosperity to the crops.

THE PASK EGG.—The custom of making presents of eggs, the symbol of new birth and fertility, is very widely distributed. It occurs in most European countries as well as in the East. The eggs are boiled, gaily coloured, though most frequently red, and otherwise ornamented, sometimes being covered with or made of silver. In Persia this use of the egg was associated with the feast of the vernal equinox. In Egypt it occurs among both Moslems and Copts, at the time of the Coptic Easter in both cases. The eggs are used in a game in the north of England which is also found in Egypt, in the Balkans, and elsewhere. The eggs are rolled or struck against one another, the conqueror, *i.e.* the egg which breaks another, counting up victories until vanquished in turn.

April 9.

EASTER CELEBRATIONS. — Reference has already been made to the feast of a roasted lamb which follows the Easter services. In England the great dish was a gammon with green herbs or a tansy pudding, *i.e.* a pudding of bitter herbs. There are frequent records of the distribution of doles such as the cakes impressed with the shape of two females at Biddenham in Kent, or the cake once cut up and distributed to children in Twickenham church on Easter Sunday. These may have a sacrificial character, for the cross bun or Easter cake was originally an offering or part of a sacrificial meal, as was the lamb.

EASTER MONDAY.—Of numerous observances, only the more significant can here be noted. It was the occasion for sports, or rather contests, especially with a ball. In the Early Church bishops used to sport at handball with the inferior clergy. The significance of such contests as marking the break between two seasons, such as winter and spring or summer, has already been noted. There is, however, a group of customs which, while not superficially related, when taken together appear to have a deeper significance. At Coleshill in Warwickshire young men tried to catch a hare, and if they brought it to the parson before ten o'clock, they were rewarded with a gift of a calf's head, a hundred eggs, and a groat. The hare is here a symbol of fertility. At Greenwich on Easter Monday girls used to roll down the hill. This is well known from a number of parallels as a fertility custom. In various parts of England and Wales, but especially in the north, the custom of heaving or lifting obtained. On Easter Monday the men used to lift the women, either on their arms or in a chair, and obtained a kiss or the forfeit of a shilling for their pains, while on the following day the women heaved the men. The custom of lifting or jumping is noted by Frazer as occurring among the European peasantry to promote the growth of the corn.

In Yorkshire and Durham on Easter Sunday or Monday the young men stole the buckles from the girls' shoes. On the following day the girls stole the buckles or the hats of the young men. The property was redeemable on the Wednesday by a small pecuniary forfeit to be spent on a tansy pudding. At Portaffery, in the north of Ireland, it was the custom for hundreds of young people to resort to a walk outside the town, when the men kissed the girls promiscuously without offence. Finally, in a Glamorgan custom, a burlesque meeting of men held on the Sunday and Monday was taboo to women. Any woman caught observing the proceedings was liable to lose her shoe, which was redeemed by a kiss, or, if a married woman, a small fine. Of these customs, some are obviously connected with fertility; others involving a rivalry of the sexes, the stealing of a shoe or shoe buckle, and kissing either as a right or a forfeit, suggest the sexual licence which among primitive peoples has been noted as characteristic of seasonal festivals and as a means of promoting fertility.

Societies and Academies.

LONDON.

Linnean Society, Mar. 15.—Stanley W. Kemp: Whaling research and the work of the *Discovery* Expedition. The principal object of the *Discovery* Expedition is the study of whales and whaling in the southern hemisphere. The history of whaling in the north shows that species have been reduced, sometimes almost to the point of extinction, by methods far less deadly than those at present employed. Experience indicates that when once a stock of whales has been seriously depleted, recovery, if it is ever effected, is a matter of centuries, and it follows that, if too many rorquals are taken in the south, there is a grave risk that a very important source of wealth will be destroyed. The actual extermination of any species of whale, however, is most improbable under present conditions, for long before this point can be reached, commercial operations would cease to be profitable. The two ships of the expedition, the *Discovery* and the *William Scoresby*, have for the most part been engaged in research on the plankton and hydrography of southern waters with the view of obtaining precise information on the environment of whales. In the south, whale-food appears to consist exclusively of a single species of Euphausia (a crustacean related to the decapods), and a special study of this species and the reasons for its great abundance in certain parts of the Antarctic has been made. Hydrographic work, to determine the physical and chemical constitution of the water, has been undertaken in conjunction with the planktonic observations (see also NATURE, Oct. 30, 1926, p. 628).—P. J. Greenway: The forest flora of south Central Africa. Much of the material was collected by Mr. R. Bourne, of the Imperial Forestry Institute, while on a tour of inspection on behalf of the Northern Rhodesian Government. The collection represents 131 species, comprised in 80 genera and 34 families. The three families of Leguminosæ furnish the largest number of species. Only two genera, Monotes and Marquesia, of the Dipterocarpaceæ, are met with; of the former there are several reputed specimens, which are fairly common in the dry savannah-forest. *Marquesia macroura* Gilg, the 'Musesjie,' is one of the most abundant trees in Northern Rhodesia and the Katanga, where it attains a height of 65 to 80 feet; the wood is described as very hard and of good quality, and is used for finishing houses and in carriage-building. Of especial interest is the occurrence of a species of Hirtella (Rosaceæ). This genus is chiefly American in its distribution, being represented by about 40 species in Central and South America.

