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Ethics and Archæology

IN these days when public interest in science is growing—in itself an excellent thing, even though not universally regarded as an unmixed blessing—and calls for constant stimulation by accounts of the latest discovery, the problem of acknowledgment and the legitimate use which may be made of the results of recent research is one which in its general bearing affects all research workers in science and its practical and theoretical application.

Apart from the legal question of copyright, to plain straightforward people the rights of discovery at first sight are a simple matter. Credit must be given where credit is due. One rough and ready formula is that facts are free for use, but inference and theory must be attributed to their authors. This, however, is not universally applicable and in many instances is inadequate. In archæology and ethnology, both guidance and a safeguard are afforded by the nature of the material with which these studies deal. Unless a fact is so familiar as to have passed into the generally accepted currency of scientific data, as for example the discovery and determination of the character of Piltdown man, it must be authenticated before it is admissible as evidence. In the physical sciences, it is generally true that a statement of fact can be tested by the repetition of observation or experiment. The ethnologist and the archæologist must rely solely upon an observation which possibly may, but more often cannot, be repeated. When once an archæological site has been investigated by excavation, or an implement or other object has been moved from the exact spot on which it was found, its value as evidence has passed to the excavator's record. The conditions of discovery cannot be restored, and at best, assuming that the investigator is trustworthy and adequately qualified, the evidence as recorded can only be subjected to the test of internal consistency and congruence with the general body of scientific knowledge.

It is true that when the evidence of a material object is invoked, reference can be made to specimens in a museum or collection, as for example Sumerian gold ornaments or an Arunta churinga in the British Museum ; but their evidential value in most contexts will be dependent on the fact that the former were found by Mr. C. L. Woolley in certain recorded levels at Ur in Mesopotamia and the latter was acquired by, let us say, Spencer

and Gillen while it was actually in use among aborigines in Central Australia. Thus authentication and acknowledgment go hand in hand and are inseparable. In practice, any departure from this observance is unscientific, as well as lacking in a sense of obligation.

The Editor of *Antiquity*, in a recent issue of that journal, touched upon this point of ethics in archæology, referring to "the exploitation of other peoples' work before they have been able to exploit it for themselves" as a "Fleet Street pastime", and his comment was followed up by a correspondent, who asked for a ruling upon the length of time which should elapse before an exhibit in a museum may be considered available for the purposes of archæologists in general. The Editor of *Antiquity* having stated that he does not intend to discuss the matter further, we propose to offer some comments, dealing specifically with archæology and kindred studies.

As to how far it may be legitimate for an archæologist or ethnologist to make use, as material for his own work, of objects placed on exhibition in a public museum—naturally question does not arise in the same form in a museum in which the collections are privately owned—and whether there should be a 'closed time' for reference to such objects, the problem has been complicated by practices which have grown in recent years. In the ordinary course, it would be safe to say that any object which has been placed in a public collection and is open to the inspection of the public, is available for citation. If for any conceivable reason complete publication were not desirable, it would be within the discretion of the museum authorities; for presumably a photograph or accurate drawing would be an essential to such publication, and permission for access to the object for that purpose could be withheld.

This, however, affects only objects which come into the museum collections in the ordinary course; a more difficult question arises when a more or less extensive group of objects is shown as a collection of unitary interest. Owing to the growth of public interest in the expeditions of archæological exploration in which the museums, and especially the British Museum, now participate, such as that of Mr. Woolley at Ur, it has become a regular feature of the archæological year that the season's finds allotted to the Museum, and usually those allotted to other participants in the expedition while awaiting distribution, should be shown to the public for some weeks. This takes place before any report is sent to the excavator, and obviously places him at a disadvantage should he wish to make special use of any of the material, even if he were not busily occupied in clearing up the thousand and one loose ends after a season spent in the field.

The question of the use of the evidence afforded by the material objects thus exhibited, before the excavator has had time or opportunity to express his views concerning their bearing on the more general aspect of the problems upon which he is at work, is closely analogous to amplification or inferential treatment based upon either the isolated announcements of important discoveries or the periodical reports on work in the field, which it is now customary to send home for publication in the technical journals or even in the daily press. When archæological fields are so closely related in theoretical discussion and reconstruction as they are to-day, and students of prehistory are working along cognate lines of inquiry in which the evidence from one field may at any moment throw light upon the problems of another, it is difficult to draw any line beyond which it is fair to say there lies the exclusive field of original discovery.

Further, however nice the feeling which would err on the side of discretion rather than offend, there unquestionably must be a time limit. It is not every archæologist who is so prompt as Sir Flinders Petrie in the publication of the facts which have been brought to light by his excavation. Time and again, archæologists have had cause to deplore the delay in publication which has hampered research. Only recently in a notable archæological work, the author felt constrained to confine himself to one period only of his subject, and that not the most interesting, because the official report of the excavations in which he himself had participated was not yet published, although some years had elapsed.

There is another aspect of this question in which perhaps some relaxation of rule might be admitted. This is the popular exposition of the progress of discovery, however much this may be regarded as a "Fleet Street pastime". Any more extended understanding of the objects of archæological investigation among the more intelligent section of the public benefits the science in the long run. But to those who have no technical knowledge and whose acquaintance with even the barest outlines of knowledge of the prehistory of any specific area is of the sketchiest, the simple announcement of a discovery or even the account of the

progress of an excavation is of little interest. It must be provided with a background, and it must be assigned to its place in some scheme of knowledge which is likely to be familiar to at least a fair proportion of its readers. Even so, it does not necessarily follow that the writer must be guilty of unjustifiable exploitation; but should that happen, the number of writers whose technical knowledge is sufficient to allow them to prejudice seriously the position of those who have first claim, is probably limited enough to ensure that punishment will follow and that it will fit the crime.

Modern Aspects of Chemistry in Space

Stereochemie: eine Zusammenfassung der Ergebnisse, Grundlagen und Probleme. Herausgegeben von K. Freudenberg. Lieferung 1. Pp. vi + 160. 18 gold marks. Lieferung 2. Pp. 161 – 320. 18 gold marks. Lieferung 3. Pp. 321 – 480. 18 gold marks. (Leipzig und Wien: Franz Deuticke, 1932.)

THE publication of an authoritative work on stereochemistry by a team of workers under the leadership of Prof. K. Freudenberg is a development which will be welcomed by many chemists. It is a sign of the times that an organic chemist should have secured the co-operation of so many workers outside his own field; and the thoroughness with which their co-operation has been sought and used is shown by the fact that Part I, dealing with aspects of the study of "Chemistry in Space" which have come into existence exclusively during the last two decades, includes chapters by Goldschmidt, Mark, Mecke, Wolf and Werner Kuhn, all of whom have in recent years been invited by the Faraday Society to take part in its general discussions, and are thus already well known to workers in Great Britain. It is therefore a very attractive scheme whereby each of these pioneer workers has been given an opportunity of providing an up-to-date report on the subjects in which he is specially interested.

These reports have, however, been written on the assumption that the organic chemists who read them are competent mathematicians, with an ample knowledge of physics, since no concession is made to the preference for chemical rather than mathematical equations and formulæ which sometimes decides the choice between organic and physical chemistry. The two subsequent parts, dealing respectively with the stereochemistry of carbon and of other elements, will include the topics which two successive generations have discussed under this title. The whole work is to be published in about eight instalments; but British chemists will be staggered when they receive a bill for considerably more than a pound sterling for an instalment of 160 pages.

(*a*) Prof. Goldschmidt's report on the "Crystallography and Stereochemistry of Inorganic Compounds" includes a study of atomic and ionic radii, on the lines of the author's lecture to the Faraday Society in 1929, but of much wider scope. As a contribution to a book on "Chemistry in Space", it is easy to follow, since the reader may be assumed to have acquired the habit of 'thinking in three dimensions', even if Einstein's fourth dimension is still beyond his powers of imagination. The numerous diagrams, in which the centres of the atoms are indicated by small well-spaced circles, are also clear and easy to understand, although the difference between the zinc oxide and zinc blende structures is not adequately explained in the text. The suggestion (on p. 70) that crystals of iron pyrites contain "the molecules S_2 which are already known in the gaseous state", is however perhaps ambiguous, since the reviewer has always regarded the twinning of the sulphur atoms as evidence that iron pyrites is a *ferrous disulphide*, $Fe^{++}S^{-}_{-}S$, containing a bivalent diatomic anion which may be compared with the peroxide ion in compounds such as $Na^{+}O^{-}_{-}O^{+}Na$, or with the diatomic mercurous ion $Hg^{+}_{+}Hg$ in mercurous nitrate. The report concludes by describing the fascinating work of W. L. Bragg on the silicates, of which an account has already been given in English in the new edition of the reviewer's "Inorganic Chemistry".

Two additional structures which might have been cited in detail are palladium monoxide, PdO, where each atom of palladium is surrounded by four coplanar atoms of oxygen at the corners of a *square*, whilst each atom of oxygen is surrounded by four atoms of palladium at the apices of a *tetrahedron*; and molybdenum and tungsten disulphides, MoS_2 and WS_2, where each atom of metal is surrounded by six atoms of sulphur at the corners of a *triangular pyramid* instead of the more familiar *octahedron*. These structures, which are illustrated by figures in a recent article by Maurice Huggins in *Chemical Reviews*, are so suggestive, as illustrations of the applications of X-ray analysis to stereochemical theory, that they

might well be given a conspicuous place in a future edition of the present work.

(*b*) Prof. Mark's three contributions include an introductory report on "The Basis of X-Ray Analysis of Crystals", which does not call for special comment.

The second contribution, on "Interferometric Study of Molecular Form", supplements Prof. Goldschmidt's report, since it deals with the determination of interatomic distances in gaseous molecules by the diffraction of X-rays (Debye) and of electrons (Wierl), and with the application of X-ray analysis to solid organic compounds. A summary of the results obtained by the methods of Debye and of Mark and Wierl is very useful at the present stage, and their concordance is quite remarkable. Wierl's observations on pentane, hexane and 1:5–dichloropentane are particularly interesting in that the only spacings shown by the two hydrocarbons are 1·5 A. (between contiguous carbon atoms) and 2·5 A. (between alternate atoms), since these are unaffected by free rotation about the single bonds. The absence of a well-defined spacing between the two chlorine atoms of the pentane derivative confirms the conclusion that the hydrocarbon chain is not a stiff zigzag, although the mutual repulsion of the protons may suffice to impart a linear orientation to the hydrocarbon chains in the process of crystallisation. The free rotation or 'spinning' of a long hydrocarbon chain in crystals of the substituted ammonium halides provides another example of flexibility of molecular structure where rigidity might have been expected.

The absence of all but a centre of symmetry in the molecules of crystalline benzene is recorded; but observations of the diffraction of electrons in the vapour have shown that the carbon atoms form a "regular hexagon with an edge-length of 1·39 ± 0·03 A.U." Nevertheless in Fig. 16, a zigzag ('chair') configuration is assigned to the two aromatic rings of diphenyl. This also exhibits a centre of symmetry, so that the rings must be coplanar, instead of being twisted relatively to one another about the long axis of the molecule. The report concludes with an account of the results obtained by the X-ray analysis of long-chain hydrocarbons, fatty acids, synthetic polymers, natural polymers such as cellulose and rubber, and protein chains such as the silk fibre, in reference to which Meyer and Mark have already published an important volume.

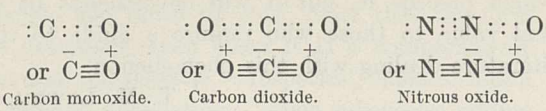
The third contribution, on "Directed Valency from the Point of View of Quantum Mechanics", gives a most illuminating account of the way in which the newer quantum mechanics has replaced the localised electrons and electron orbits of earlier theories by electron clouds, the density of which is a measure of the probability of the electron being found at a particular point. The way in which the fine structure of the *L*-shell has been correlated with the angles between the bonds in compounds of oxygen, nitrogen and carbon is explained very clearly; and an interesting estimate is given to the effect that work amounting to 600 cal. per mol. would be required to bend through 5° the straight bonds between HC and CN in hydrogen cyanide, whilst 1000 cal. per mol. would be required to distort by 5°–10° the tetrahedral angles between the bonds in diamond.

(*c*) Prof. Mecke's report on "Band Spectra and Stereochemistry" covers only thirty pages and is therefore perhaps too concise for chemical readers who are not already familiar with the subject. In particular the equations which are used to describe the *P*, *Q* and *R* branches of a band spectrum might have been accompanied by a description of the phenomenon in general terms, for the benefit of the non-mathematical reader. In view of its great importance as evidence of complete symmetry in gaseous molecules, the phenomenon of alternating intensities in band spectra might also have been described in greater detail by the author who discovered it.

One of the most interesting features of this report is the description of the 'binding constant', *k*, which Mecke himself has introduced to represent the work which would be needed to double the distance between the atomic nuclei of a molecule, on the assumption that Hooke's law remained valid throughout. A paragraph in small print explains that, in order to double the size of a water molecule by stretching the bonds, an expenditure of about 1,000 kilogram calories per gram molecule would be required, whereas the work done against cohesion in doubling the volume of liquid water would be about 8 kilogram calories.

The values of *k*, as calculated from the vibration frequency and the moment of inertia of the molecule, are fairly constant at 27, 54 and 77 volts, for single, double, and triple bonds, and can thus be used to diagnose the nature of the bonds. Chemists will, however, be very reluctant to accept the conclusion that the structure of carbon dioxide is similar to that of carbon monoxide, containing quarter-polar quadruple bonds, with

three covalent linkages between carbon and oxygen, thus:

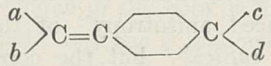


Indeed, the evidence for this formula is not very convincing, since the 'binding constant' is only 61 volts for CO_2 and 62 volts for N_2O, as compared with 54 volts for the double bond in C_2H_4 and 70 volts for the triple bond in C_2H_2. Other values recorded in the table are 55 volts for CS_2 and SO_2, 78 volts for the triple bond in HCN, 77 volts for CO and 85 volts for N_2.

(*d*) Prof. Dadieu's report on "Raman Effect and Stereochemistry" supplements Prof. Mecke's more general spectroscopic report. Raman spectra can be produced by symmetrical vibrations, which cannot be excited by the absorption of infra-red radiation; they therefore provide a valuable method of diagnosing the origin of the individual lines. Moreover, by means of a weak Raman line, with the vibration frequency of a double bond, Dadieu and Kohlrausch have detected the presence of HNC as a minor component in prussic acid, the spectroscopic properties of which are predominantly due to HCN.

(*e*) It would be difficult to praise too highly the report by Wolf and Fuchs on "Structure in Relation to Electrical Properties". In the theoretical sections, the symbols differ from those used in Debye's book on "Polar Molecules", and are rendered obscure by the use of too many subscripts. The methods for determining dipole moments are, however, adequately described, illustrated and discussed; and it is a special merit of this report that it deals also with the cognate phenomena of depolarisation of scattered light by anisotropic molecules, and the Kerr effect of double refraction in an electrostatic field. The collection of experimental data is remarkably complete, and has the advantage of being classified in a series of more than twenty tables, so that abundant data are at once available to illustrate every theoretical point that is raised by the author, or that may occur to the reader. In particular, the problems of free and impeded rotation and of distortion of valency direction are presented with full experimental evidence for the conclusions that are reached.

(*f*) Dr. Werner Kuhn's report on "Optical Activity" deals with the fundamental property of optical rotatory power, which led to the initial development of three-dimensional chemistry by Pasteur nearly a century ago. It is therefore unfortunate that in an early paragraph the author appears to underrate the importance of the classical experiment, whereby Pasteur first resolved sodium ammonium racemate into the *d*- and *l*-tartrates, since he claims that (by making use of the selective decomposition of *d*- and *l*-azidopropionic dimethylamide by circularly polarised light) he has developed the "only method whereby up to the present the optical antipodes of a racemate can be separated arbitrarily without the aid of other optically-active substances". A similar criticism is invited by a statement that "optically active compounds containing one asymmetric carbon atom, e.g., the compound



had already been discovered in the time of van't Hoff", whereas in fact a compound of this type was first resolved by Pope, Perkin and Wallach in 1909, which was thirty-five years after the publication of van't Hoff's "Chemistry in Space", although two years before his death in 1911.

Dr. Kuhn's report consists mainly of a description of the views which he has himself put forward during the past four years; and a considerable part of the report has been taken verbatim from a recent monograph by Kuhn and Freudenberg under the title "Drehung der Polarisationsebene des Lichtes"[1]. The hypothesis is adopted that optical rotatory power is developed by an unsymmetrical coupling of electrons, such that when one vibrates in a north-and-south plane the other has a component vibration in an east-and-west plane. Thus the major component of the rotatory power of azidopropionic ester is attributed to the coupling of the electrons of the azido-group (which gives a weak absorption band in the middle ultra-violet) with the electrons associated with the asymmetric carbon atom (which is supposed to possess an extremely intense band in the inaccessible Schumann region). The development of optical activity by the coupling of electrons is described by him as "vicinal action".

In this connexion attention may be directed to a letter in NATURE of April 19, 1924, on "Induced Asymmetry of Unsaturated Radicals in Optically-active Compounds"[2], which is cited in Kortüm's recent monograph, but not in the present report. In this letter, the hypothesis was put forward "that unsaturated chromophoric groups can be

made asymmetric by induction from a fixed asymmetric centre, and thus develop optical activity"; "induced asymmetry" was, however, only attributed to the chromophoric groups *when coupled sufficiently closely to an asymmetric complex.* This hypothesis was based on the experimental fact "that the dispersion equations for camphor and its derivatives are haunted by a low-frequency term *the period of which is definitely characteristic of the ketonic group.*"[3] In a similar manner, Kuhn was able to show some years later that the azido-group which (like the ketonic group) normally contains a plane of symmetry, nevertheless produces an important partial rotation in the azido-propionic esters. The optical activity which was attributed in 1924 to the "induced asymmetry" of the unsaturated radical is attributed by Kuhn to the "induced anisotropy" of the absorption band of this radical; but the correct term for the phenomenon is obviously "induced dissymmetry" or "induced optical activity", since anisotropy alone cannot produce optical activity, and complete asymmetry although usual is not essential.