EDINBURGH.

Royal Society, Mar. 5.—H. Graham Cannon: On the feeding mechanism of the fairy shrimp, *Chirocephalus diaphanus*. Chirocephalus feeds on minute suspended particles. Water is sucked in between the limbs mainly from in front and from above, the animal normally swimming on its back. The trunk limbs are phyllopodia armed with a series of backwardly projecting endites, of which the proximal is comparatively large. Food particles are drawn into the mid-ventral space by the suction produced by the forward stroke of the limbs. They are prevented from passing into the inter-limb spaces by the long setæ borne on the basal endites and are finally blown towards the mouth by the anteriorly directed feeding current.—Charles Henry O'Donoghue and Eileen (Bulman) Abbott: The blood vascular system of the spiny dogfish, *Squalus acanthias* Linné, and *Squalus sucklii* Gill. The objects of the paper are (1) to provide a comparative account of the blood vascular system of a generalised selachian, and (2) to revise the homologies and consequently the nomenclature of certain of the more important vessels. The fact that the branchial arches in the embryo Squalus are practically identical with those in the embryos of all the higher groups of vertebrates gives a key to the homologies of the anterior arteries. Thus, for example, the vessel termed the posterior carotid by Parker, or external carotid by other authors, is the same vessel as the stapedial of the mammalian embryo or the adult reptile.—S. Williams: Sporangial variation in the Osmundaceæ. There is a considerable range of variation in the sporangia of the Osmundaceæ, particularly as regards the characters of the annulus. The bearing of these variations on the systematic placing of certain fossils is discussed, and it is concluded that Kidstonia, Boweria, and possibly *Discopteris Rallii* may be assigned to some near relationship with the Osmundaceæ. The variations described also provide evidence for the view that the sporangia of the Osmundaceæ lead on to those of Plagiogyria and so on to those of the Gymnogrammoid forms.—Claude W. Wardlaw: Size in relation to internal morphology. (3) The vascular system of roots. The passage of water into the tracheides and wood vessels of roots is largely dependent on the close association of the living parenchyma cells with the tracheides and wood vessels. In root steles of increasing diameter, the xylem does not remain of uniformly simple structure (as in small roots) but becomes progressively disintegrated and complex. By these changes the large surface of contact with the living parenchyma cells is maintained. Thus the changes in the structure of the xylem in roots of increasing diameter are such that actual size does not act as a limiting factor to the important physiological activities of the tissues involved.—J. Caldwell: Localised translocation in the swede. The south-facing half of a Swede 'bulb' grown under ordinary field conditions is more largely developed than the north-facing side, and analysis shows that it contains an appreciably larger amount of total carbohydrate. Asymmetry can be induced artificially by removing the leaves from one side of the shoot during the growth of the bulb. The carbohydrate manufactured in the leaves of one side of the shoot is thus apparently stored in the corresponding region of the bulb. Confirmatory evidence of localised translocation is afforded by the behaviour of a stain such as eosin, which, when introduced at the cut end of a petiole, is distributed over the corresponding third (approximately) of the vascular cylinder in stem and bulb.

PARIS.

Academy of Sciences, Feb. 27.—Marcel Brillouin: The kinetic theory of a gas in the neighbourhood of a wall. Position of the mathematical problem.—Th. Anghelutza: Generalised symmetrical and symmetrisable nuclei.—A. Buhl: Permutable operators and groups of transformations.—Octav Onicescu: The topological properties of the transformation defined by a uniform function of the complex variable z.—Julius Wolff: A property of a series of rational fractions.—Ch. Dévé: A machine with automatic epicycloidal transformations for working optical glass surfaces.—Svyngedauw: The deformations of the element of the pulley belt which approaches the pulley.—E. Baticle: The theory of equilibrium of heavy massifs submitted to pressure from below and its applicability to the stability of barrages and slopes.—M. Mesnager: Remarks on the preceding note.—P. Fatou: The sense of the displacement of the node of certain orbits.—R. Ferrier: Molecular geometrical

specificity.—**E. Brylinski**: The velocity of the earth. Remarks on a recent communication of Piccard and Stahel.—**Girault**: The principle of relativity and the law of gravitation.—**Mario A. da Silva**: The affinity of oxygen for the electrons.—**R. Cornubert**: α-Dimethylcyclohexanones.—**L. Bert**: Houben's reaction. This is a method of preparing hydrocarbons based on the reaction $RMgX + R'X' = RR' + MgXX'$. The small yields frequently obtained by Houben's reaction appear to be due to the condensing action of the magnesium halides produced. This action somewhat resembles the action of aluminium chloride in the Friedel and Craft reaction. The yields are much improved by using as a diluent a saturated hydrocarbon such as cyclohexane or petroleum ether boiling between 70° and 90° C.—**Stanislas Landa**: The slow combustion of hydrocarbons. The slow combustion of paraffin wax by air at 280° to 300° C. The following substances have been identified among the volatile oxidation products: acetone, methyl alcohol, butyric aldehyde, methylethylketone, ethyl alcohol. Higher aldehydes were also present. These results are regarded as confirming the views of Bone on the slow combustion of hydrocarbons.—**J. Campardou** and **M. Séon**: The decomposition of the acid anhydrides. The preparation of anhydrides by direct dehydration of the acids. Some acetic anhydride is produced by the action of titanium dioxide on the vapour of acetic acid at 300° C.—**Gibault** and **P. Rougerie**: Magnetic measurements in the east of France. Results are given for 28 stations, 8 of which are new. The isomagnetic curves in this region show no marked magnetic anomaly, but in the north-west of the Department of the Meuse the slight deformation of the curves indicates a prolongation of the magnetic anomaly of the Ardennes.—**Ph. Joyet-Lavergne**: Contributions to the study of the chondriome of a fungus of the genus Saprolegnia. The filaments of the chondriome give reactions characteristic of glutathione. The chondriome possesses both oxidising and reducing properties.—**Raymond-Hamet**: The effects of the simultaneous stimulation of the vagus and of the sympathetic on the heart and on the intestine.—**Maugnon** and **E. Knithakis**: Variations of the *p*H of the blood and of the alkaline reserve in the course of watery diet in the dog.—**M. Abeloos**: The cycle of growth in *Planaria gonocephala*.—**C. Mathis, A. W. Sellards**, and **J. Laigret**: The sensibility of *Macacus rhesus* to the virus of yellow fever. Three specimens of *Macacus rhesus* were infected, one by inoculation with the blood of a yellow-fever patient, and the two others by bites of mosquitoes infected by the same patient. All three died from yellow fever.

ROME.