Dr. Kuhn's model leads to mathematical equations of a type which had already been developed by Drude in 1906; but these have been adapted to absorption bands of a form which agrees more nearly with that which is observed in practice. These equations, however, now provide a numerical estimate of the distance between the coupled electrons, with the interesting result that the distances thus calculated are considerably greater than the extreme linear dimensions of the molecule. Another important deduction states that, since the process of coupling affects both electrons, the sum of the partial rotations (for example, as expressed by the numerators in Drude's equation) must be zero. A 'simple rotatory dispersion' then results, as the algebraic sum of partial rotations of similar frequency, when *all* the active absorption bands are in the Schumann region, whilst complex and anomalous rotatory dispersions result when one or more of the bands is in the visible or in the accessible ultra-violet region.

(*g*) Part I concludes with a report by Dr. Stefan Goldschmidt on "Reaction Velocity". This report (of which only one-half is included in the third instalment) does not call for detailed criticism at this stage, since it consists mainly of a review of the evidence for and against the doctrine of "Steric Hindrance" in organic reactions of many different types. It does not therefore break new ground in the same way as the reports which precede it, but it will nevertheless be of real value to those who require a guide to the literature dealing with this phenomenon.

T. M. LOWRY.

[1] "Hand- und Jahrbuch der chemischen Physik," Band 8, Abschnitt 3.
[2] Lowry and Walker, NATURE, **113**, 565, April 19, 1924.
[3] Lowry and Cutter, *J. Chem. Soc.*, **127**, 613, 1925.

Nomenclature in Lepidoptera

The Macrolepidoptera of the World: a Systematic Description of the hitherto known Macrolepidoptera. Edited by Prof. Dr. Adalbert Seitz. Supplement to Vol. 1: *The Palæarctic Butterflies.* Pp. vii+399+16 plates. (Stuttgart: Alfred Kernen, 1932.) 132 gold marks.

IN the supplement lately issued to the volume of Seitz's "Macrolepidoptera" dealing with the palæarctic butterflies, the editor and his collaborators have, within their self-imposed limits, produced a work of great value and of high interest. How far these limits will commend themselves to students of the various groups concerned, may be doubtful; it is at least certain that disputable points have been carefully considered, and that in most of the decisions arrived at account has been taken of the dictates of common sense.

"It is impossible in these supplementary volumes," the editor remarks, "to take up an extreme attitude either in the nomenclature or with the giving of new names." That the latter proceeding can be carried to excess is evident from the fact that more than one hundred forms of one species of *Parnassius* have each received a name. Most people will agree with the editor that "nomenclature itself is not a science, but that it should be an aid to science. As soon as it proves itself the reverse it is worse than useless and should be opposed." There can also be little doubt that names which are merely abbreviated diagnoses, such as *croceosemivirgatus-cœrulescens*, should be disallowed as a retrograde step towards the system happily reformed by Linnæus. At the same time, the trinomial system now so widely adopted serves a useful purpose in grouping together, under a common specific designation, various closely related but distinct forms which may be judged not to be deserving of specific rank. But here also restraint is necessary; a tendency of the trinomial to become a quadrinomial or multinomial system should generally be checked.

In the matter of specific names, assent will probably be given by most lepidopterists to the principle laid down by Prof. Seitz that the form first described, even when it is a comparatively rare and inaccessible 'subspecies', should retain the specific appellation; other subspecies adding their distinctive designations to the common name denoting the species.

An inherent difficulty in the whole matter is the fact that nomenclature has to presuppose the existence of hard and fast lines where such do not exist in Nature. Perfect correspondence between the system and the facts is unattainable; every student will have his own idea of the best form of compromise. What is to be aimed at in practice is the establishment of a well-considered standard of nomenclature, sufficiently reasonable to induce students to sink their individual opinions and preferences for the sake of general agreement.

The editor and his collaborators have borne in mind throughout that their undertaking is mainly intended as a work of reference and not of criticism. This justifies the admission of many new names that from a strictly scientific point of view might well be disallowed. On the whole, they have exercised a wise discrimination, and have been guilty of few, if any, sins of omission.

Leaving aside the topics dealt with in the preface and introduction, we have found little to call for special notice. A discoidal cell (p. 8) should not be called "open" merely because it is not bounded by a black streak. The view expressed (p. 93), that a name should only be given when specimens can be denominated even without the particulars of the locality and the date, seems, on the whole, reasonable. But it would not be difficult to suppose cases where the rigid application of such a rule might be inadvisable.

The English version of the book is for the most part well executed; but one is inclined to suspect that the intricacies of the English language have occasionally been a little too much for the translator. The plates, sixteen in number, reach a high standard of merit. F. A. D.

Short Reviews

Business Rationalisation, its Dangers and Advantages considered from the Psychological and Social Standpoints: Three Lectures given at the London School of Economics under the Heath Clark Bequest to the National Institute of Industrial Psychology. By Dr. Charles S. Myers. Pp. vii+76. (London: Sir Isaac Pitman and Sons, Ltd., 1932.) 3*s.* 6*d.* net.

THIS book attempts to give a more comprehensive picture of rationalisation than is suggested by its title, and in emphasising the importance of the human factor in rationalisation and the bearing of rationalisation on the general structure of society the book makes a needed and valuable contribution. In discussing the significance of rationalisation, Dr. Myers has scarcely placed sufficient emphasis on the growing tendency under modern conditions for the really progressive large combines to display in their general policy a remarkable approximation to the spirit of service characteristic of what might be termed national service or public utility departments. This tendency is likely to become even more pronounced, and public opinion will judge rationalisation largely by the extent to which service rendered to the community in the broadest sense dominates the policy of the rationalised combines.

On the question of leadership and particularly on the development of leadership by scientific management in industry Dr. Myers has little to say, though he notes the importance of personality, and his treatment of the dangers of rationalisation is too academic. Similarly in discussing its advantages, Dr. Myers has rather strangely omitted to set rationalisation in its true perspective in an age which demands increasing world co-operation, or to discuss the significance of international industrial co-operation for world peace. More care might have been taken to distinguish rationalisation from mere amalgamation, for such confusion is responsible for widespread misunderstanding of, and opposition to, valuable and overdue schemes of rationalisation in certain industries.

The subject headings of the chapters are by no means happily chosen; some of the most important observations on the dangers of rationalisation are to be found, for example, in the other chapters. The book just misses an opportunity for a timely exposition of rationalisation from an aspect which is of growing importance but often overlooked.

R. B.

Industrial Psychology in Practice. By Henry J. Welch and Dr. George H. Miles. Pp. xiii+249. (London: Sir Isaac Pitman and Sons, Ltd., 1932.) 7*s.* 6*d.* net.

NUMEROUS examples drawn from many different industries, illustrating the practical results which have already attended the application of the methods and principles of industrial psychology to commercial and industrial problems, are recorded in this volume, which demonstrates convincingly the value of such applications alike from the point of view of the worker and of the employer. The fact that investigations of working conditions such as lighting, heating and ventilation, noise, or hours

of work, fatigue and monotony and the most effective method of carrying out a specific operation or process have almost invariably increased the efficiency or output of the worker has frequently led to an even more important result being overlooked—the improvement in the health of the worker, who is also less fatigued by the effort required for the greater output under the new conditions. Industrial psychology is clearly of the utmost importance from both points of view and this book tends to redress the balance of emphasis by stressing the importance of such methods to the worker in the prevention of accidents, in the planning of work and elimination of waste, the selection and training of personnel, etc.

Material has been taken freely from the reports of the Industrial Health Research Board, the Home Office Safety Pamphlets, the investigations of the National Institute of Industrial Psychology, as well as from foreign sources, and the book demonstrates conclusively the immense value of the human sciences to the community, and the wide possibilities in the settlement of human problems not by opinion, rule of thumb or tradition, but by scientific methods based on ascertained facts. It should be of great service in enlisting further support for the work of the Industrial Health Research Board and the National Institute of Industrial Psychology, and in encouraging the wider application of such methods in industry.

R. B.

Bibliographical Survey of Vitamins, 1650–1930: with a Section on Patents. By Mark H. Wodlinger. Compiled by Ella M. Salmonsen. Pp. viii + 334. (Chicago: Mark H. Wodlinger, 1932.)

The literature of the vitamins now runs to several thousand original papers. In this bibliography, more than 11,000 publications are mentioned; 326 references appear in the historical section covering the period 1650–1910. Thereafter the papers of each year are listed separately, and from 1916 onwards a separate section is devoted to each vitamin: vitamin E first appears in 1921.

The earlier references are, of course, to the deficiency diseases, which we now know to be caused by the absence of a particular vitamin from the diet, and also to medicaments such as cod liver oil which owe their efficacy to their content of vitamins, although this was not realised at the time their use was originally advocated. These early references will be of special value to those interested in the historical side of the subject and might form the basis of a study of the development of our knowledge of the real cause of different deficiency diseases.

The references to each vitamin are arranged in the alphabetical order of the authors' names: provided the name is known it takes but a moment to find any particular paper, even although the year of publication is not known. It would take only a short time to extract from these pages a list of papers dealing with any particular aspect of the vitamin problem, since the title of each paper (or book) is given in full.

This book should be of great use to all workers in this field: it supplements the reviews and monographs on the vitamins and precedes the issue of *Nutrition Abstracts and Reviews*, which should now provide an adequate index to the literature. In the last section the list of 240 patents should be of value to manufacturers or to research workers who may wish to patent their process.

A History of the Birds of Suffolk. By Claud B. Ticehurst. Pp. xi + 502 + 18 plates. (London and Edinburgh: Gurney and Jackson, 1932.) 24*s.* net.

With the progress of ornithological interest it is impossible to work with a book that is forty-five years old, however good it was when published. Those interested in the birds of Suffolk will welcome an up-to-date work by one who is singularly competent to write it. From the hours of a busy life, Dr. Claud Ticehurst was able to take some leisure and to make his notes and record his observations. He has spent twenty years in producing this volume, seventeen of which were spent in Lowestoft.

In the introduction are given a description of the country; changes in the avifauna; migration; a list of the collection of Suffolk birds; the names of former Suffolk ornithologists and the scope of the volume explained. The order and nomenclature used are those of the "List of British Birds" published in 1915. We think the 1923 "List" would have been preferable. The species are treated on modern lines, doubtful records examined and the latest and most reliable views expressed. The photographic plates add to the work and the map of Suffolk is, of course, a necessity.

Einführung in die Mechanik und Akustik. Von Prof. R. W. Pohl. (Einführung in die Physik, Band 1.) Zweite verbesserte Auflage. Pp. viii + 251. (Berlin: Julius Springer, 1931.) 15.80 gold marks.

This second edition of Prof. Pohl's elementary treatise should need little commendation to the notice of English readers. Its treatment of the subject is well off the lines of the traditional method and, both in its insistence on apt experimental illustration, and in the small demand it makes on the reader's mathematical knowledge, it forms an effective foil to the conventional English textbook. It is to be hoped that a translation, modified a little (in scope rather than in outlook) to suit the work of the junior university and senior classes of schools, will make the book available to those who cannot read the German text. Despite the excellence of the text, such modifications would seem to be needed, more especially in that section which deals with acoustics.

A notable feature of the book is its wealth of illustrations, many of them produced most effectively as deep black silhouettes.

A. F.

Early History of the Determination of Atomic Charge

ATOMICITY is a characteristic of twentieth century physics, so that modern physics may be said to begin with those early investigations by which the atomic nature of electricity was first established. The facts relating to early investigations of the atomic charge are scattered through the literature of the subject, and it will be of interest to bring them together in a brief account of the development of the methods which led to the accurate determination of this fundamental constant.

That electricity has an atomic structure appears first to have been suggested to explain Faraday's laws of electrolysis, on the supposition that the charge on a monovalent ion was the smallest separate quantity. This hypothesis was strongly advocated by Stoney and Helmholtz. It follows from Faraday's experiments that if E be the charge on a monovalent ion in a liquid, and n the number of molecules in a cubic centimetre of a gas at 15° C. and 76 cm. pressure, the product $n.E$ is $1{\cdot}24 \times 10^{10}$, E being expressed in electrostatic units. This E is taken as the fundamental atomic charge.

The quantities n and E could not be deduced separately from experiments on electrolysis, and in the earliest attempts to determine E the above value of $n.E$ was used with approximate estimates of n. All that was known about n prior to a direct measurement of an atomic charge, was that "it lies between the limits 10^{18} and 10^{21}" as stated by Sir J. J. Thomson in his book "The Discharge of Electricity through Gases" published in 1898, where he also gives a description of the first experiments on the direct determination of the atomic charge made by Townsend,[1] who was at that time demonstrator in the Cavendish Laboratory, Cambridge.

These experiments of Townsend are notable as being the prototype of the investigations which led finally to the accurate determination of the atomic charge made by Millikan.

It was known that in many cases electrically charged clouds were formed when newly prepared gases were bubbled through water. Townsend conceived the idea of measuring the charge on a drop in such a cloud, which he supposed to be an atomic charge, and for this purpose he used gases prepared by electrolysis, adopting the following procedure. The total weight W of the drops in a cubic centimetre of the cloud, and the total charge Q carried by them, were found by direct measurements, but in order to determine the average charge on a drop it was necessary to find the number of drops in a cubic centimetre of the cloud; to obtain this number the weight w of a drop was required.

The weight of a drop and also its radius were obtained from the rate of fall of a cloud in a beaker, by an ingenious application of Stokes's formula for the velocity of a sphere moving slowly in a viscous medium under the action of a constant force. The first value found for an atomic charge was 3×10^{-10} E.S.U., but after allowing for the fact that the cloud contained drops with charges of different sign, Townsend[2] gave a corrected value 5×10^{-10}.

The importance of this investigation was immediately recognised, and in 1898 Sir J. J. Thomson used the same method modified in details to investigate the charge carried by ions produced by X-rays. In Thomson's experiments a cloud was formed in a closed vessel as in C. T. R. Wilson's experiments in which an ionised gas is cooled by a sudden expansion causing water vapour to condense on the ions. With this modification, it was necessary to determine the charge Q per cubic centimetre and the weight W indirectly, consequently Q was obtained from the electrical conductivity of the gas and W by estimating the amount of moisture condensed on ions by the expansion.[3] The gases were ionised by X-rays and the values $6{\cdot}5 \times 10^{-10}$ E.S.U. and $6{\cdot}7 \times 10^{-10}$ E.S.U. found for the charge on a drop in air and hydrogen respectively. Later he obtained the value $6{\cdot}8 \times 10^{-10}$ for negative ions generated by the action of ultra-violet light.[4] In a subsequent determination[5] which he considered to be more accurate, he used a radioactive substance to ionise the gas, obtaining for the value of the atomic charge $3{\cdot}4 \times 10^{-10}$.

The determinations of Townsend and Thomson involve various inaccuracies, and also the serious uncertainty in the assumption that each drop in the cloud carried a single atomic charge. Millikan states that, in the clouds produced in ionised gases by expansion, some of the drops may carry one, some two, some ten or almost any number of unit charges, though this does not imply that before condensation the ions in the gas have multiple charges.

There remained, in addition, the difficulty of establishing a relation between the charge e on an ion in a gas and the charge E on a monovalent ion in an electrolyte. A method of showing that these charges are identical was first given by Townsend[6], who showed that if e be the charge on an ion in a gas, U its mean velocity in the direction of an electric force Z, and K the coefficient of diffusion of the ions, then the value of $n.e$ is obtained from the equation $U/K = n.e.Z/P$ where P is the pressure of a gas containing n molecules per cubic centimetre at the temperature at which U and K are determined ($P = 10^6$ C.G.S. units).

In order to find the product $n.e$, Townsend devised a method by which he measured the coefficient K, and taking the mean values of K for moist and dry gases with the corresponding values of U obtained by Rutherford, he found the following values for $n.e \times 10^{-10}$: air 1·35; oxygen 1·25; carbon dioxide 1·30; hydrogen 1·00.

These values of $n.e$ were so near the value $1{\cdot}24 \times 10^{10}$ of $n.E$ for monovalent ions in a liquid that Townsend was able definitely to state that

the charge on ions produced by X-rays and the charge E on a monovalent ion in a liquid are the same. In later investigations in which the ions were produced in various ways, he found that the value of $n.e$ for negative ions in gases was in close agreement with the value of $n.E$ for electrolytic ions.

Further progress in the accurate determination of e was made when H. A. Wilson introduced an important improvement into the method of finding the charge on a drop, whereby it was possible to avoid the uncertainty of dealing with drops with an unknown number of atomic charges. The cloud was formed in the ionised gas by expansion, in an apparatus containing two horizontal parallel electrodes, so that it was possible to establish a vertical field Z in the space where the cloud was formed. A retarding or an accelerating force, $Z.e$, was thus superimposed on the force of gravity w acting on each drop. The weight w of a drop was determined by measuring the velocity when Z was zero and by applying Stokes's formula as in the original method. The charge e was determined by finding the change in the velocity when the force $Z.e$ and w acted together. In this method it was unnecessary to find the number of drops in the cloud. It was observed that the change in the velocity due to the electric force was not the same for each drop, since the cloud appeared to fall in groups of drops with charges in the proportion 1 : 2 : 3.

This important observation showed that the charge on a drop, if not equal to, was a multiple of the smallest charge. H. A. Wilson gave $3{\cdot}1 \times 10^{-10}$ as the value of the atomic charge according to this method.[7]

It is well known that the most accurate determinations of the atomic charge were made by Millikan in the period 1909–1916.[8] As it was unnecessary to find the number of drops in the cloud in order to determine e, Millikan applied H. A. Wilson's method to single drops. Inaccuracies due to evaporation were avoided by using drops of non-volatile oil, which were placed in electric fields of such strength that they could be made to move against gravity or held in suspension at will. A single drop could thus be kept under observation for long periods. He tested Stokes's formula, which had been assumed by his predecessors, obtaining an empirical correction to it in the case of small drops, and his very consistent results[8] showed that the charges carried by drops were always exact multiples of the atomic charge $4{\cdot}77 \times 10^{-10}$ E.S.U.

The earliest investigations of the atomic charge had an important bearing on the interpretation of the experiments made to determine the ratio of the charge e to the mass m of an electron. The first trustworthy determinations of the ratio e/m were made in 1897 by Wiechert,[9] Kaufmann,[10] and Thomson,[11] who found that the ratio e/m for cathode rays was about 1/2000 of the ratio E/M of the atomic charge E to the mass M of an atom of hydrogen. It was known from experiments on electrolysis that the ratio E/M was $2{\cdot}9 \times 10^{14}$ while the best experiments gave $5{\cdot}3 \times 10^{17}$ for the ratio e/m, and from the first it was suggested by Wiechert that the charges E and e were equal and consequently that the mass m was about $M/2000$. This suggestion, however, could only be regarded as a plausible hypothesis until the identity of the charges E and e had been established in 1899, in relation to which Townsend's investigation of the product $n.e$ ranks in importance with the accurate determination of the atomic charge e.