Royal National Academy of the Lincei, Dec. 4.—**F. Severi**: The correspondences between the points of a variable curve on an algebraic surface.—**G. Scorza**: The fundamental sub-groups of a group.—**U. Cisotti**: Helico-conical vortices. The designation spiral has been given to a type of plane vortices which result from the compounding of the motion due to a plane punctiform source with a circulatory motion around the same, the lines of flux being logarithmic spirals about the position of the source, to which they tend asymptotically. Prosecution of this notion leads to the development of a type of spatial vortices arising from the composition of the motion due to a spatial punctiform source with circulation about an axis containing the source; such are termed helico-conical vortices, since the lines of flux are conical helices, which give Archimedean spirals as their projections on any plane normal to the axis.—**L. Cambi** and **Ada Clerici**: The action of nitric oxide on the thiosulphates of metals of the eighth group (1). The formulæ attributed by Manchot to nickel and cobalt nitrosothiosulphates, namely, $[(S_2O_3)_2Co(NO)_2]K_3$ and $[(S_2O_3)_2Ni(NO)]K_3$, correspond as well with univalent cobalt and nickel, with NO as a neutral additive molecule, as with tervalent cobalt and bivalent nickel with NO as a residue of hyponitrous acid. The supposed univalency of the metal is based on purely formal deductions, and does not correspond with the chemical behaviour of the two compounds or with the conditions of their synthesis. The NO radicles of these thiosulphates exhibit the same behaviour as those of the nitrososulphides and are thus residues with the functions of halogens.—**P. Vinassa**: Symmetry in the electrons. Of a total of 3830 artificial organic and inorganic compounds examined, more than 3700 have even molecular numbers, so that the rule recently given for the mineral components of the earth's crust is of general application. The term *electronyl* being given to the atomic entity active by the effect of the number of electrons in excess or deficit of the nuclear charge existing in them, it may be shown that (1) the number of electronyls represented in the principal states of equilibrium is always 8 or 12, and (2) electronic numbers corresponding with groupings of five or seven electrons are always lacking.—**P. R. Pirotta**: Agrarian ecology and the International Grain Conference.—**F. Sbrana**: The approximate calculation of a harmonic function in three variables and of its successive derivatives.—**V. Hlavatý**: The reduction of orthogonal systems of linear differential equations.—**G. Vranceanu**: The trigonometrical stability of equilibrium in dynamics.—**B. Finzi**: Stationary slow motions of viscous liquid films.—**G. Krall**: Functional dependency on the outline of the Green-Somigliana tensor for elasticity equations.—**G. Andreoli**: Certain of Lie's infinite groups connected with the theory of algebra and with the absolute differential calculus.—**C. Mineo**: A formula, analogous to that of Stokes, for the determination of geoids with deviations of the vertical.—**F. Rasetti**: The intensity of the lines of the principal series of potassium. Determinations of the number of dispersion electrons for the first lines of the potassium series show that these do not obey Trumpy's law, according to which the coefficient of probability of transition from the state mP to the state S decreases in proportion to $1/m^3$, although this law holds for the higher terms of the series.—**G. Natta** and **M. Freri**: X-ray analysis and crystal structure of cadmium-silver alloys (2). The β'-phase of these alloys, obtained by re-heating the β-phase below 480°, is resolved into a mixture of crystals of the α- and γ-phases when re-heated below 200°. This transformation occurs only with solid solutions of silver in the compound AgCd, but not with those of cadmium in this compound or with alloys still richer in cadmium. The γ-phase of the system exhibits close structural analogy to the γ-phase of the brasses, and has a cubic elementary cell of side $a = 9{\cdot}99$ A., containing 52 atoms, the calculated density for the alloy with 64·1 atomic per cent. of cadmium being 9·59; the hypothetical chemical compound constituting this phase may be given the formula Ag_5Cd_8. The δ- and ϵ-phases, comprising alloys with 67 to beyond 90 per cent. of cadmium, give photograms of the same aspect, the lines corresponding with a compact, hexagonal structure having the axial ratio $c : a = 1{\cdot}58$. The η-phase has the same crystal structure as cadmium and consists of solid solutions of silver in the cadmium lattice.—**A. Quilico**: Sulphonation of phenolic ethers with aminosulphonic acid. The formation of ammonium *p*-anisolesulphonate by the action of aminosulphonic acid on anisole appears to be applicable to phenolic ethers in general.—**G. Cumin**: Certain

rocks encountered in the perforations of Ripi (Latium).—R. Fabiani: Remains of mammifers in the Tertiary and Quaternary of Ragusa (Sicily).—Giambattista Dal Piaz: Outliers of the Dent Blanche in the post-Triassic formations of Grivola.—G. Montalenti: Rearing of termites without the protozoa of the cæcal pouch.—M. Fedele: The organisation and the functional characteristics of the nervous activity of the Tunicata (3). The visceral nervous system.—P. Pasquini: The lentogenic capacity of the optical vesicle in the embryos of amphibia and the 'organiser' of the crystalline lens.—R. Savelli: A case of incomplete dominance in the achene of maize.—V. Bambacioni: The development of the female gametophyte and the increase of the chromosomes in the chalazal region in *Fritillaria persica* L.

Official Publications Received.

BRITISH.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 57, July to December 1927. Pp. viii+249-468+18+47. (London.) 15*s*. net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 3, No. 2, March. Pp. 93-178. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

Descriptive Account and Catalogue of the Home Office Industrial Museum and Exhibits, with Explanatory Notes. Pp. vi+178+14 plates. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Leeds Public Libraries. What to Read on Psychology. By Prof. William McDougall. Pp. 20. 2*d*. What to Read on Citizenship. By H. A. L. Fisher. Pp. 23. 2*d*. What to Read on English Economic History. By G. D. H. Cole. Pp. 40. 2*d*. What to Read on Evolution. By Prof. J. Arthur Thomson. Pp. 31. 2*d*. (Leeds.)