[1] J. S. Townsend, *Proc. Camb. Phil. Soc.*, Feb. 1897.
[2] *Phil. Mag.*, Feb. 1898.
[3] J. J. Thomson, *Phil. Mag.*, Dec. 1898.
[4] *Phil. Mag.*, 1899.
[5] *Phil. Mag.*, March 1903.
[6] J. S. Townsend, *Phil. Trans.*, May 1899.
[7] H. A. Wilson, *Phil. Mag.*, April 1903.
[8] R. A. Millikan, "The Electron", University of Chicago Press, 1917.
[9] E. Wiechert, *Sitz. Phys. ökon. Ges. Königsberg*, Jan. 1897.
[10] W. Kaufmann, *Wied. An.*, July 1897.
[11] J. J. Thomson, *Phil. Mag.*, Oct. 1897.

Scientific and Industrial Research*

THE seventeenth annual report of the Department of Scientific and Industrial Research covering the period August 1, 1931–July 31, 1932, appears appropriately as if to punctuate the tributes to the importance of research in our national life which have recently been paid by high authorities in finance. A more impressive picture of the manifold ways in which scientific research is daily applied not merely to the solution of our industrial problems but also to the service of the innumerable needs of a civilised community than is contained in the annual reports of this Department it is difficult to imagine. The present report, including the brief report of the Privy Council, signed by the Right Hon. Stanley Baldwin, and the longer report of the Advisory Council, over Lord Rutherford's signature, is no exception to the rule. Lucid as are these reports and the summaries of the work carried out by the National Physical Laboratory, the Chemical Research Laboratory, the research associations, and under the direction of some forty-five research boards and committees, a popular exposition of the matter contained in them should be invaluable propaganda and assist the ordinary citizen to appreciate the magnitude of the contribution thus made to the necessities and luxuries of his daily life—food and clothing, air and water supply, transport and housing, business and pleasure. Appendices to the report deal with finance, publications and the personnel of the various boards and committees.

There is no department of State in which the beneficial influence of the Department of Scientific and Industrial Research is not felt and no

* Department of Scientific and Industrial Research. Report for the Year 1931–32. (Cmd. 4254.) Pp. iv+193. (London: H.M. Stationery Office, 1933.) 3*s*. net.

proportion of the national income is more profitably spent than that controlled by this Department. It is satisfactory to find that the expenditure detailed in the current report shows only a slight reduction on that recorded in the previous report; the gross expenditure for the year amounted to £695,677 as compared with £740,520 in 1930–31, and the actual expenditure to £534,700 as against £555,691. Receipts showed a decrease from £184,829 to £160,977, most of which is represented by decreased receipts of the National Physical Laboratory from outside bodies and firms, Government departments, etc. The net expenditure on headquarters administration is £24,900, grants for research amounted to £34,398 net, and to research associations £82,307, an increase of £6,652 on the previous year. Expenditure on the Geological Survey and Museum amounted to £62,730, and on the National Physical Laboratory to £200,754 gross, against which receipts amounted to only £93,982 instead of £104,706 in 1930–31. The net cost of the Chemical Research Laboratory was £19,450, of radio research £10,482, of water pollution research £10,796, fuel research £82,707, receipts diminishing the gross expenditure on the latter by £6,033. The major part of the expenditure on food research is met by a grant of £30,502 from the Empire Marketing Board and this and other receipts bring the gross expenditure of £46,997 to £11,530 net. Similarly, receipts amounting to £7,680 and £7,896 reduce the expenditure on building and forest products research to £34,519 and £33,792 respectively.

Nineteen research associations received grants during the year, and the report records that certain of these associations have been able to record a marked increase of industrial support during the past year while others are hopeful of attaining similar success in the near future. The British Electrical and Allied Industries Research Association now derives approximately one-half of its industrial income from supply undertakings, and the majority of lead manufacturers in the country are now members of the British Non-Ferrous Metals Research Association. Refractory material makers are supporting more strongly the British Refractories Research Association, and the voluntary levy scheme launched by the Wool Industries Research Association two years ago is now working smoothly but, mainly owing to bad trade conditions, has not yet shown signs of yielding an income sufficient to meet the Association's present scale of expenditure.

On the other hand, the British Cast Iron Research Association, in spite of the highly important and eminently practical research results to its credit, is experiencing great difficulties in maintaining its industrial income, while membership of the Cutlery Research Association has declined from fifty to ten firms in two years. In view of this lamentable lack of interest in the Association's investigations, the Department concluded that continued expenditure of the public funds at the disposal of the Association was unlikely to lead to results of benefit to the industry as a whole and, with the consequent surrender of these funds, termination of the Association's activities has been inevitably involved.

Reviewing the work of the research associations as a whole, the report emphasises the importance of their work to industries other than those designated by their respective titles and notes movements for widening the basis of industrial support. Few of the research associations appear to be in favour of a compulsory levy scheme, and accordingly the Advisory Council is unprepared at the present time to make representations in favour of introducing a general measure to authorise the compulsory adoption of a levy.

The general interest of the work of the research associations may be illustrated by a few typical examples selected from many to which space forbids even reference. In the iron and steel industry, research has reduced the consumption of coal per ton of finished steel from 31 cwt. in 1924 to 23 cwt. in 1930, representing an estimated average saving on coal used after the pig iron stage of more than £1,468,000 on the 1930 production. Important work on smoke abatement, refractories, etc., is being carried out in collaboration with other interests concerned. With the support of the water-supply authorities and others, the Non-Ferrous Metals Research Association has commenced a study of the bursting of water-pipes by frost by a thorough investigation of the properties at low temperatures of the materials used for them. The Association is also investigating the quality of galvanised iron with special reference to the corrosion of hot-water tanks and the retention of brightness of polished white metals, such as are used for shop fronts, name plates, etc. These are matters in which the ordinary citizen or householder is as interested as the industrialist, and the same may be said of investigations carried out by the Electrical and Allied Industries Research Association on conducting leads in gas-filled lamps used for office and factory lighting, which have enabled a considerable reduction in the rise of temperature in the fittings to be effected and simultaneously reduced the fire risk. The same Association has developed a simple portable apparatus for determining the conductivity of the ground along a proposed cable route, so that the correct size of cable required to carry the current can be ascertained. Other investigations have been concerned with the efficiency of electrical earthing and on the cause and prevention of interfering noises on telephone lines.

The Refractories Research Association provides a striking example of an association of which the work is of general interest, and closely associated with its investigations are representatives of the Institution of Gas Engineers, the National Federation of Iron and Steel Manufacturers and the British Pottery Manufacturers' Federation. These investigations have ranged over such subjects as the durability of refractory materials and its improvement, the permeability of refractory

materials to high temperatures and changes in physical structure during the firing of fire clay goods.

The Research Association of the British Paint, Colour and Varnish Manufacturers has continued its investigations on the measurement of the physical and mechanical properties of paint, varnish, and lacquer films, the hiding power of paint, the relations between crystal structure, surface characteristics and pigmentary value. The recently formed Research and Standardisation Committee of the Institution of Automobile Engineers, to which the Department contributes financially, has occupied itself with problems of cylinder and piston wear, lubrication, and with such problems of general interest as silencing, for which a new instrument has been designed.

The Cotton Industry Research Association is not only carrying out important fundamental studies of dyestuff solutions, the dyeing process, and mercerisation, but has also made special efforts to demonstrate to its members the practical value of its operations. More than two thousand visits were paid to mills and works during the year by its liaison staff, and the prestige of the Association is distinctly greater in the trade than a year ago.

The Wool Industries Research Association has been concerned with the various causes of fading such as light and atmosphere, laundering and perspiration, which are often of immediate interest to the public. The Linen Industry Research Association has similarly been concerned with wearing properties under laundering as well as with levelness and regularity of weave. The Launderers' Research Association has been concerned with detergents as well as with the mechanical conditions, with the object of decreasing attrition and the prevention of felting of wool, etc.

Among the problems occupying the attention of the Leather Manufacturers' Research Association have been the deterioration of leather on storage, the factors responsible for dermatitis associated with dyed leather, while the Boot, Shoe and Allied Trades Research Association has designed new lasts on which the contracts for the Army marching boots are being carried out, using vegetable tanned leather curried according to the Association's recommendations. The sound-absorption of rubber flooring in auditoriums, improving the resistance of rubber to oils, ageing, and water absorption are directions in which the Rubber Manufacturers' Research Association is assisting the utilisation of rubber and the revival of this depressed industry.

The Research Association of British Flour Millers is investigating the blending of wheat to give flour of regular and improved qualities. The Research Association for the Cocoa, Chocolate, Sugar, Confectionery and Jam Trades has been concerned with such varied problems as the 'solubility' of cocoa, standardised specifications of purity of materials, including wrappers, coatings of sugar crystal, while the Food Manufacturers' Research Association has carried out successful investigations on the canning of kidneys and liver as well as on the development of satisfactory gums and pastes for labels.

These investigations are, however, only a fraction of those concerned with food with which the Department as a whole has been concerned. The importance of food in the maintenance of health and in the control of disease is being more and more widely recognised in days when emphasis is laid on preventive as against curative methods. It would be difficult to overstress the importance to public health of some of the work which is being carried out to preserve the freshness of food. Merely to enumerate the investigations on the storage of chilled beef, opening up the prospect of chilled beef from Australia being marketed in Great Britain, on the storage of bacon and ham, on canning problems, on the smoke-curing of fish, on the preparation of fish livers for treating pernicious anæmia and on the storage of fruit and vegetables, should bring home to the most unimaginative citizen the value he receives from the expenditure of this insignificant proportion of the national reserve, even if its importance to home industries and to the shipping companies is less apparent.

The importance of the physical and chemical survey of the coal resources of Great Britain has been enhanced by the events of the last two years, and other work carried out under the Fuel Research Board dealing with the scientific utilisation of fuel, including low temperature carbonisation, represents an attack on perhaps the most crucial problem with which the Department is concerned, bearing directly on the unemployment problem as well as, through its reaction on atmospheric pollution, on public health.

Again, it is a simple matter for the ordinary citizen to appreciate the immense importance of the work of the Building Research Board outlined in this report, whether as applied to the testing of building materials, the weathering of materials, or the design of reinforced concrete piles for the foundations of big buildings, momentary stresses in which are now being measured by an ingenious application of radio methods. He will readily grasp also the significance of the researches on steel structures now so widely used in building, and the activities of the Radio Research Board, which are frequently as closely related to the needs of the ordinary listener and amateur as to those of the Post Office, the Admiralty, the War Office, the Air Ministry and other bodies at the request of which many of them were originated. The work of the Forest Products Research Board bears directly on the life of timber and the efficiency with which it can be preserved against insect or fungoid attack, whether by the death watch beetle for example or by dry rot, and once again touches many a householder closely.

To do justice to the activities of the National Physical Laboratory might well require volumes, and only a few examples can be given. In the William Froude Laboratory, research on wind resistance has indicated ways in which the air

resistance of most types of vessel can be reduced by about 30 per cent, while other improvements have been effected in the design of small coaster vessels as well as in the humble barge, the improved design showing on towing tests a 33 per cent improvement in speed for slightly less power. The National Physical Laboratory played an important part in designing the high speed seaplanes which won for Great Britain the 1931 race for the Schneider trophy, as well as in the development of new and safer types of aircraft. Other work assists in the provision of improved materials for industry, including steel and steel alloys capable of withstanding the high temperatures at which modern machinery such as turbines and aircraft engines must work, and workers in other sections of the Laboratory again are investigating the glare effect of different systems of street lighting, the best beams for traffic control signals, the transmission factors of coloured railway signal lights and the lighting of docks, quays and their approaches. It needs little imagination to realise what advance in these fields means not merely to industrial efficiency but even more in the elimination of much suffering and loss of life.

The field covered by the work of the Chemical Research Laboratory is almost equally wide, ranging from products for treatment of sleeping sickness in human beings and in animals, to the preparation of synthetic resins, corrosion research, researches at high pressures, tar research and water pollution. With the latter subject a special board is concerned, and following on the survey of the River Tees recently carried out, one on the River Mersey is now projected.

Space does not permit further reference to many activities of the Department which are of scientific as well as of industrial and general interest. This brief review contains no account of important metallurgical researches for which the Department is responsible, or of its investigations on electrodeposition, lubrication or dental problems. Mention should, however, be made of the Geophysical Survey Research Committee, which has now completed its work and through the activities of which the danger that the development and use of this new applied science in Great Britain would be neglected has been dispelled. Sufficient has been said, however, to demonstrate the unique and invaluable contribution which the Department is making not merely to industrial efficiency but also to industrial development and the public welfare, and to indicate how essential it is in days when economy is the watchword that there should be no restriction of services which have been so productive.

Obituary

LIEUT.-COL. ALFRED W. ALCOCK, C.I.E., F.R.S.

WITH the death on March 24 of Alfred Alcock, there has passed away a type of doctor who in the past has so often graced the ranks of the Indian Medical Service—that of the surgeon-naturalist. Zoological science in India has been always enriched by the labours of distinguished medical men, of whom the late Sir Joseph Fayrer and Alfred Alcock may be taken as representing the acme of a period which will never be seen again.

Alfred Alcock was born in Bombay on June 23, 1859. His father, who was a sea captain in the days of windjammers, retired and lived at Blackheath, and there the subject of this memoir went to school and afterwards became a Westminster scholar. In the 'seventies, owing to ruinous losses due to the sudden depreciation of Egyptian Government bonds, he was taken away from school, in 1876, quite unexpectedly. He was then packed off in September of that year to Wynaad in the Malabar District of Southern India, to a coffee plantation, where he had an uncle engaged in this industry. He lived in the jungles of Wynaad and in the neighbouring native State of Cochin, and was able to observe all the operations connected with coffee-planting and also to study the birds and beasts.

As coffee planting was then obviously in the decline, Alcock obtained in September 1877 a post in a newly established firm of commission-agents in Calcutta, and on the voyage from Madras to Calcutta, the ship that carried him, the *Duke of Buccleuch*, was rammed and almost sunk by a steamer, appropriately named the *Vixen*. The commission-agent business not proving a success, he next started as a freight-broker on his own account, but soon gave that up to proceed to Chota Nagpur as an assistant to a coolie-recruiting agent, where he remained until February 1880. It is necessary to mention this, as in some ways it proved the turning point of his career, for he met there a young Bengal civilian who lent him Michael Foster's "Primer of Physiology", which cost the sum of one shilling, and this little book proved to him to be what the light of heaven was to St. Paul. It set his face towards natural science, and throughout the rest of his life he thought of Michael Foster (whom he had never met) with the gratitude of a disciple. He next met the Deputy Sanitary Commissioner of Chota Nagpur, Lieut.-Col. J. J. Wood, and this good man took the young Alcock to his heart and hastened him on his way with an old microscope, several timely books and many long talks on botany, natural history and chemistry. This led him to do a little body-snatching on his own in places where the poorer natives disposed of their dead, and from that source he obtained bones to study and began to read Darwin's "Descent of Man" and "Origin of Species". He had now fully resolved to become a medical man.

Alcock next became assistant schoolmaster at a large school for European boys in Darjeeling.

He was justified in applying for this appointment since during the whole of his jungle life he had assiduously read his Horace and his Homer along with the "Canterbury Tales" and the "Golden Treasury". Fate was kind to him, because his "sanitary friend", Col. Wood, immediately rejoined him in the Darjeeling district, and actually entrusted him with the tuition of his eldest boy. Quite unexpectedly, he was helped financially by his sister, who had married a distinguished officer in the Indian Civil Service, and was able to proceed to Aberdeen, to begin work in the Marischal College of that University. In 1882 he had taken first place in the class, and the medal for natural history, and was appointed University assistant in zoology. In 1883 he obtained a bursary in natural science, and in April 1885 he graduated M.B. and C.M. with honourable distinction, while later on in that year he passed eighth into the Indian Medical Service, and in October of the same year, he joined the class at Netley Hospital, where he came under the influence of the celebrated Timothy Lewis, the professor of pathology.

Alcock's interest in the beginnings of tropical medicine had already been stimulated by the lectures of Sir Alexander Ogston, the professor of surgery in the University of Aberdeen. Ogston had discerned the great significance of the discoveries made by Patrick Manson in China on insect-borne disease, and this had impressed itself so much on his mind that it remained a guiding factor for the rest of his life.

In March 1886 Alcock again sailed for India, and was first stationed at Allahabad, and on June 6 of that year he was ordered to join the 1st Sikh Infantry at Dera Ismail Khan on the Punjab frontier. There he found himself soon shot out into the Punjab desert, and had many interesting adventures, during one of which he crossed the desert of 150 miles in the middle of the hot weather, and on another occasion he had the misfortune to break his leg and lay for some time with only a native hospital assistant to look after him. In this desert he observed many cases of snake bite, some fatal, by the horned viper. His promotion was very rapid, and in May 1888 he was gazetted to permanent medical charge of the 2nd Punjab Infantry.

Regimental life had been an extremely happy experience to Alcock, but a regimental hospital did not quite satisfy his ambitions for scientific work, and soon an unexpected opportunity presented itself when he was appointed surgeon-naturalist to the R.I.M.S. *Investigator* for the zoological section of the Indian Marine Survey of 1888–92. He joined his ship at Port Blair in the Andaman Islands on November 20, 1888. These four years he regarded always as the happiest of his life, and his experiences were summarised in that fascinating book "A Naturalist in Indian Seas" published in 1902, and it was this book that obtained the highest commendation from Sir Joseph Hooker. During this time he roamed the coastal inlets and Indian Seas, dredging for Crustacea and describing the marine fauna, including many denizens of the deep hitherto unknown to science. During his travels he visited the Andaman Islands, the Cocos Keeling, Minicoy and other sparsely inhabited islands of the Indian Ocean, studying their human inhabitants and the island fauna.

In April 1893 Alcock began his association with the Indian Museum as professor of zoology in the Medical College of Bengal, and he served many happy years in this capacity until 1907. His period of service was broken in 1895 when he was appointed as surgeon-naturalist to the Pamir Boundary Commission, and spent one year at these alarming altitudes over 14,000 ft. He actually reached the tomb of Bazai at the eastern end of the Little Pamir. His report on the natural history results of the Pamir Boundary Commission was published in Calcutta in 1898, and received general recognition.