Seale-Hayne Agricultural College, Newton Abbot, Devon. Report of the Advisory Departments, 1927. (Pamphlet No. 27.) Pp. 31. 6*d*. Department of Plant Pathology: Fourth Annual Report for the Year ending September 30th, 1927. (Pamphlet No. 25.) Pp. 29. 6*d*. (Newton Abbot.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 12, Part 3: The Sphegidae of South Africa, Parts ix and x, by Dr. George Arnold; Stone Age Cultures on the Zululand Highfeld and in Northern Natal, by Dr. V. Lebzelter and F. K. O. Bayer. Pp. 191-288+plates 8-17. (Cambridge: Printed at the University Press.)

Proceedings of the Edinburgh Mathematical Society. Edited by Prof. T. M. MacRobert and Prof. H. W. Turnbull. Series 2, Vol. 1, Part 2, March. Pp. 71-138. (London: G. Bell and Sons, Ltd.)

Journal of the Royal Microscopical Society. Series 3, Vol. 48, Part 1, March. Pp. xv+127. (London.) 10*s*. net.

Philosophical Transactions of the Royal Society of London. Series A, Vol. 227, A649: The Mechanical Equivalent of Heat. By Prof. T. H. Laby and E. O. Hercus. Pp. 63-92. (London: Harrison and Sons, Ltd.)

Memoirs of the Punjab Irrigation Research Laboratory. Vol. 1, No. 1: A Statistical Examination of the Sensitivity of a Water Table to Rainfall and Irrigation. By Bernard Howell Wilsdon, with R. Partha Sarathy. Pp. ii+52. (Lahore: Government Printing Office.) 1.12 rupees; 2*s*. 4*d*.

Seale-Hayne Agricultural College, Newton Abbot, Devon. Four Years' Variety Trials with Potatoes. By A. Noble. (Pamphlet No. 24.) Pp. 15. 6*d*. Grassland Management: a Report on Intensive Stocking and Nitrogenous Manuring, 1927. By T. J. Shaw. (Pamphlet No. 26.) Pp. 20. 6*d*. (Newton Abbot.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 6: Standard Methods of Drying Sultana Grapes in Australia. By A. V. Lyon. Pp. 16. (Melbourne: H. J. Green.)

FOREIGN.

U.S. Department of Agriculture. Farmers' Bulletin No. 1543: Insects Injurious to the Rice Crop. By J. W. Ingram. Pp. ii+17. (Washington, D.C.: Government Printing Office.) 5 cents.

Occasional Papers of the California Academy of Sciences. No. 14: The Rudistids of Southern Mexico. By Robert H. Palmer. Pp. 137 (18 plates). (San Francisco.) 1.75 dollars.

Proceedings of the United States National Museum. Vol. 72, Art. 25: Synopsis of Pentatomid Bugs of the Subfamilies Megaridinae and Canopinae. By W. L. McAtee and J. R. Malloch. (No. 2721.) Pp. 21+2 plates. (Washington, D.C.: Government Printing Office.)

Merentutkimuslaitoksen Julkaisu Havsforskningsinstitutets Skrift. No. 45: Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1925. Herausgegeben von Gunnar Granquist. Pp. 47. 20 Fmk. No. 46: Die thalassologische Terminfahrt im Jahre 1926. Von Risto Jurwa und Erik Palmén. Pp. 20. 20 Fmk. No. 47: Die Tätigkeit des Instituts für Meeresforschung im Jahre 1926. Von Rolf Witting. Pp. 17. 20 Fmk. No. 48: Beobachtungen von Strom und Wind an den Leuchtschiffen in den Jahren 1924 und 1925. Von Erik Palmén. Pp. 23. 20 Fmk. (Helsinki.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 31: Some Experiments on Periodic Columnar Forms of Vortices caused by Convection. By Torahiko Terada, and Second Year Students of Physics. Pp. 47+5 plates. (Tôkyô: Kôseikai Publishing House.) 1.00 yen.

Smithsonian Institution: United States National Museum. Bulletin 141: Collection of Heating and Lighting Utensils in the United States National Museum. By Walter Hough. Pp. viii+114+99 plates. (Washington, D.C.: Government Printing Office.) 70 cents.