In 1896, after ten and a half years continuous service in India, Alcock returned to England on leave, and in July 1897 he married Margaret Forbes Cornwall of Aberdeen, whom he had known in his student days. In 1901 he was elected to the fellowship of the Royal Society and in 1903 was created a C.I.E.

There is no doubt that the finest work that Alcock performed in India was that of the organisation and rearrangement of the Indian Museum, which he made a model of its kind. It was here that he came under the notice of Lord Curzon, with whom he had some difference of opinion regarding the future of this Museum. He then made, too, a lasting and life friendship with Sir Leonard Rogers, and with him became greatly interested in the classification of the *Thanatophidia*, and collaborated with him on the toxicology of snake venoms. In the meantime, he had become the outstanding authority on the Crustacea of India, a group to which he had always paid special attention, and wrote the "Catalogue of the Indian Decapod Crustacea", a work for which he was awarded the Barclay medal of the Asiatic Society of Bengal in 1907. At this time he wrote numerous papers on the river crabs (Potamonidæ) and was elected natural history secretary in 1888, general secretary in 1895, and vice-president in 1901 of the Asiatic Society. In 1906 he was on furlough in England, working through the major's course for promotion at the Royal Army Medical Laboratories and at the West London Post Graduate School, and also the Lister Institute. Here he made the acquaintance of Sir William Leishman, Sir Jonathan Hutchinson and Sir Charles Martin.

In 1907 Alcock retired from the Indian Medical Service, and immediately placed himself at the services of Sir Patrick Manson and of his new School of Tropical Medicine in London. Here he felt like a new man after what he considered to be his sad failure at the Indian Museum. Manson was the magnet which drew him, and the foundation of medical zoology on a proper basis, was

his aim. He became Manson's most faithful lieutenant and admirer; to him it was a pious task to defend Manson's reputation and to aid in preserving his memory, for, apart from all his discoveries and his greatness, he considered that Manson was the embodiment of the Hippocratic tradition. Henceforward he became the first teacher of medical entomology in the School of Tropical Medicine, and he added greatly to his reputation by the publication of his text-book, "Entomology for Medical Officers", 1912, which reached its second edition in 1920. This work was written in response to requests from students in his own School, and whilst directing its attention principally to the arthropods concerned in the dissemination of disease, it almost became an outline of zoology.

To thousands of post-graduate students of all nationalities, in his charming and unpretentious way, Alcock became guide, philosopher, and friend. Soon he became responsible for the foundation and establishment of the entomological collections of the School, and for the collection of poisonous snakes and other reptiles; in fact, the whole zoological fauna that make up the science of tropical medicine. He organised the Tropical Diseases Library of the School, and from 1912 onwards actively participated with Dr. A. G. Bagshawe in reviewing for the *Tropical Diseases Bulletin*, becoming the assistant director of the Bureau in 1921. He was very gratified in being elected in 1920 to the professorship of medical zoology in the University of London. His reviews of medical zoology, as indeed every letter and article he wrote, were characterised by a charming scholastic style, embroidered with a wealth of literary and classical allusions, which could scarcely be surpassed, and gave his work an air of great distinction.

Then came the War, and in his endeavours to serve his country, Alcock found himself appointed as surgeon to an Indian hospital at Brighton, but he found himself 'at sea' when armed with a scalpel, and instead devoted himself to instructing R.A.M.C. officers, proceeding overseas, in the elements of tropical medicine. The War being over, he returned to his active teaching, and in the following years he collaborated with Dr. P. Manson-Bahr in "The Life and Work of Sir Patrick Manson", which was published in 1927. He was thus afforded an opportunity of making clear the everlasting truth of medical biology as evidenced by the life story of Manson.

Alcock retired from active teaching in 1924, and had been living in seclusion at Belvedere in Kent, but in no wise did his zeal for his favourite subject abate.

It is scarcely necessary to enlarge further on his character—that of the true naturalist, and man of science, and a lover of his fellow creatures—in fact, a friend of all mankind. It was a common experience for a stranger on seeking his road in far away Belvedere to Alcock's house, to inquire the way of some whistling schoolboy, and to receive as an astonished reply, "Oh, that's where Col. Alcock lives; he is a great pal of mine." It is appropriate to quote his favourite lines:

"Nature is made better by no mean,
But nature makes that mean; so, over that art
Which you say adds to nature, is an art,
That nature makes—The art itself is nature."

His philosophy of life, like that of old Pittacus, of Mitylene, was: "The greatest blessing a man can enjoy is the power of doing good." So, when he is gone, we realise that the era of the pioneers of tropical medicine is closed.

Alcock was an LL.D. of the University of Aberdeen, and a corresponding member of the Zoological Societies of London and of the Netherlands, and also of the California Academy of Sciences.

Dr. John Belling

Dr. John Belling, elder son of the late John Belling, inspector of Army Schools, who died on February 28 in San Francisco, was born at Aldershot, England, on October 7, 1866. He taught in various schools, attending lectures meanwhile at London and Birmingham, and obtained a London B.Sc. (Hons.). In later life he was given the honorary degree of Doctor of Science by the University of Maine in 1922. He lectured in the Horticultural College at Swanley, England; and later at Llanidloes, Wales, in 1900–1. Shortly after this he went to the British West Indies where he became investigator in the Department of Agriculture. In 1907 he went to the Florida Experiment Station as assistant botanist and carried out important researches there on hybrid beans.

Shortly after the War, Belling went to the Carnegie Institution of Washington as cytologist in the Department of Genetics, and was associated with Dr. A. F. Blakeslee in the investigation of the chromosomes of *Datura*. Here his genius in microscopy and his philosophical insight opened up a new field in the study of the behaviour of chromosomes and in the interchange of segments between non-homologous chromosomes. Belling was subject to periods of depression during which he did some of his most brilliant work. Believing that it was important for him to have a change of scene, he was transferred by the Institution to Berkeley, California, where he worked in a corner of Prof. E. B. Babcock's laboratory, continuing his fundamental researches on the structure of chromosomes in hyacinths and various lilies. In these investigations, under superlative technique, he believed he was able to see structures, which on account of their number and size, he identified with genes.

Belling was the author of a book on the use of the microscope, which has been eminently successful. He had also made considerable progress with a work on the study of the chromosomes.

After the Sixth International Congress of Genetics, held in Ithaca last summer, a number of foreign delegates travelled to Berkeley to examine Belling's preparations showing the structure of the chromosomes, and to discuss with him his interpretations of them. He was also the author of a small book of verse, "The Life-World. Poems of Science" (published by the Margaret Mary Morgan Co., 619, California Street, San Francisco). It contains sixty poems concerning scientific (chiefly genetic) phenomena and also three others, the last of which, "Elegy", is of exceptional beauty.

Belling married Miss Hannah Sewall, who died in 1926 without issue. He is survived by a brother, James Belling, residing in the Cheltenham district, also by a sister, Miss Annie Belling.

Prof. E. C. Starks

With the passing at a comparatively early age of Prof. Edwin C. Starks, American ichthyological science has suffered yet another grievous loss, following, as it does, close upon the deaths of David Starr Jordan, Charles H. Gilbert, Carl H. Eigenmann and Barton Warren Evermann. Thus, within a comparatively few years the five zoologists, who, with Theodore N. Gill (1837–1914), may be said to have dominated the study of fishes in the United States during the last half century, have died.

Prof. Starks was born at Baraboo, Wisconsin, on January 25, 1867, studied at Stanford University from 1893 until 1897, and was then appointed assistant to the United States Biological Survey. From 1899 until 1901 he held the position of curator and assistant professor of zoology at Washington (Seattle). In 1901 he returned to Stanford University, being appointed curator in 1901, assistant professor in 1908 and associate professor in 1927.

A list of Starks's published works on fishes, including those in which he collaborated with Jordan, Gilbert and others, would contain some seventy or more titles. Many of these were of a systematic nature, and included the results of an ichthyological survey about the San Juan Islands, Washington, the fishes of Panama Bay (with Gilbert), and the fishes of Puget Sound (with Jordan). In collaboration with Jordan he was responsible for an important series of revisions and monographs of Japanese fishes published between 1901 and 1906. By far the most valuable of his contributions to ichthyology, however, were the series of papers dealing with the osteology and affinities of various groups of bony fishes. These papers, with their careful descriptions and well-drawn illustrations, furnish a monument of accurate and painstaking research, and are invaluable to students of fish taxonomy.

J. R. N.

We regret to announce the following deaths :

Prof. E. W. Hobson, F.R.S., formerly Sadleirian professor of pure mathematics in the University of Cambridge, on April 18, aged seventy-six years.

Sir Edward Rigg, C.B., C.V.O., who was appointed assistant assayer in the Royal Mint in 1873 and was superintendent of the Operative Department from 1898 until 1918, on April 14, aged eighty-three years.

News and Views

Rubber Industry Bill

In the House of Commons on April 11, Mr. H. Williams asked the president of the Board of Trade whether he was aware that the Research Association of British Rubber Manufacturers had discharged many of its staff and suspended research work for lack of funds. (This matter was referred to in a leading article in our issue of February 11.) Mr. Williams asked further whether, in the circumstances, facilities would be given for further progress of the Rubber Industry Bill. Mr. Runciman stated that he was aware of the situation. He said: "The Government recognise that it is desirable that the work of this Association should continue and have decided to give an opportunity for further discussion in Parliament of the Rubber Industry Bill." Owing to pressure of business in the House of Commons, it is proposed to introduce the Bill at an early date in the House of Lords.

Improvement of Beef Cattle in Australia

If, as predicted by Dr. J. B. Orr, Australia is to become "the stock farm of the Empire", one of its urgent needs is the improvement of the beef cattle breeds in the northern tropical parts of Queensland, North Australia and Western Australia. The handicaps to British breeds are sparse fodder and prevalence of ticks and tick fever. The success reported to have followed the introduction of Brahman (Zebu) strains into herds in poorly grassed, tick-infested territories bordering on the Gulf of Mexico induced the Australian Council for Scientific and Industrial Research in 1931 to make a close investigation of the actual position. As a result, it has for some time strongly advocated experimental breeding in Australia to evolve a suitable cross for the north between British and Brahman cattle. Lack of funds prevented immediate action, but four pastoral companies have now made sufficient money available to ensure a thorough test of the possibilities of the cross. An officer of the Council is in the United States selecting suitable animals (probably eight bulls and two cows) which will be shipped to Australia and, after compliance with exacting quarantine conditions, will be divided amongst the properties of the companies, which at present carry chiefly shorthorns and Herefords. All breeding and culling will be under the sole supervision and control of the

Commonwealth Council for Scientific and Industrial Research. Many years will be required for the evolution of an animal suitable for northern tropical conditions but success, if attained, will be of considerable importance to many parts of the Empire.

Coloration Problems in Animals

ALL who are concerned with the problems raised by the coloration of animals will be interested in the announcement that two hog-deer (*Cervus porcinus*) have just been born at the Gardens of the Zoological Society of London. This animal, of about the size of a roe-deer, has a more or less conspicuously spotted coat in the summer, and one of a uniform brownish hue speckled with white in the winter. But the young are heavily spotted, as with our fallow and red-deer, the spots serving to form a 'concealing' coloration. Another coloration problem, and in a way yet more interesting, now presents itself in the sixteen flamingoes just purchased and sent to the Society's park at Whipsnade. These birds lose much of the brilliance of their pink coloration in captivity. Careful note should therefore be made of the intensity of pigmentation of the new arrivals. It has been stated that birds in the London Gardens recovered their lost brilliance when they were turned out into a paddock affording free access to a large pond, well-stocked with small crustaceans. In the gardens of the New York Zoological Society an interesting experiment was made, years ago, on the beautiful rosy flamingo (*Phœnicopterus ruber*) which, in successive moults during captivity, became paler and paler, and finally almost white. By mixing a harmless dye with the food the fading process was considerably lessened, while some retained their original full colour for years. What was the 'harmless dye', and was it continuously administered ? Under the more favourable conditions at Whipsnade, perhaps these birds may breed. In this event a valuable opportunity will be furnished to mark the effect, if any, of climatic influence, and food, on the coloration in their progeny.

Australian Sector in the Antarctic

THE Australian National Research Council is very much gratified at the announcement that an Order in Council has been issued by the British Government affirming that His Majesty the King has sovereign rights over the antarctic territory, other than Adelie Land, south of lat. 60° S., between long. 160° and 45° E., and placing such territory under the authority of the Commonwealth of Australia from the date on which the necessary legislation is passed by the Commonwealth Parliament. Seven years ago, during the presidency of Sir David Orme Masson, the Research Council urged that sanction be sought for Australian administration of that part of the continent between long. 160° and 90° E. The matter was discussed at the Imperial Conference in 1926 when it was placed on record that there were certain areas to which British title existed by virtue of discovery. More thorough exploration of this 'Australian sector' was, however, obviously desirable and to that end the Governments of Great Britain, Australia and New Zealand, with liberal financial aid from Sir MacPherson Robertson of Melbourne, fitted out the "Discovery" expeditions under Sir Douglas Mawson in the seasons 1929–30 and 1930–31. These explored the greater portion of the sector between long. 160° E. and 45° E. including Enderby Land, Kemp Land, Queen Mary Land, King George V Land and new areas to the east of Kemp Land which were named MacRobertson Land and Princess Elizabeth Land. Australia will now presumably assume a measure of responsibility for developing and regulating existing and possible industries in the sector, including the enforcement of the International Convention on Whaling.

International Cloud Photography

THE intensive international study of meteorology during the Second International Polar Year, 1932–33 includes also the sky, and General Delcambre, president of the International Commission for the Study of Clouds, selected two periods for specially detailed investigation in France and neighbouring countries. The first was on April 12 and 13, while the second is arranged for July 12 and 13, 1933, and General Delcambre has asked for material from England. Should conditions on July 12 and 13 be suitable, meteorologists with cameras are asked to take at least three cloud photographs each day, as near as possible to the hours of 8 a.m., 2 p.m. and 7 p.m. B.S.T., and others at intermediate hours whenever the general character of the sky changes. The purpose of the photographs is to represent the changes of the sky as a whole, and cloud-systems should be photographed rather than individual clouds, using, for preference, a wide-angle lens. Artistic merit is a secondary consideration ; the prints should show as much detail as possible, but should not be re-touched. Filters should be used if necessary to bring out the structure. It is important that the following information should be given on the back of each print : name and address of the photographer, place where taken, date and time. It is desirable also that notes should be added as to the fraction of the sky covered by cloud, the nature of the clouds in the part of the sky not included in the photograph, the direction in which the camera was pointing and the approximate elevation above the horizon. Prints, suitably packed, should be addressed to : M. le Ministre de l'Air, Office National Météorologique, 196 rue de l'Université, Paris 7, and in the corner should be written "Année des Nuages".

Trevithick Centenary Commemoration Programme

THE centenary commemorations of the death of Richard Trevithick will be held on April 22, 23 and 24. On Saturday afternoon, April 22, a demonstration will be held at Camborne, where Trevithick made his first experiments with a steam road carriage, and on Sunday afternoon a memorial service will be held in the Tregajorran Methodist Chapel, in the parish of Illogan, Cornwall, his birthplace. On Sunday morning a memorial service will be held at 11 a.m. in Dartford Parish Church, Kent, where the preacher will be the Right Rev. the Lord Bishop

of Rochester. At the close of this service an address on Trevithick will be given by Mr. L. St. L. Pendred, and a wreath will be placed on the memorial which recalls Trevithick's death at the Bull Inn, Dartford, on April 22, 1833. At evensong at 3 p.m. in Westminster Abbey on Sunday, special reference will be made to the centenary by the preacher, the Ven. Archdeacon V. F. Storr, and at the end of the service a chaplet will be placed beneath the Trevithick window in the north aisle of the Abbey. Finally, on Monday, April 24, at 6 p.m., a memorial lecture will be delivered by Prof. C. E. Inglis, at the Institution of Civil Engineers, Great George Street, S.W.1, by kind invitation of the Council. The chair will be taken by Sir Murdoch Macdonald.

Unemployment and the Schools

AT the National Union of Teachers' annual conference on April 15 the new president, Mr. H. N. Penlington, of Hemsworth, Yorkshire, opened his address with the declaration that unemployment is the outstanding problem of our age; and this *leit-motif* dominated the rest of his discourse under the headings of school objectives, school buildings and school staffs. With the ever-increasing displacement of human labour by machinery, leisure seems destined to bulk more and more largely in human life, and it follows that preparation for life must increasingly include equipment for commendable uses of leisure. Unemployment in the building trade could be substantially relieved by carrying into effect school building programmes in respect of more than fourteen hundred schools which are admittedly insanitary or in other ways totally unfit for their purpose. Not less urgent is the need of relief of overcrowding of classes, in nearly eight thousand of which the enrolment exceeds fifty pupils. Meanwhile, the number of unemployed teachers grows and is expected to reach between two and three thousand by September next. If the school-leaving age should remain unchanged, the number of 'school-leavers' this year will be about half a million—an exceptionally large number—and a large proportion of these must go to swell the numbers of the unemployed. The time is opportune, Mr. Penlington suggested, for raising the school-leaving age, and he emphasised the dangers of an unenlightened and reactionary policy spreading discontent, already rife, on account of the 'cuts' in the Burnham scales.

Herrings and the Origin of Petroleum

IT would seem at first a far cry from a modern herring catch to petroleum genesis, but a recent discovery off the coast of Alaska proves this to be by no means the case. Some twenty or thirty years ago a boat loaded with herrings was wrecked off Admiralty Island, Alaska, and recently samples of the sea deposits, near to where the wreck occurred, were dredged up and sent to the United States Geological Survey in order that an analysis could be made of an unusual waxy substance which they contained. The investigation was in charge of Dr. R. C. Wells of the Survey, who proved that the wax was a complex compound formed of decomposition products of the fat in the fish, combined with calcium and magnesium salts of the sea-water. It was further found that high-temperature distillation of this wax gave rise to an oil having affinities with petroleum. In all theories of organic origin of petroleum the most difficult part to understand is precisely how the original substance underwent conversion into the hydrocarbon oil which we recognise in crude petroleum and, while we may visualise the environment under which these changes took place, the actual chemical mechanism involved is far more difficult to conceive.

As a report issued by Science Service (Feb. 14) states in connexion with this matter, the fact that the fatty acids formed by decomposition of the fish united into a complex waxy salt with minerals in the sea-water suggests that something of the same sort may have happened in the ancient seas in which petroliferous deposits have been laid down. The only criticism we have to make in this instance is that practically all scientific evidence available tends to show that the time factor is of fundamental importance in the production of petroleum, quite apart from the environment in which it may have been conceived. In this particular illustration, it would seem that comparatively little fundamental change could have taken place in the organic substance deposited by this wreck, and we question whether the results of distilling this wax-like material are really indicative of more than would be expected from interaction between animal substance and sea salts, interactions which must, in point of fact, be constantly in process in every sea and in all kinds of environments.

Mechanical Transport in India

DURING the last forty years, railways have been a great boon to India, but now their practical monopoly is being seriously challenged by vehicles propelled along roads by internal combustion engines. The paper read to the Indian Section of the Royal Society of Arts on March 10 by Col. F. P. Barnes on the development of mechanical transport is therefore a timely one. He computes that the number of motor vehicles in India is about 160,000 and is rapidly increasing. But this only gives 1 vehicle for every 2,000 inhabitants. This compares with 1 in 5 in the United States and 1 in 32 in Great Britain. There is thus plenty of room for development. Amongst the advantages of motor transport are that it employs a large number of people, it adds to the amenities of life and has a civilising effect. It now gives employment to about 200,000 people in India. Instead of using the tonga and bullock wagon, the business man uses a car and can cover a much larger area in a much shorter time. He can also send his family to the hills in comfort. The civilising effect is shown in Waziristan, where a great circular road has been constructed running through a country of tribesmen who, a few years ago, were formidable enemies of the British. The road was largely constructed by men who had fought against the British and some of them

are now employed as policemen to patrol it. Many passengers now leave their rifles at home, showing that law and order is being established. Col. Barnes pointed out the great advantages that would accrue to the railways if the motor industry were developed so as to feed and not to compete with them. Mechanical transport in India has received little encouragement from the Government. It has been mainly regarded as a source of extra revenue and heavily taxed. Despite this, it has flourished and is now one of the principal industries in the country. There can be little doubt that if it is encouraged, there will be a great future in India for mechanical transport.

Meteor Crater, Arizona

THE *Meccano Magazine* for March contains an illustrated article on this unique formation. The photographs give a vivid idea of the force of the impact, which shattered the rocks, and forced up great blocks of limestone. Mr. D. M. Barringer has for many years been making efforts to discover the meteor itself. Two vertical shafts were sunk near the centre of the crater, but there was no success, and the work was impeded by the influx of water, which turned the powdered rock-flour into a quicksand. Eventually experiments on the impact of projectiles led to the conclusion that oblique impacts give a nearly circular depression; Mr. Barringer had at first assumed that the meteor would lie under the centre of the pit, but further examination of the shattered rocks suggested that it had come from the north and was likely to lie under the southern edge of the pit. A shaft is now being sunk in undisturbed soil a quarter of a mile to the south of the pit; this will be continued to a depth of some 1,400 ft., and then a horizontal shaft will be run to the north, in the hope of encountering the meteor, which may be either a single great metal mass (in which case it is estimated to weigh some ten million tons) or a compact swarm of smaller masses. There is still some trouble from water, but it is hoped to overcome this by surrounding the shaft with reinforced concrete. Mr. Barringer has now been carrying on his arduous exploration for many years, and certainly deserves success. The article makes some estimates as to the date of the impact; it cannot be less than seven centuries ago, from the evidence of old trees growing on the rim; and it is thought to be less than five thousand years ago, from the fact that little erosion of the scattered blocks has taken place. Also the native Indians have a vague tradition of a fiery descent from heaven. Probably it may be dated between one and two thousand years ago.

Mind as a Living Process

THE second of the L. T. Hobhouse Memorial Trust lectures was given by Dr. Charles S. Myers on May 19, 1932, and has been published under the title of "The Absurdity of any Mind-Body Relation" (Oxford University Press. 2*s*. net). Dr. Myers maintains the view that any relation between mind and body is absurd because mental activity and living bodily activity are identical. The mechanical principles of the natural sciences are only an abstraction from the quasi-dual set of principles—direction and mechanism—that govern the entire universe. Each is an abstraction from the whole activity. Mind and life are identical properties of living matter, which differs from lifeless matter in its inherent, purposive, self-directive, and finally purposeful struggle for existence. From this point of view then, the hypotheses of psycho-physical parallelism, of interactionism, and of either form of monism are untenable. Dr. Myers quotes with approval from Hobhouse to the effect that life arose not from dead elements, but from pre-material elements which also gave rise to inanimate matter, so that all life contains a germ of mind. Mind is thus to be regarded as the expression of the directive activity of living matter. This directive activity is to be regarded as the highest unitary activity of the nervous system: the lower directive activities may not always be in harmony with the highest and hence the mental conflicts, conscious and unconscious. Dr. Myers discusses the relation of the cognitive, affective and conative aspects of experience and the part played by instinct and intelligence. The point of view is most lucidly expressed and raises interesting questions for philosophy, psychology, biology and physical science. It is worthy of note that ancient and medieval thought realised the problem also, and that only from the context in many writings can one know whether the word 'anima' is to be translated life or mind.

Origin of the Irish Flora and Fauna

IN his presidential address delivered last November to the Royal Irish Academy, Dr. R. Lloyd Praeger returned to a subject which has occupied his attention for forty years—the problem of the Irish flora and fauna (*Proc. Roy. Irish Acad.*, **41**, 125). The problem has been much discussed, but always with an obscurity of background due to absence of fossil evidence which might give the clue to the routes and periods of past immigrations. In such circumstances conclusions assume a personal interpretation and Dr. Praeger's view is that much of the present flora and fauna reached Ireland over land-surfaces, either during inter-glacial (Aurignacian) times, or in the same way after the ice had finally passed away, or probably during both periods. Certain plants and animals found with these immigrants, including the American and probably the Lusitanian element, are older than these, and survived the main glaciation. These oldest elements migrated northward in pre-glacial times along the western European coast line, or eastward from America when the intervening barriers of sea were at least much less formidable than they are at present.

Migration of Red Grouse

THE University of Aberdeen inquiry into the movements of the red grouse would welcome the co-operation of owners or tenants of grouse-moors willing to ring young or adult birds during the present season. Rings, with instructions for their use, may be obtained from Prof. James Ritchie, Marischal College, Aberdeen.

Economic Minerals

THE third number of *Sands, Clays and Minerals*, a new quarterly magazine devoted to economic minerals, contains a series of articles covering a varied and attractive field. Particularly noteworthy is a paper on British coals by Mr. A. L. Curtis in which a wealth of interesting information on the origin, composition and classification of coals and related materials, such as graphite, jet and peat, is gathered together. This is effectively illustrated by a beautifully produced coloured plate showing typical hand-specimens of fourteen of the materials dealt with. Other articles describe raw materials such as sands, tripoli powder, and sapphire (with two plates of rough and cut stones); research methods involving the application of ultra-violet light, elutriation, magnetism and heavy liquids; the mining of china clay, the properties of refractory cements, the decay and restoration of building stones, and the sources and uses of tantalum and niobium. The magazine is likely to be of great service to technical and commercial men who are interested in mineral products but may not have the time or opportunity to follow the more specialised literature. It is published by Mr. A. L. Curtis, Westmoor Laboratory, Chatteris, the annual subscription being 5*s*.

Researches on Cacao

THE first annual report on cacao research in 1931 carried out by the Imperial College of Tropical Agriculture, Trinidad, has just been published. Founded in 1922, the first years of the life of the College were necessarily occupied in academic duties, and although cacao was included in the scheme for long-range research work in 1927, it was not until 1930, when contributions from the cacao-producing Colonies and some of the manufacturers in Great Britain allowed of the purchase of a small estate and the recruitment of three special research officers, that any large development in this side of the work took place. The report deals with the results of the first year's investigations and it is a tribute to the College that so much fundamental information should have been gained in such a short time. On the botanical side, the problem has been approached from three main aspects, namely, propagation studies, genetical survey and studies of fruitfulness, and it is proposed to continue the work on similar lines in the future. The chemical and ecological section has begun an environmental study of the cacao tree and has carried out a soil survey of the Gran Couva district with a view of determining how soil types and environment affect productivity. Both growers and manufacturers alike should profit from the improved yield and quality in the crops, which there is every hope will result from these investigations. The report, price 1*s*., may be obtained on application to the Editor of *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, British West Indies.

Deaf and Dumb in England and Wales

THE National Institute for the Deaf has issued a memorandum commenting upon a report by the late Dr. Eichholz to the Minister of Health and the President of the Board of Education on "A Study of the Deaf in England and Wales, 1930 to 1932". It is considered that the proposals contained in the report are inadequate to meet the needs of the deaf and dumb and of those who become deaf through disease or accident. Disappointment is expressed with regard to some of the proposals, and suggestions are made which it is considered would better the position, though it is realised that it may be impossible at present to incur fresh expenditures upon the work necessary to ensure the well-being of these classes.

Bibliography of Earthquakes

THE Dominion Observatory at Ottawa has continued its useful work by publishing a list of one hundred memoirs on earthquakes received during the third quarter of 1932. With very few exceptions, the memoirs belong to the last two years. All the principal countries in which earthquakes are studied are well and uniformly represented, a result that is no doubt due to the appointment of collaborators in Italy, France, England, Canada, Japan and Germany, as well as in various parts of the United States.

New Air Speed Record

WARRANT OFFICER FRANCESCO AGELLO, of the Italian Air Force, set up a new air speed record on April 10, when he attained an average speed of 423·76 miles an hour. Agello was flying a Macchi-Castoldi 72 seaplane at Desenzano, Lake Garda, and it is stated that on one run he reached a speed of more than 430 miles an hour. The machine was one of those originally intended for the Schneider trophy race of 1931. The previous record, 408 miles an hour, was set up on September 29, 1931, in a Vickers-Supermarine *S* 6*B* seaplane flown by Flight-Lieut. G. H. Stainforth.

New Director of the U.S. Bureau of Standards

IT is announced by Science Service, Washington, D.C., that Dr. Lyman J. Briggs has been appointed director of the U.S. Bureau of Standards, in succession to Dr. G. K. Burgess, who died on July 2, 1932. Dr. Briggs has been chief of the Division of Mechanics and Sound of the Bureau since 1920. He has carried out much research on aerodynamics, gyroscopic stabilisation and properties of liquids. He is the co-inventor, with Dr. Paul R. Heyl (also of the Bureau of Standards), of the earth inductor compass that is now widely used in aircraft. For this invention, Drs. Briggs and Heyl shared the Magellan fund and medal, awarded by the American Philosophical Society for "the best discovery or most useful invention relating to navigation, astronomy, or natural philosophy".

Sectional Meeting of World Power Conference

THIS year the World Power Conference sectional meeting will be held in Scandinavia, on June 26–July 8. Everyone interested in the energy problems of large industrial undertakings is cordially invited to take part. The Conference opens at Copenhagen

on June 26. The members next proceed to Stockholm by special sleeping-car trains, where the opening address will be given by the Crown Prince of Sweden. A number of very attractive tours has been arranged, including one to Finland by aeroplane or boat. The closing session will be held in Oslo on July 8. The Conference Bureau will assist those who desire to pay a visit to any holiday resort. A large number of rooms have been reserved in the smaller hotels at prices which are stated to be far below the usual Continental level. The exchange also is in favour of sterling. Further details can be obtained from the offices of the World Power Conference, 63 Lincoln's Inn Fields, London, W.C.2.

Fifth Pacific Science Congress

AT the invitation of the Government of Canada and under the auspices of the Canadian National Research Council, the Pacific Science Association will hold the fifth Pacific Science Congress, for the study of Pacific problems, in Victoria and Vancouver, B.C., Canada, on June 1–14. It is expected that some thirty countries bordering on the Pacific Ocean will be represented at the Congress by four to six hundred men of science. The president of the Executive Committee of the Congress will be Dr. H. M. Tory, president of the National Research Council of Canada and director of the National Research Laboratories. The Congress will open at Victoria on June 1, where sessions will be held until June 3. On June 4, it will proceed to Vancouver, where further sessions will be held until June 14. A post-Congress tour has also been arranged from June 14 until June 19, when it will terminate at Calgary. The Congress will work in two divisions: Biological Sciences, under the chairmanship of Prof. C. McLean Fraser, professor of zoology at the University of British Columbia, Vancouver, and Physical Sciences, under the chairmanship of Prof. R. W. Brock, professor of geology and geography at the University of British Columbia. The secretary of the Congress is Mr. S. J. Cook of the National Research Council, whose address, in connexion with the Congress, is Hotel Vancouver, Vancouver, B.C., Canada.

Announcements

THE King has been pleased to appoint Sir William Cecil Dampier, fellow and sometime senior tutor of Trinity College, Cambridge, to be one of the Development Commissioners, in succession to the late Mr. Vaughan Nash.

BY an order of the Committee of Privy Council, Sir Thomas Lewis, director of the Department of Clinical Research in University College Hospital, London, has been appointed a member of the Medical Research Council in succession to Prof. J. J. R. Macleod, regius professor of physiology in the University of Aberdeen.

THE Melchett Medal for 1933 of the Institute of Fuel has been awarded to Sir John Cadman, chairman of the Anglo-Persian Oil Co., Ltd., and the Iraq Petroleum Company. The medal is an annual award for "original research or professional, administrative, or constructive work of an outstanding character, involving the scientific preparation or use of fuel."

IN view of certain changes in the administration of the Ministry of Agriculture of Brazil, the Directoria de Meteorologia will henceforth be entitled the "Instituto de Meteorologia, Hidrometria E Ecologia Agricola". Mr. R. P. Xavier retired from the position of director of the Brazilian Meteorological Service on March 6, and has been succeeded by Mr. C. de A. Martins Costa.

IT is announced by the Paris correspondent of the *Times* that the French Government has created a chair of mathematical physics at the Collège de France for Prof. A. Einstein. Special legislation was necessary and a Bill was prepared by the Ministry of Education and passed rapidly through the necessary stages in the Chamber of Deputies before the Easter recess. A few days earlier, the Madrid correspondent of the *Times* stated that the Spanish Minister of Education had announced the acceptance by Prof. Einstein of a chair in Spain and that, while the Government had made no precise conditions, it was thought Prof. Einstein would go to Madrid.

THE forty-fourth Congress of the Royal Sanitary Institute will be held at Blackpool on June 17–24, under the presidency of the Right Hon. Lord Cozens-Hardy. The Congress will be divided into the following sections: Preventive Medicine; Architecture, Town Planning and Engineering; Maternity, Child Welfare and School Hygiene; Veterinary Hygiene; National Health Insurance; Hygiene of Food. Conferences of representatives of sanitary authorities, medical officers of health, engineers and surveyors, sanitary inspectors and health visitors will also be held in connexion with the Congress. Particulars can be obtained from the secretary of the Institute, Mr. J. W. Dudley Robinson, 90, Buckingham Palace Road, S.W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior assistant in the surgical unit of the Welsh National School of Medicine (University of Wales), The Parade, Cardiff—The Secretary (April 25). A lecturer in civil engineering and building at the Portsmouth Municipal College—The Registrar (May 5). A dairy bacteriologist in the Department of Agriculture and Horticulture of the University of Bristol—A. W. Ling, Agricultural Advisory Office, 22, Berkeley Square, Bristol 8 (May 6). An assistant lecturer in engineering at the Cardiff Technical College—The Director of Education, City Hall, Cardiff (May 6). A lecturer in electrical engineering at the Chelmsford School of Art and Technology—The Clerk to the Governors (May 8). A lecturer in pathology to dental students in the University and pathologist to the Queen's Hospital, Birmingham—The Secretary, The University, Birmingham (May 15). A demonstrator in physiology at St. Thomas's Hospital Medical School (University of London)—The Dean of the Medical School (May 27).

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.*]

Remarkable Optical Properties of the Alkali Metals

I DESCRIBED in the *Philosophical Magazine*, about fifteen years ago, the high transparency for ultra-violet light of thin films of sodium and potassium, deposited by condensation at liquid air temperature, and their complete opacity for visible light. A resumption of the work has brought out some extraordinary properties.

A film of potassium, several wave-lengths in thickness, through which the sun is quite invisible, transmits about 25 per cent of the light included in the spectrum range 3000–1860 A.; the reflecting power from 3000 A. to 2700 A. is about 75 per cent, which means that practically no energy is absorbed, thick and thin films having equal transmitting power in this region. Below 2700 A. the reflecting power falls off very rapidly, soon reaching a value less than that of the bulb of fused quartz. But the most remarkable property is that interference bands are found in the spectrum of the reflected light. An end-on hydrogen tube was used as a source, and the film thickness increased by small steps, a spectrum being taken for each thickness. The dark bands entered from the short wave-length side and accumulated in the spectrum, orders so high as the fifth recording before the opacity became too great.

The filament of a tungsten lamp was invisible through a film which gave only two orders, the transmission of visible light being less than 1/100,000. Films of more than double this thickness gave very distinct interference bands, which means that the ultra-violet light, after two transmissions through the film, has still sufficient intensity to interfere with the light reflected from the first surface. The interference bands cannot be driven into the region above 2700 A., as the reflecting power of the first surface is too high to permit of interference, the bands being found only in the region of low reflectivity. In this region potassium has optical properties resembling those of selenium and the aniline dyes, the conducting electrons appearing to be without influence.

It seems probable that it will be possible to determine the dispersion in this region by the direct observation of the Brewsterian angle of polarisation, and experiments are now in progress along this line. All the alkali metals have now been examined, the transmission region moving down the spectrum as we pass from cæsium to lithium.

With cæsium the transmission band begins at about 4300 A., the films appearing of a blue-violet colour by transmitted light, of a purity equal to that shown by a strong solution of cuprammonium or dense cobalt glass. The film thicknesses are being determined by depositing a circular patch on the inner wall of a bulb, measuring its opacity to visible light and then opening the bulb and determining the amount of metal by titration with phenolphthalein. Experimental determinations of n and κ by the customary methods of metal-optics will be commenced shortly for the region of high reflecting power.

In the earlier work, it was reported that these films were unstable at room temperature, breaking up in a few minutes into globules and becoming almost perfectly transparent. I now find that if the quartz bulb is thoroughly out-gassed before the metal is distilled into it, the potassium films are permanent for several days, especially if moderately thick. A thin-walled quartz bulb with such a film makes a very useful filter for spectroscopic work; the sun's disc is invisible through it, yet we can photograph the solar spectrum through it with an exposure of only about four times normal exposure, the spectrum extending from a little above H and K to the extreme end. The transparency of such a film is nearly uniform as far down as the aluminium line 1862 A., and the lower regions are now being examined with a vacuum spectrograph.