Crystallographic Tables for the Determination of Minerals. By Victor Goldschmidt and Samuel G. Gordon. (Special Publication No. 2.) Pp. 70. (Philadelphia: Academy of Natural Sciences.) 1.50 dollars.

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 11, Part 1: Insects of Porto Rico and the Virgin Islands. Diptera or Two-winged Flies. By C. H. Curran. Pp. 118. (New York City.)

Columbia University Bulletin of Information. Professional Courses in Optometry: Announcement 1928–1929. Pp. 35+3 plates. (New York.)

Veröffentlichungen aus dem Kaiser-Wilhelm-Institut für Silikatforschung in Berlin-Dahlem. Herausgegeben von Prof. Dr. Wilhelm Eitel. Erster Band. Pp. v+269. (Berlin: Gebrüder Borntraeger.) 28 gold marks.

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 87: Paper Wrappers and their Effect upon Physical and Chemical Properties of Horticultural Products. By H. D. Brown. Pp. 29. Technical Bulletin No. 91: Taxes on Michigan's Rented Farms, 1919–1925. By R. Wayne Newton. Pp. 34. Special Bulletin No. 162: Pruning the Red Raspberry. By Stanley Johnston and R. E. Loree. Pp. 23. Special Bulletin No. 167: Chicory Growing in Michigan. By C. E. Cormany. Pp. 11. Special Bulletin No. 168: The Management of Michigan Muck Soils for the Production of Onions. By Paul M. Harmer. Pp. 48. Special Bulletin No. 174: Spraying Calendar. By W. C. Dutton, R. H. Pettit and C. W. Bennett. Pp. 31. (East Lansing, Mich.)

CATALOGUE.

Medizinische Fachkataloge: Biologie, Physiologie, Pathologie. Pp. 144. (Berlin: Julius Springer.)

Diary of Societies.

TUESDAY, APRIL 10.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—G. J. Wells: The Report of the Heat Engine and Boiler Trials Committee.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—C. H. Oakden: The Invention of the Micropolariscope.—Prof. W. T. Gordon: Rocks of Organic Origin.

THURSDAY, APRIL 12.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. Hele-Shaw and T. E. Beacham: The Variable Pitch Airscrew.

INSTITUTE OF METALS (London Local Section) (Annual General Meeting) (at 83 Pall Mall, S.W.1), at 7.30.—R. B. Pilcher: Alchemists in Art and Literature.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

FRIDAY, APRIL 13.

ROYAL SOCIETY OF MEDICINE (War Section), at 4.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (War and Otology Sections), at 4.30.—Special Discussion on Effects of Middle-ear Disease on Efficiency in Civil and Military Life.—Speakers:—For Section of War: Wing-Comm. D. Ranken, Major Hare, and Surg.-Comm. Maxwell. For Section of Otology: S. Scott, Dr. T. J. Faulder, and T. R. Rodger.

ROYAL ASTRONOMICAL SOCIETY, at 5.—J. J. M. Reesinck: Note on the Theory of the Outer Layers of a Pulsating Star.—Prof. E. A. Milne: The Effect of Collisions on Monochromatic Radiative Equilibrium.—R. Invrea: Occultations of Stars by the Moon, observed at the Royal Observatory, Pino Torinese, 1926–1927.—B. M. Peek: Occultations observed at Herne in 1927.

ROYAL SANITARY INSTITUTE (at Sessions House, Maidstone), at 5.—Dr. A. Greenwood and others: Discussion on The Health of Hop Pickers and the Sanitation of Hop Pickers' Encampments.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—A. Page: Address.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—Dr. R. H. Pickard: Fundamental Researches in the Leather Industry.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. P. Morris: Calculating Apparatus and Diagrams for Engineers.

PHILOLOGICAL SOCIETY (at University College), at 8.—N. W. Thomas: African Words in New English Dictionary.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (jointly with Chemical Engineering Group) (at Engineers' Club, Birmingham).—Dr. C. M. Walter: Paper.

CONFERENCE.

APRIL 13–16.

GEOGRAPHICAL ASSOCIATION (at Oxford).

April 14.—Sir Halford Mackinder: The British Empire in Relation to the Geography of the World (Lecture).

April 16.—Col. C. H. D. Ryder: Surveys from Air Photographs (Lecture).—Dr. L. Dudley Stamp and others: Discussion on Practical Steps in Regional Survey Work and Local Studies.