R. W. WOOD.

Johns Hopkins University,
Baltimore.
March 20.

March 28.—Supplementing my letter of March 20 on the remarkable optical properties of the alkali metals in the ultra-violet region, I am now able to state that my prediction that potassium would show a Brewsterian angle of plane polarisation in the region below 2700 A. has been verified. The angle found for 2500 A. was 37°, which makes the refractive index $n = 0{\cdot}75$. I am not yet sure how accurately the angle can be determined, or how complete the polarisation is, but the intensity ratio of the two images obtained with a quartz Rochon prism was 1 : 120. The images had equal intensity in the visible and near ultra-violet.

Total reflection is thus to be expected for angles of incidence greater than 50°. This too was verified, at least in part, though I have not yet secured a sharply defined angle. At normal incidence the reflection at wave-length 2200 A. is of the order of 2 per cent, and the first few photographs taken indicate that a rather high value sets in for angles greater than 45°—though the increment seems to be gradual as the angle increases above this value. Better results are expected when more nearly plane reflecting surfaces are secured.

The angle of polarisation shows thus far no evidences of dispersion, which is perhaps to be expected, as the dispersion of the metal in the visible region is extremely small, as shown by Duncan, from measurement of principal incidence angles and azimuths.

Interference maxima and minima up to the fifth order appear in the spectrum of the reflected light between $\lambda = 2100$ and 3000 (not 2700 as reported in my earlier letter).—R.W.W.

Absorption Spectrum of Vitamin A at Low Temperatures

WE have been trying to devise more precise physical criteria for the recognition of biologically important molecules. Obviously, the only ultimate test for such a molecule is its action on living organisms. Physical tests can, however, be used as a guide to decide whether it is worth while to apply biological tests.

The physical criterion which has proved most valuable in this field is the absorption spectrum of the complex molecules, but this has nearly always been measured in solution at ordinary temperatures,

and has usually given broad structureless bands which frequently appear similar for different molecules.

At low temperatures the bands of many molecules develop a structure with a considerable amount of detail[1], since (i) the ground-states of the molecules are simplified by the elimination of all but those of lowest energy, and (ii) the blurring caused by the molecular fields of neighbouring molecules is reduced as these become quiescent. Both effects tend to diminish the width of the absorption bands and to bring out details of structure which cannot be recognised at atmospheric temperatures. These structured bands can be used as a much more definite discriminant than the continuous bands obtained at ordinary temperatures.

Thus, in the case of carotene dissolved in ethyl alcohol, the visible bands at

4790, 4440, and 4200 A.

become sharper and are displaced to

4990, 4670, and 4350 A.

whilst a fourth band appears at 4060 A. On the other hand, the ultra-violet band at 2700 A. becomes narrower, but it is not displaced and develops no structure.

This method of analysis has been used to discriminate between vitamin A and the product, giving a band near 3280 A., obtained by irradiating carotene[2] with the mercury line Hg 2650, under conditions which probably permitted the access of traces of oxygen. The two physical tests for vitamin A (the absorption band with its maximum at 3280 A. and the development of a blue coloration with antimony trichloride) did not discriminate between these two materials; but we now find that when concentrates of vitamin A are cooled to the temperature of liquid air, the maximum at 3280 A.* is displaced to 3350 A. and that new bands are developed at

2900, 2770, 2580, 2510, and 2430 A.

The last three were of low intensity. Identically the same structure was found in a B.D.H. concentrate and a concentrate from turbot liver oil, prepared by Dr. T. Moore. The detailed structure may conceivably be due to an impurity associated with vitamin A, but this difficulty cannot be completely excluded from any spectroscopic observations not made upon pure substances.

When the product obtained by irradiating carotene is cooled, the band near 3280 A. breaks up into a series of bands at

3780, 3570, 3410, and 3210 A.

The more precise spectroscopic test therefore shows definitely that the molecule produced by irradiating carotene is different from that associated with the band at 3280 A. in vitamin A concentrates.

We propose to extend this method of investigation, by cooling with liquid hydrogen in order to develop more fully the fine structure of the absorption bands of complex molecules.

F. P. BOWDEN.
S. D. D. MORRIS.
C. P. SNOW.

Physical Chemistry Laboratory,
Cambridge.
March 22.

* A faint subsidiary maximum at 3100 A. was also observed at ordinary temperatures for all the concentrates examined.

[1] L. B. Anold, Jr., and G. B. Kistiakowsky, *J. Amer. Chem. Soc.*, **54**, 5, 1713; 1932.

[2] F. P. Bowden and C. P. Snow, NATURE, **129**, 720; 1932.

Cultivation of Parasitic Nematodes

THE following is an outline of a method of obtaining large numbers of the larvæ of nematodes parasitic in sheep in media the composition of which can be much more accurately controlled than any that have hitherto been used. Experimental work on these organisms should throw light on the physiology of nematodes and be of great assistance in the treatment and control of these parasites.

(1) Obtain eggs from the fæces, or contents of the large intestine of sheep, by placing these in a cone shaped sieve and passing water through this into a large jar, stirring all the time. Allow the contents of this jar to settle, pour off the fluid, and repeat two or three times. Mix a portion of the final sediment with an equal quantity of a solution of sugar 1 lb., water ¾ pint, formaldehyde 1 per cent. Fill a narrow-mouthed vessel rather overfull with this and cover the top with a large cover-slip, taking care that there are no air bubbles left. After 12 hours or so, remove the cover-slip, and wash off the eggs floated up on it to a clean tube[1].

Another method is to obtain female worms from the fourth stomach and intestines of sheep, and to set free the eggs by breaking up the worms in a mortar with a little water. By this method the easily-obtained species *Graphidium strigosum*, common in the stomach of English wild rabbits, or *Trichostrongylus retortæformis* in the duodenum, give excellent cultures. Eggs obtained in this way do not hatch so well, probably because fewer are mature.

(2) Wash the eggs in a centrifuge three or four times in sterile water to remove sugar solution and debris.

(3) Treat for 30 minutes with 5 per cent Antiformin in 10 per cent formaldehyde[2]. Experiments are being done here on various other and less drastic antiseptics.

(4) Wash six times in sterile distilled water.

(5) Sow the eggs into sterile Petri dishes in which is a layer not more than 3 mm. deep of plain broth 1 part water 10 parts. Simpler media are now being devised.

(6) Inoculate each dish with a loopful of *B. coli*. It is possible that the larvæ will not develop on some strains of this organism. The strain used in this laboratory has been obtained from the intestines of the parasitic stages of the larvæ themselves.

(7) Leave the dishes at 18°–20° C. preferably in the dark or in the shade. Third stage infective larvæ, enclosed in their characteristic loose sheaths (which are the cast skins of the second stages which have not been thrown off) will be present in 6–10 days. The hatching of the first stage larvæ can be quickened by incubating the cultures, but this may also cause too rapid a growth of the *B. coli* and is not necessary.

Thousands of free-living stages of the larvæ can be so obtained and should be excellent subjects for experimental work. The number of larvæ obtained is limited only by the number of eggs used.

(8) The first parasitic stages can be obtained by placing the third stage larvæ in a 1 in 20 dilution of 'Milton'. They ex-sheath in 20 minutes or less at laboratory temperature. Stronger solutions damage or kill the larvæ. Other solutions containing hypochlorite will also induce ex-sheathing, but I have found the above to be best, because it remains stable, and ex-sheathed larvæ will live three or four days in the dilution of 1 in 20. Hypochlorite appears to be essential, chlorine failing to cause ex-sheathing.

(9) This 'Milton' solution also sterilises the larvæ

and kills the *B. coli*, so that these first parasitic stages can be put into sterile media, of whatever composition the worker desires.

(10) More than two hundred media have so far been tried in attempts to cultivate these ex-sheathed larvæ further, but so far no method has been found of inducing them to cast the next sheath and so become fourth stage larvæ. Experimental work is needed to find out the conditions required for this.

It is impossible in a brief letter to indicate the innumerable problems which have arisen during the working out of this method, but I should be glad to supply further details to anyone interested. There are also many interesting problems for the study of which the 'adult' nematodes parasitic in sheep might be used, rather than such relatively specialised species as *Ascaris*.

GEOFFREY LAPAGE.

Institute of Animal Pathology,
Cambridge, March 11.

[1] Wood, Second Rep. Direct. Inst. of Animal Path. Cambridge, 1931, p. 204.
[2] McCoy's method, *Amer. J. Hyg.*, 11; 1930. An important paper, giving the results of its author's experimental work by modern methods on eggs and larvæ of *Ancylostoma caninum*.

Anode Spot in a Neon Tube

WHILE studying the phenomena of the moving striation and anode spot in a discharge tube filled with neon, our attention was directed to the fact that the anode spot is intermittent in its emission, with a rhythmic fluctuation in its intensity.

A photograph taken by a falling plate camera is reproduced in Fig. 1, while Fig. 2 shows another plate taken in a similar way but with the portion near the anode more magnified. In Fig. 1, + and − denote anode and cathode respectively, which were about 17·5 cm. apart. The discharge tube was a straight one 4 cm. in diameter. It was filled with pure neon at a pressure of a few centimetres and was excited

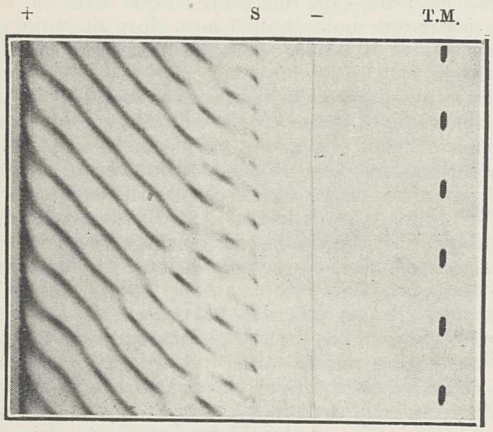


FIG. 1.

by a 2 kw. direct current generator giving 1,200 volts, the current in the tube being 190 ma. T.M. are the time marks, with an interval of 1/800 sec.

As will be seen in Fig. 2, the image of the anode spot, which was single in this case, is discontinuous in its emission. In fact, we see a series of luminous dots gradually increasing in its intensity, until, near the maximum intensity, one layer of the moving striation is detached from the anode and proceeds toward the cathode. The process is repeated at an interval of about 1/1160 sec. In the case shown in Fig. 1 the velocity of the moving striation, at the middle of the positive column, is about 30 metres per second.

Another point of interest seen in Fig. 1 is the rhythmic fluctuation in the intensity of each of the moving striations. Apparently, the intensity of each stria decreases as it approaches the cathode, until it begins to appear on the plate as discontinuous strips. Near the end of the positive column, a small luminous sphere is seen which is detached from the uniform positive column. The luminosity of this sphere (marked S in Fig. 1) is also found to be intermittent, with an interval of 1/1880 sec.

The remarkable regularity in the arrangement of

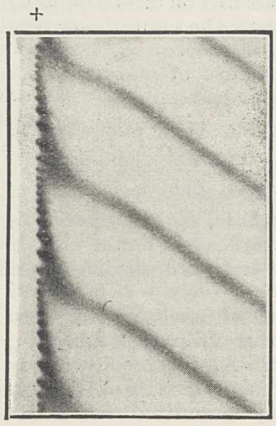


FIG. 2.

the strips in Fig. 1 would seem to suggest that there may be an interference between the moving striæ and some kind of disturbance regularly coming against it from the cathode.

As the anode spot is in fact the starting point of the moving striation, the closer investigation of its change with time may be of significance in the study of discharge through gases.

The details of the experiment will be published in the Scientific Papers of this Institute.

T. TAKAMINE.
T. SUGA.
A. YANAGIHARA.

Institute of Physical and Chemical Research,
Komagome, Hongo-ku, Tokyo.
Jan. 23.

Rôle of the Solvent in Electrolytic Dissociation

IN a recent paper[1] Sir Harold Hartley and Mr. O. L. Hughes bring forward evidence for the view that "solvation (of ions) is a *statistical* process, the relative amounts of the two kinds of molecules (in non-aqueous solutions containing small quantities of water) being roughly proportional to the concentrations in which they are present in the solution". This view is supported by the work of Butler[2], who found that, although lithium chloride in alcohol–water mixtures is solvated preferentially by water, solvation by water is not an exclusive process.

Sir Harold Hartley goes on to interpret the degree of association of electrolytes in terms of (1) the size of the solvated ions, considered as rigid structures the motion of which obeys Stokes's law, and (2) the distance of approach of oppositely charged ions below which, according to Bjerrum's formula[3], the number of ion-pairs (consisting of solvated ions) increases rapidly.

In the light of the aforementioned ideas about solvation, is this treatment free from objection? On the statistical view of solvation, the solvent shell around an ion cannot be a rigid structure. An individual solvent molecule can leave it and its place be taken by another molecule or perhaps by an oppositely charged ion. Consequently the solvent shell of an ion does not act as an impenetrable barrier to other ions and undissociated molecules of the kind which occur in vapourised strong electrolytes at temperatures such as 2,000° C. can be formed. The size of the solvated ion is not of prime importance. The deciding factors are the free energies of the systems (1) cation and anion solvated to average extent and (2) undissociated molecule, possibly solvated as well. That solvation of an undissociated molecule may be a factor comparable with solvation of an ion can be shown by an approximate calculation for a dipole similar to that of Born for an ion[4].

The larger ionic radius in non-aqueous media often given by Stokes's law[1,5] may be due to the solvent molecules being larger and hence the solvated ion larger, although the energy of solvation may be less than in water and the solvent shell may even contain a smaller number of molecules.

Chemistry Department, A. R. MARTIN.
University of Aberdeen.
March 25.

[1] Hartley and Hughes, *Phil. Mag.*, **15**, 610; 1933.
[2] Butler and Shaw, *Proc. Roy. Soc.*, A, **129**, 519; 1930.
[3] Bjerrum, see Falkenhagen, "Elektrolyte", p. 257, Leipzig, 1932.
[4] Martin, *Phil. Mag.*, **8**, 547; 1929.
[5] Davies, "Conductivity of Solutions", p. 183, London, 1930.

Dimensions of Fundamental Units

PROF. CRAMP has proposed[1] that the dimensional expressions for the electrostatic and electromagnetic units may be simplified by regarding quantity of electricity Q as fundamental. To my reply[2], that including Q would cause confusion because, whereas M, L and T are quantities which vary with the velocity of the observer, Q is invariant, Prof. Cramp's[2] rejoinder is the question: How it is known that Q is invariant? The invariance of the charge carried by a moving particle is, I believe, generally accepted. A simple proof of the consistency of this invariance with the special principle of relativity is given in N. R. Campbell's "Modern Electrical Theory", p. 361.

Prof. Stansfield[3] makes a plea for the simplification introduced by regarding k and μ as mere numerals. I agree with Prof. Stansfield, but in order to make this point of view logical, I think that we must regard 'magnetic pole', m, as a unit derived from 'electric charge', Q, rather than as an independent unit.

The hypothesis tentatively accepted in physics is this, that there are in the physical world two fundamental factors, namely, positive charges ('protons') and negative charges ('electrons'). Each of these is a symmetrical radial field of unlimited extent. The lines of flux of the proton are directed radially outwards, those of the electron radially inwards. The lines possess 'tension' and also 'mass per centimetre', the magnitudes of which agree (in analogy with $v = \sqrt{F/m}$ for the transmission of transverse disturbances along a stretched string) with the fact that transverse disturbances are transmitted along the lines with the velocity, c, of light. Fluxes similarly oriented show mutual lateral repulsion; those oppositely oriented show attraction. Vectorial combination of fluxes permits the resultant forces to be expressed in terms of the tensions in the lines. When electric fluxes are in relative motion, laterally, the 'charges' from which they emanate exert mutual forces on account of this relative motion, namely, the charges are mutually repelled when their laterally approaching fluxes are oppositely oriented, and are mutually attracted when the fluxes are similarly oriented. Experiment shows that the magnitude of these forces depends on the relative lateral velocity of the fluxes.

In empty space the law of force between charges Q and Q^1, at rest, d cm. apart, is $f = Q \times Q^1/d^2$. Usually, however, the space is not empty but contains some medium, that is to say, it contains protons and electrons. These exert forces on Q and Q^1 and the resultant apparent mutual force between Q and Q^1 is not $(Q \times Q^1)/d^2$ but is $(Q \times Q^1)/kd^2$, where k is a *numeral* intended to take account of the 'nature of the medium'.

The force between charges, resulting from relative lateral motion of their fluxes, involves Q, Q^1 and d and, in addition, the velocity of relative lateral motion. This force is called 'magnetic'. Its value, for two moving fluxes due to charges in empty space, involves only Q, Q^1, d and the relative velocity v of lateral motion of the fluxes, but in space which is not empty but contains a medium, the apparent mutual force between Q and Q^1 is due, partly, to the action on the fluxes of Q and Q^1 of the fluxes due to moving protons and electrons in the medium.

A 'unit magnetic pole' is a fictitious thing. There are no known means of producing such a field of flux as a unit pole is imagined to produce. The notion of such a pole is useful, however, because we can produce by means of currents (that is to say, by moving charges) effects (locally) such as poles ought to produce. This means, I think, that we assume the meaning of the equation $f = (m \times m^1)/\mu d^2$ to be the same as that of the equation $f = (Qv \times Q^1 v)/\mu d^2$ where μ is a numerical constant taking into account the presence of moving charges within the medium, and v is the relative velocity with which two like charges must move past each other in order that their 'magnetic' repulsion shall equal their 'electrostatic' repulsion. Experiment has shown that this velocity is c, the velocity of light.

If then we write Coulomb's laws, $f = (Q \times Q^1)/kd^2$ for charges and $f = (Qc \times Q^1 c)/\mu d^2$ for magnetic poles, we find that the nature of a charge, Q, may be expressed either as $k^{\frac{1}{2}} d f^{\frac{1}{2}}$, using the E.S. system of units, or as $\mu^{\frac{1}{2}} d f^{\frac{1}{2}} c^{-1}$, using the E.M. system, the ratio of the two expressions being c, the velocity of light.

From this simple point of view, which I think is sound, we must regard both k and μ as mere numerals, and 'pole', m, not as an independent unit but as equivalent to the product $Q \times c$. Always we measure a thing by its effects. Charge has two ways of producing the same effect. A charge Q at distance d from a like charge repels that charge *electrostatically* with force f if the charges are at rest, or *magnetically* with the same force f if the charges have relative lateral motion of c cm. per second.

F. M. DENTON.
Department of Electrical Engineering,
University of New Mexico,
Albuquerque.
Feb. 12.

[1] NATURE, **130**, 368, Sept. 3, 1932.
[2] NATURE, **130**, 892, Dec. 10, 1932.
[3] NATURE, **131**, 59, Jan. 14, 1933.

Boundary Tides in the Kattegat

In order to facilitate observations on the vertical movements of the boundary surface far from the shore a recording boundary gauge has been constructed. A commercial steel barrel of about 200 litres capacity used for kerosene was provided with an axial tube of two inches width running through the barrel and having its ends welded to the flat ends of the barrel. Thick glass rings inserted at both ends of the tube serve to reduce friction against a vertical guide, 25 metres in length, of phosphor-bronze wire rope, which runs straight through the tube. The wire rope has its upper end attached to a large buoy, which is kept five metres below the surface by means of a double anchorage[1], a heavy weight attached to the wire rope at its lower extremity keeping it vertical and well stretched. The barrel is thus free to move in a vertical direction between depths of 6 and 30 metres.

The barrel, filled partly with large spherical glass floats, partly with fresh water, was hermetically closed and finally balanced with the recording instrument and with an additional load, so as to be in equilibrium in sea-water of the density 1·022. This is the average density of the water at the boundary surface in the central Kattegat, where two or three such instruments were kept anchored during several weeks of the fall of 1932. By means of a precision pressure gauge attached to the barrel, its varying depth, which may be taken as equal to the depth of the boundary, is recorded on a large drum turned by clockwork, which runs for three weeks or more. An automatic record of the boundary waves is thus obtained, which it would otherwise require continuous hydrographic soundings from ships anchored at the points of observation to realise. Moreover, the boundary gauges also draw their records under weather conditions which would make observations from anchored ships impracticable.

The records prove that very considerable wave-like movements of the boundary round its average depth at about 17 metres were going on the whole time the instruments were working. The total depth at the anchored systems varied between 40 and 60 metres. Waves of a semidiurnal period between 11 and 13 hours from crest to crest, with a maximum height of about 6 metres, were conspicuous in the diagrams. These waves attained their largest amplitude about full moon and new moon, but there were also considerable variations in amplitude apparent over shorter intervals of time.

A harmonic analysis carried out on a fortnight's record gave an amplitude of the semidiurnal lunar tide in the boundary of ± 0·6 metres (the M_2–component tide), and of the semidiurnal solar tide ± 0·2 metres (the S_2–component tide). The surface tides in the Kattegat are much smaller; thus at Varberg the amplitude of M_2 in the surface is ± 0·038 metres and of S_2 ± 0·01 metres. The amplitudes of the tidal components in the boundary brought out by analysis, however, only account for a fraction of the maximum height of the boundary waves in our records.

Boundary waves of semi-diurnal period were first discovered in the Great Belt in 1907 by Otto Pettersson and have since then been recognised at other localities and also in the open sea by other observers. Local variations in the amplitude of the waves revealed by our records seem to support Zeilon's theory, that topographical features of the sea-bottom play an important part at the generation of the boundary waves.

It is of interest to note, that 'inertia currents' similar to those found from current measurements in the central Baltic (see the accompanying letter by Gustafson and Kullenberg), appear also to influence the boundary movements in the Kattegat. An analysis of one of our curves carried out with periods varied by steps from 13·9 to 14·5 hours gave a very distinct maximum of amplitude ± 0·3 metres for the sine curve with a period of 14·3 hours, which is equal to 12 pendulum hours at the latitude of the anchored systems : $\varphi = 57° 15'$ N. Analysing shorter fractions of 6 × 14·3 hours, the amplitude of the same sine curve occasionally rises to ± 0·7 metres, and the phase as well as the amplitude undergoes irregular variations, such as may be expected from waves set up by extraneous forces.

It is suggested that boundary gauges of the type here described suspended from ships, either drifting or at anchor, may be used for the study of such short period boundary waves, as were observed in the central Atlantic Ocean during the *Meteor* expedition.

Hans Pettersson.
Börje Kullenberg.

Bornö Station.
Feb. 8.

[1] Nature, 115, 639, May 2, 1925.

Inertia Currents in the Baltic

Theoretically, a particle moving without friction on the surface of a rotating planet should describe a circular path in the course of twelve 'pendulum hours', that is, with a period given by $T = \frac{\pi}{\omega \sin \varphi}$ where ω is the angular velocity of the rotation and φ is the latitude. It is generally assumed, that these movements are insignificant compared to the currents actually existing in the ocean.

In the course of Swedish investigations on the downward spread of the wind-current, carried out by means of recording current-meters suspended from large buoys, which were kept well below the surface by means of double anchorage, currents, apparently of the inertia type, were recorded near the surface in the central Baltic, lat. 56° 44′, long. 19° 37′, depth of observation 17 metres, total depth 136 metres. Beside a current of nearly steady direction set up by the wind, there was a current component turning clock-wise at the rate of 24° 6′ an hour. This rate remained practically constant for several days, so that altogether fifteen revolutions were made in about eight days. A strong wind blowing for some thirty hours in the middle of the observations produced a change of phase in the rotation, but the angular velocity before and after the break remained the same.

When the residual current was strong, the rotating current caused periodic variations in its velocity and direction, but when it was weaker than the rotating current, as was generally the case, the resultant current described spirals, which soon approached to an almost circular movement.

The period of the rotating current is on an average 14½ hours, whereas 12 pendulum hours at this latitude amount to a value slightly less or 14·3 hours. Measurements at different depths, from 11 to 22 metres, and at different points in the same locality, gave practically the same results.

A natural interpretation of these results would be,

that in the Baltic, where tidal movements are very small, the wind current, as the wind abates, gradually degenerates into a circular, or rather a spiral, movement of decreasing amplitude, the diameter of the paths of the water-particles varying from some 3 kilometres downwards. It appears likely, that similar 'inertia currents' are also to be found in the sea, at least where the tidal movements are not too strong to obscure them completely. An examination of current-records from the west coast of Sweden is being undertaken with this purpose.

TORSTEN GUSTAFSON.
BÖRJE KULLENBERG.

Bornö Station.
Feb. 8.

Factors Controlling Date of Spawning in Frogs

IN NATURE of April 8, p. 521, reference is made to the factors which determine the time of spawning of the common frog, *Rana temporaria*.

Through the courtesy of the Royal Meteorological Society, I have been enabled to utilise the voluminous data contained in the Society's Phenological Reports for the investigation of this matter. The results, it is hoped, will shortly be ready for publication, but since the matter has now been raised, it may be of interest to state briefly that frogs are scarcely at all affected by the weather at the time of spawning, or that immediately preceding, but there is a close relation between the mean temperature over a long period prior to spawning and the mean date of spawning in a district. For example, within fifty miles of London, only a few cases of spawning usually occur in February, and March is the usual spawning month, most reports being about the middle of the month. I have calculated a correlation co-efficient of $-0{\cdot}77$ between the mean temperature at Kew for *February* and the mean spawn date for the area. The effect of March temperature is perceptible if one employs a weighted mean, allowing for the distribution of the spawn dates over the period, but it is much smaller. The only important effect of the weather at the time of spawning seems to be the break in the normal sequence of spawning caused by a very cold 'snap'.

R. MAXWELL SAVAGE.

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Early History of the British Solomon Islands

SEVERAL references were made in the Calendar of Geographical Exploration published in NATURE last year to the Solomon Islands, and the following notes on their early history may be of interest.

The Solomon Islands lie some five hundred miles east of New Guinea and were discovered on a voyage from Callao, Peru, in 1568 by the Spaniard, de Mendaña. After naming most of the larger islands during a six months' cruise, the two frigates returned to South America.

Mendaña named the islands after King Solomon with the idea of attracting colonists to search for gold and treasure. However, it was not until thirty years later that a second expedition of four ships set sail but failed to find the Solomons proper, arriving instead at Santa Cruz Island to the east, where a brief settlement was made until Mendaña's death in October 1595. The survivors (only three ships arrived) under the Portuguese navigating officer de Quiros made an attempt to reach San Cristobal, previously discovered in 1568. Not only were they unsuccessful in locating it, but they also failed to strike any land before the Philippines, whence they sailed for Peru.

For nearly two centuries nothing was known of the Solomons until Capt. Carteret in the *Swallow* rediscovered Santa Cruz and Malaita in 1767, without however landing anywhere. Next year came the French navigator de Bougainville, followed by de Surville (1769), Maurelle (1781) and Shortland (1788).

The climax of eighteenth century navigation was the shipwreck of two frigates under La Perouse which reached Vanikoro, Santa Cruz, in 1788, but about which nothing was known for forty years until Dillon, in command of the East India Company's *Research*, found proof in 1827 of their fate.

By this time whalers and traders, the latter in search of bêche-de-mer, sandal wood and tortoise-shell, had already begun the nineteenth century commercial exploitation of the tropics.

R. J. A. W. LEVER.

Tulagi,
British Solomon Islands Protectorate,
Jan. 20.

A New Alloy, 'Stainless-Invar'

INVAR, invented by Ch. Ed. Guillaume in 1896, has a small coefficient of thermal expansion, about $1{\cdot}2 \times 10^{-6}$. Since then, no better invar has been obtained. I have, for the last six years, been engaging in the investigation of alloys having a small coefficient of expansion and obtained in June, 1929, an alloy[1] containing about 63·5 per cent iron, 31·5 per cent nickel and 5 per cent cobalt, which has a smaller coefficient of expansion than that of fused silica.

Several explanations of the small expansibility of invar have been proposed, but none can be considered to be satisfactory. I also tried to explain this phenomenon and developed a new theory[1] by which the small expansibility of invar can be satisfactorily explained from magnetic data. Following up this theory, I began to investigate the thermal expansion of the ternary alloys of iron-cobalt-chromium and found that an addition of a small quantity of chromium to iron-cobalt alloys containing more than 50 per cent cobalt considerably reduces their expansibility. In July, 1931, I obtained an alloy having a much smaller coefficient of expansion than that of fused silica. For example, the coefficient of linear expansion at ordinary temperature of an alloy containing about 36·5 per cent iron, 54·5 per cent cobalt and 9 per cent chromium is less than 10^{-7} in the annealed state, and that of another alloy having a very similar composition to the above has even a negative coefficient amounting to $-1{\cdot}2 \times 10^{-6}$. These alloys are so resistant to corrosion that polished surfaces can be left for several months in a moist atmosphere, water, sea water, etc., without showing any rust spots; they have been called 'stainless-invar' (Hakar Masumoto).

KÔTARÔ HONDA.

Research Institute for Iron,
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March 10.

[1] *Sci. Rep. Tôhoku Imp. Univ.*, **20**, 101; 1931.

Research Items

Ethnology of Manihiki and Rakahanga, Cook Islands. Te Rangi Hiroa (Dr. P. H. Buck) has published as a separate monograph (Bull. 99, Bernice P. Bishop Museum), that part of the material collected by him on the Cook Islands expedition which was derived from the two atolls Manihiki and Rakahanga. The special interest of this investigation lies first in the fact that the people of the two atolls were one, passing as a body from one atoll to the other when forced to migrate by the depletion of the stock of coco-nuts and taro, until 1852 when the practice was stopped, owing to the loss of life in transit, and the community split into two; and secondly, because the original settlers were a single biological family—a fact which has had a marked effect on social organisation and tradition. According to tradition, the atolls were discovered by Huku of Rarotonga, who later settled his sister and her husband Toa on them. No priests came with the settlers; and in consequence the traditions and mythology are defective, the genealogical records poor in extent and detail—the primary parents are not remembered—and for seven generations the people had no gods. Family genealogies give a period of about 550 years from the first settlement, this agreeing with the date of the last migration to New Zealand. Owing to the peculiar circumstances of the settlement, Toa, in order to secure a male heir, married each of his four daughters and his granddaughter in succession, sons being born of the last two unions only. Male descent is all-important in the succession to rank and title, otherwise descent is bi-lateral; but more importance is attached to male descent, unless the mother comes of the more important lineage. After the people had been without gods for seven generations, two gods were introduced from another island.

Bitumen in Embalming. From the time of Herodotus onwards, the tradition has been that the Egyptians made use of bitumen, mainly from Judæa, in embalming; but since 1908, Mr. A. Lucas, of the Government Laboratories, Cairo, has contended in a series of papers that bitumen did not come into use for this purpose before the time of the Ptolemies, and that even though it might have been used for this purpose then and afterwards, he had found no evidence of it. For his evidence he relied on solubility tests and on sulphur content, in which Judæan bitumen is high, as well as characteristic smell, fluorescence and the colour and appearance of substances extracted by solvents. Dr. Percy E. Spielmann has now applied the tests of fluorescence and spectroscopic analysis of the ash to certain samples (*J. Egypt. Arch.*, **18**, pts. 3–4). While bitumen gives no trace of fluorescence, samples of resin show colours averaging round a strong yellow ochre. In the spectroscopic analysis, vanadium and nickel, accompanied by molybdenum, were the predominant components in the bitumen ash; but on the other hand the resins show only the faintest trace of these metals, so that they could be used for detecting the presence of bitumen. When applied to Egyptian material—from a cranial cavity (Ptolemaic), a head (Ptolemaic), and bones from the junction of ribs and spine—it was found that there was strong evidence, with certain reservations, for the presence of bitumen in two of the three samples examined. A similar examination made with wood-tar, a material the presence of which Lucas had definitely identified, suggested that the metal-free wood-tar would be just the substance to act as a diluent for both the bitumen and the resin, thus accounting for their presence in embalming material in relatively low proportions. It seems clear, however, that bitumen was used in embalming, mixed with wood-tar and resin.

Vital Capacity and Occupational Characteristics. "Physiological Standards and Occupational Characteristics of Bodily Functions of the Japanese" by Tomoyosi Isikawa (Reports of the Institute for Science of Labour, Kurasiki, Japan) gives the results of measurements of vital capacity in nearly 8,000 Japanese ranging from four to eighty-two years of age. The aim of the investigation was to obtain some standard of physical fitness as an aid to vocational guidance. A modified Hutchinson's spirometer was used for measuring the children and students, and Verdin's centilitre spirometer was used for the adults. Vital capacity in the Japanese appears to increase rapidly up to sixteen years of age and then rises slowly to a maximum between 25–29 years in males and 30–34 years in females. Compared with some European and American data, the Japanese, especially the women, have a low vital capacity. The average measurement for 875 males aged 15–81 years was 3,213 c.c. while for 562 females aged 15–71 years the mean was only 1,964 c.c. Some attempt was made to assess vital capacity in various types of occupation but in most instances the numbers in the groups were too small to give any reliable figures. There is some indication that those engaged in light or sedentary work tend to have a low vital capacity. Dr. Isikawa would be well advised to refer to English reports on vital capacity by Greenwood, Newbold and Cripps in which the difficulties of establishing a standard of physical fitness are carefully discussed. These authors concluded that the inherent variability of vital capacity, even within homogeneous groups of apparently healthy persons, is so great that the fixation of a normal standard is impossible.

Californian Sponges. Mr. M. de Laubenfels has recently described the sponge fauna of the western coast of the United States (*Proc. United States Nat. Mus.*, **81**, No. 2927, Art. 4. Smithsonian Institution, 1932). Six out of a hundred and one species discussed are new and three new genera and five new varieties are established. Very little literature on Californian sponges has been published, therefore this work is specially welcome, containing as it does, in addition to the systematic parts, extensive notes taken in the field whenever possible on the living sponges. To mention but a few of these interesting observations there is the description of *Spheciospongia confederata* de Laubenfels, the largest sponge in the world (the author having frequently found examples nearly a metre across and mentioning a definite record of one of nearly three metres), and remarkable for its changes of colour when transferred from its original habitat. *Mycale bellabellensis* (Lambe) is also very large, funnel-shaped with a height of at least 100 cm. and a diameter of 122 cm. Many of the species are beautifully coloured, rich brown, red, yellow and blue when alive. In one case at least the deep blue colour is due to symbiotic organisms in the ectosomal

regions. A species of *Gellius* grows abundantly on the floor of a cavern just below low tide, a most unusual habitat.

Phylogeny in the Genus *Oenothera*. Since the investigation by de Vries of feral *Oenothera Lamarckiana* in Holland the genus of the evening primroses has been studied from many points of view in Europe and in the United States. Prof. R. Ruggles Gates (*J. Linn. Soc. Bot.*, 44, 173; 1933) considers the evolution of the section *Onagra*. A table of the known North American species is given and another summarises investigations of the genetic complexes and chromosome catenations in those species which have been cytologically examined. It is suggested that the subgenus *Onagra* was derived from the large-flowered subgenus *Raimannia* in Central America and that a series of dominant mutations occurred as the genus spread northwards with the retreat of the ice at the end of the last ice age. Interspecific crossing played an important part in the development of the subgenus, as a result of which most of the species are permanent crypthybrids composed of two complexes and breeding true because of catenation (linkage of their chromosomes) during meiosis. Hybrid vigour may well have led to survival and spread of such species. There is evidence that dominant mutations giving rise to smaller flowers have appeared independently and successively in different parts of the Continent from different lines of descent. Species and varieties with cruciate petals constitute another series of independent parallel mutations. It is urged that while interchange of segments between non-homologous species (internal hybridisation of Lotsy) will account for the appearance of a certain number of new types, its value as an evolutionary factor is limited in comparison with the importance of interspecific crossing and the regular occurrence of gene mutations in the hybrid swarm. Two new species are described and figured.

Age of the Andes in Ecuador. A paper on "New Fossil Fresh Water Molluscs from Ecuador" (*Proc. U.S. Nat. Mus.*, No. 2946; 1932) by W. B. Marshall and E. O. Bowles deals with a collection made by Dr. George Sheppard in the Cuenca district of Ecuador, and it includes three new genera, each represented by a new species. The genera have been named *Sheppardiconcha*, *Potamolithoides* and *Ecuadorea*. In regard to the age of these fossils, all of which are of fresh-water habitat, the authors conclude that it "cannot be later than Pliocene, and it may be earlier". According to Dr. Julia Gardner, the discovery of these fossils in the Azogues Sandstone of Ecuador is "apparently a confirmation of the theory indicated from an earlier collection from Peru that the ancestors of the recent fauna of the lower La Plata are to be found near the headwaters of the Amazon, where they lived before the divide between the Amazon and the La Plata was established". The discovery of late Kainozoic fossils in the sediments of this interandine region of Ecuador proves the existence of a continental facies of the Kainozoic rocks in this part of the world, which is almost certainly homotaxial with the marine beds of the coast-belt, and assists in the elucidation of the many tectonic problems which are associated with the uplift of the Andes in the same region. As the Azogues Sandstone, the principal formation occupying the Cuenca Basin, and in which the fossils above referred to were found, are folded into fairly steep and symmetrical anticlinal folds with a north and south trend, it is apparent that this structural movement must have post-dated the age of the included fossils of the stratified deposits, and hence may be post-Pliocene.

Humidity Tables. Messrs. Negretti and Zambra have recently placed on the market for the price of 3*s*. 6*d*. a set of tables of relative humidity for use with artificially ventilated wet and dry bulb hygrometers. The range of temperature is from 100° F. to 212° F. Dry bulb readings are set off on the left hand side of the table in steps of 2° F., and the depression of the wet bulb to the right, also in steps of 2° F. The tables are printed on both sides of a celluloid tablet which measures about 5 in. × 3½ in. There is a leatherette case to protect the tablet from damage when not in use. The figures have been derived from centigrade tables published by the National Physical Laboratory and these have been extrapolated to give a greater range. This completes a series of four similar sets of hygrometer tables, two on the Centigrade scale, with upper limits of 50° and 100° C., and two on the Fahrenheit scale, one ranging from 20° F. to 120° F. and the other, as described above, from 100° F. to 212° F. They agree closely with the Assmann and the U.S. Bureau of Standards Humidity Tables. The arrangement of the figures is convenient, and the printing is not only very clear on the sample specimen but is also deep enough to ensure continued clearness even with constant use. At the highest temperatures on the Fahrenheit scale a depression of the wet bulb of 78° is provided for, the corresponding relative humidity at 194° F. being so low as 11 per cent.

X-Ray Investigation of the Copper-Aluminium Alloys. A. J. Bradley and Phyllis Jones have re-examined (March meeting of the Institute of Metals) this system using the powder method. They confirm that the body-centred β-phase cannot be retained by quenching, and show that, contrary to the opinion of Obinata, a homogeneous β′-structure is invariably produced, which appears to be closely related to that of the face-centred α-phase. Alloys quenched in the γ-range are indistinguishable from the δ-alloys. Up to 19 per cent aluminium, the structure of δ-CuAl is essentially of the γ-brass type, photometer measurements leading to the formula Cu_9Al_4. The modification of the δ-phase beyond 19 per cent noted by Westgren is confirmed. In this δ′-phase (19–22·5 per cent aluminium), the number of atoms in the pseudo-cubic cell falls from 52 to 49. On quenching a two-phase alloy with 22·8 per cent from 700° C., the single ε-phase is obtained, which appears to be cubic. Between this composition and 29 per cent of aluminium, the annealed alloys show many types of structure, the η-phase consisting, therefore, of a number of phases of small range of stability, or one or more of gradual modification. Friauf's structure for the θ-phase, $CuAl_2$, is confirmed and it is also confirmed that this phase has not a unique composition.

Wilson Photographs of Cosmic Ray Phenomena. A full account of the results obtained by Blackett and Occhialini with their cloud-chamber photographs of cosmic ray phenomena has appeared (*Proc. Roy. Soc.*, March). The experiment has been described in a letter to NATURE (130, 363, Sept. 3, 1932). The Wilson chamber is placed with its axis horizontal

in a magnetic field of about 3,000 gauss, and the mechanism of the chamber is operated whenever there are simultaneous discharges of two Geiger-Müller counters placed above and below the chamber. Some of the photographs show single tracks passing through the chamber, but in many cases there are 'showers' of tracks numbering up to twenty or so. Similar showers have just been reported by Anderson (*Phys. Rev.*, March 1). Many of the particles appear to diverge from a single point inside or outside the chamber—in some cases ten or more such radiant points can be detected. Many of the tracks are not appreciably bent by the magnetic field; some tracks are apparently due to electrons, and others seem to require for their explanation a particle of approximately electronic mass with positive electrical charge. The direction in which the tracks are bent by the field indicates a positive charge if we accept very strong evidence of the direction of motion. The ionisation along the tracks is then found to be far too small for a particle having proton mass and charge and the experimentally found magnetic deflection ($H\rho$). The ionisation is comparable with that in an electron track of similar $H\rho$. The existence of a positive electron in cosmic ray track photographs, which has also been suggested by Anderson, is therefore very probable. The suggestion of the authors is that the positive and negative electrons are created by a collision process, and that they may perhaps be identified with the "quantum states of negative kinetic energy unoccupied by electrons" postulated by Dirac. These particles should have only a short life; they can be annihilated by a negative electron jumping into the unoccupied state, the energy being converted into radiation. The calculated lifetime of these positive electrons is not inconsistent with observing them in the cloud chamber. Protons and heavy particles generally seem to be infrequent and perhaps absent in the cosmic ray photographs.

Hydrogen Isotope. G. N. Lewis has described some preliminary experiments in which water containing a large proportion of the hydrogen isotope H^2 has been obtained (*J. Amer. Chem. Soc.*, March). When ordinary water is electrolysed, the heavy isotope accumulates in the residue, and water of specific gravity 1·035 was obtained, containing one-third of its weight of the heavy isotope. The refractive index of this water is considerably lower than that of ordinary water, and it is considered probable that the chemical properties of compounds containing H^2 will be very different from those of ordinary hydrogen compounds. Other communications from the United States show that measurements in the Bureau of Standards indicate that heavy water freezes when surrounded by melting ice, its freezing point being 0·05° C. above zero. Its boiling point is higher than 100° C.

Astronomical Topics

Nova of March 20. A preliminary announcement of the discovery of this nova appeared in Nature of April 15, p. 553. Dr. Kukarkin, of Moscow, states in U.A.I. Circ. 434 that he has found three images of this star on old Moscow plates; on 1899 March 14 its magnitude was 14·1; on 1900 March 21 it was 13·8; on 1907 February 13 it was 13·0. Plates taken on the following dates failed to show the star (the figures in brackets after the dates show the limiting magnitudes of the plates): 1901 April 9 (14·5); 1903 April 16 (13·5); 1905 March 1 (14·1); 1905 March 27 (13·5); 1905 April 8 (14·8); 1907 April 5 (13·9); 1908 January 3 (16·0); 1908 March 29 (14·8); 1910 March 1 (14·5); 1911 February 21 (14·8). Dr. Kukarkin suggests that it is a variable star of the U Geminorum type; it may have a period of about a year, but there must be some irregularity in it. The decline must be very rapid; Dr. Delporte notes in U.A.I. Circ. 434 that plates taken on March 25 and 29 go down to mag. 17·5, but there is no trace of the nova.

The Gegenschein or Counterglow. The German astronomer, Theodor Brorsen, discovered this faint patch of light opposite to the sun in the year 1885. It is difficult to observe, and can only be seen in perfectly clear air free from all glare of terrestrial lights, and when it does not fall on the Milky Way. A bulletin issued by Science Service, Washington (Feb. 11), describes a study of it made recently by Dr. C. T. Elvey at the Yerkes Observatory; he used the 40-in. refractor and a photoelectric cell to measure the luminosity. Several series of measures of light were made along parallel lines running north and south, each long enough to cover the Gegenschein and the dark sky outside it. The measures, when reduced, were plotted; they exhibited the Gegenschein as an oval area, its length along the ecliptic being 22°–35°, and its breadth in latitude 21°–26°. These dimensions are about twice as great as the area that was visible to the unaided eye. The integrated luminosity was determined to be −0·28 magnitude, which is brighter than any of the stars except Sirius and Canopus; but being spread over a large area the intensity is very feeble at any point. The report states that "at the centre, where brightest, the intensity is equal to that of a star of magnitude 6·2"; this is, however, indefinite in the absence of indication of the size of the patch of light included. October and November were found to be favourable months for the study; the region being north of the equator, and away from the Milky Way.

The phenomenon is believed to be an extension of the zodiacal light, looking brighter than elsewhere owing to proximity to the earth, and the full illumination of the particles. It is conjectured that there may be an actual concentration of particles near the earth, describing periodic orbits under the combined attraction of sun and earth.

Ephemerides of Variable Stars. The Cracow Observatory undertook at the request of the International Astronomical Union the task of preparing yearly ephemerides of eclipsing variable stars. No. 11 has appeared, bearing the title "Rocznik Astronomiczny". It is edited by Prof. T. Banachiewicz, and contains ephemerides of 300 stars, and elements without ephemerides of 722 more. The book also contains tables of precession and obliquity, and predictions of occultations of stars by the moon for Cracow and four other Polish Observatories. The explanations are given both in Polish and in Peano's flexible Latin.

A supplement to the *Japanese Astronomical Herald*, vol. 25, contains observations of variables made in Japan in 1932, and predicted maxima of 90 long-period variables for 1933.

Structure of Cellulose

THE recent annual Convention of the Technical Section of the Paper Makers' Association of Great Britain was unusual in that the subject chosen was one which appeared at first sight to be more of academic than of practical interest. Fortunately, in the able hands of Prof. H. Mark, of the University of Vienna, who opened the conference, the subject lost many of its complexities, and technical men present were stimulated to attempt to apply theory to their practical problems.

Prof. Mark's paper, which is published in a special issue of the *World's Paper Trade Review*, dealt principally with the structure of cellulose. He supported the theory, now generally accepted, that cellulose is built up of so-called micelles consisting of bundles of parallel chains of glucose molecules, and he dwelt at some length on the controversy which at present concerns the actual length of these chains. The majority of the evidence, including that based on the chemical properties of cellulose, points to a length of 150–200 glucose units, and yet one cannot ignore the work of Staudinger on viscosity, which can only be explained by a much higher figure. It may be that the lower figure represents a minimum value.

In opening the general discussion, Sir William Bragg referred to the X-ray evidence on which so much of this work is based. Subsequent speakers paid some attention to the much-debated question of the mechanism of the hydration which occurs when paper is beaten, and a suggestion was made that the resulting change in structure is analogous to that which occurs in the manufacture of true cellulose plastics by chemical reaction.

Prof. Mark also indicated how such theories might be applied to problems in the art-silk industry, although it seems that they can do little at present to explain what occurs when cellulose is beaten for paper-making, as this problem is concerned with water absorption rather than with modification of crystalline structure. When, for example, a silk fibre is bent, the outer layers are stressed more than the inner core, and so long as the elastic limit of the latter is not surpassed the fibre will return to its original position and will thus show resistance to creasing. Unfortunately, this resistance is usually decreased when a fibre is treated so as to increase its tensile strength, but it is now possible to obtain the core more highly orientated than the surface and so to preserve both properties. Here one can take a leaf from the book of Nature, since this difference in orientation is already present in the natural silk fibre. If, however, the silkworm is placed on a revolving rod, and is therefore compelled to spin more rapidly, it descends to the level of human endeavour so far as lack of creasing-resistance of its product is concerned.

Prof. Mark obviously voiced the opinion of those present when he stated that the interaction of water and cellulose is one of the most interesting questions in paper-making. He chose to approach the problem by taking absorption capacity as an index of changes produced in the area and quality of the surface of the fibre by chemical treatment or by beating. His results indicate that hydroxyl groups are responsible for the fixation of water molecules on the surface of the cellulose, and act by virtue of the secondary valencies of the oxygen atoms; treatment with a chemical reagent opens up small slits or holes in the micelle into which further molecules of water may pass. Penetrations of solvents and swelling agents into the cellulose lattice is not unknown, but as a rule X-rays show evidence of well-defined addition compounds. Until now, however, no one has succeeded in preparing a true cellulose hydrate, so that an important link in an otherwise strong chain of evidence is still missing.

Sunspots and Meteorological Phenomena

IN a monograph entitled "L'Influence Solaire et les Progrès de la Météorologie"* Henri Mémery advances the theory that sunspots show a tendency to increase and decrease at certain definite times of the year, and that this tendency is shown whatever period of years is considered. He suggests further that there is a relationship between the amount of sunspot development and numerous terrestrial disturbances, for example, spells of abnormal rainfall and temperature, and also between individual groups of sunspots and meteorological phenomena. Fifty years of solar and meteorological observations made at the Observatoire de Physique solaire et de Météorologie, Talence, provide a large part of the experimental data on which his views are based.

To most astronomers and meteorologists, the theory that sunspot activity shows any permanent relationship with the dates on our terrestrial calendar will probably appear a highly improbable one, to be accepted only in the face of overwhelming evidence of its truth. The evidence in this paper rests upon curves showing the average area on the sun's disc covered by sunspots on each day of the year for periods of 12, 41 and 50 years. There are, however, apparent discrepancies between the lengths of the periods implied by the statements made alongside these curves and those given above the curves. The periods are quoted as 12, 40 and 50 years in the latter case and it is possible that 40 should replace 41 in the algebraic expressions given below. It will be seen, however, that the conclusions reached are not affected by this uncertainty, nor even by the doubt as to whether the 12 year period should not have been taken as 13 years. Few would deny that the three curves show considerable similarity, but the periods covered are 1889–1901, 1880–1920, and 1880–1929, that is, the 12 years in the first group are used also in the groups for 41 and 50 years, and the overlap is even greater for the 41 and 50 year means.

The question arises whether the similarity in the curves cannot be explained simply by this overlap. Take the case of the curves for 12 and 41 year periods. The similarity between these is held to imply a positive correlation between the ordinates. The two

* L'Influence solaire et les progrès de la météorologie: résultats de 50 années d'observations solaires et météorologiques comprenant les observations et les recherches effectuées à Talence à partir de 1900. Par Henri Mémery. Pp. iv+23. (Talence: Observatoire de Physique solaire et de Météorologie, 1932.)

variables are x_1, and $(12x_1+29x_2)/41$ where x_1 and x_2 are the means for the common period of 12 years and for the remaining 29 years of the 41 year period, respectively. The correlation between x_1 and $12x_1/41$ is of course unity, and, unless it is true that the shapes of the annual sunspot curves obtained by using entirely separate series of years are similar, the correlation between x_1 and $(12x_1+29x_2)/41$ will by a well-known statistical formula bear the same ratio to unity as does the standard deviation of $12x_1/41$ to the standard deviation of $(12x_1+29x_2)/41$. This correlation coefficient works out to $+0{\cdot}38$.

The correlation coefficient between the 12 and 41 year mean curves was then determined, using the ordinates of the two curves at the beginning and middle of each month. The figure found was $+0{\cdot}38$, that is, exactly that which is to be expected solely from the overlap. (The *exact* agreement between the two coefficients must of course be accidental. Had the experimental figure been even $+0{\cdot}5$ or $+0{\cdot}6$ the evidence that the overlap was not the cause of the similarity would still have been inadequate, but with a coefficient of $+0{\cdot}8$ or more the author's claim would have been well supported.) A similar analysis could be applied to the other pairs of curves, but it has been deemed sufficient to show by a single random test that a faulty method has been used with misleading results. Although no further example of overlapping is evident in the comparative curves illustrating the other relationships claimed in this paper, the method adopted throughout has been to give purely statistical evidence for alleged physical relationships in such a way that a critical reader cannot see, until after considerable mathematical analysis of this evidence, whether the latter does in fact give any support for the supposed relationships.

It seems safe to conclude that most astronomers and meteorologists will not accept the author's ideas until more up-to-date statistical methods are used.

E. V. N.

Atmospherics Research in the Southern Hemisphere

A FEW years ago the Australian Council for Scientific and Industrial Research established a Radio Research Board to conduct scientific and technical research into some of the more fundamental problems associated with radio communication. Amongst the items of work which it was planned to carry out were the repetition of some of the investigations already in progress in Great Britain under the British Radio Research Board, with the view of obtaining a direct comparison of the propagation of electric waves in the two hemispheres. As a useful aid in this matter some of the investigators appointed in Australia had the advantage of receiving their training in radio research under the organisation in Great Britain. The results of the work already carried out in Australia are being published in a series of special reports, and the latest of these is entitled "Atmospherics in Australia (I)".* This report contains the results of observations made chiefly by means of two cathode ray oscillograph direction-finders supplied by the British Radio Research Station at Slough, where this type of instrument has been developed to a high degree.

The first series of observations were made on board the s.s. *Baradine*, in December 1929 and January 1930, when Messrs. Munro and Huxley were on their way to Australia to take up their appointments. After setting up the apparatus on board, observations were made on the transmissions from a number of European stations to enable a calibration curve to be obtained showing the error in apparent direction of arrival of the waves caused by the metal work of the ship. Regular daily observations on atmospherics were commenced one day before reaching Port Said and were continued during the remainder of the voyage. From the indications on the cathode ray oscillograph screen, both the true direction of arrival and the strength of each atmospheric was recorded. These observations, which were carried out on a wave-length of 30 km., supplied very definite evidence in favour of a thunderstorm origin for atmospherics. The directions, as recorded on the voyage through the Red Sea and across the Indian Ocean, converged on an area in Central Africa which is known to be the most active thunderstorm area in the world. Beyond Colombo, the directions of most of the other sources of atmospherics observed passed through other active thunderstorm areas in the East Indies and Northern Australia. Round the south coast of Australia, the predominant sources appeared to be within, or near to, the north of the continent.

On arrival in Australia, the apparatus used on the ship was installed near Melbourne for preliminary observations. Towards the end of 1930, a second cathode ray direction-finder arrived in Australia and was set up on a selected site about three hundred miles from the first instrument. The circuit arrangement of each instrument was modified to make the oscillograph unidirectional in its indications, and a short-wave wireless link was provided between the two stations so that simultaneous recording of the direction and intensity of individual atmospherics could be carried out; and such observations were commenced in March 1931. The majority of these observations were carried out on a wave-length of 3 km. as it was thus found possible to restrict the range from which atmospherics were received to about 2,000 miles, whereas on a wave-length of 30 km. the range was at least 5,000 miles. The origins of the atmospherics observed were located by taking simultaneous bearings at the two stations. Systematic observations taken in this manner on a wave-length of 3 km. showed that the range of intensities, when corrected for the distance travelled and the attenuation in the path, was quite small, being of the order of 4 to 1; and also that the intensity distribution about the mean was a normal probability one.

A large proportion of the atmospheric sources located were within the Australian continent itself. The small range of intensities noted above suggests a similar origin for all the atmospherics observed, and this has been confirmed by the correlation found between the indicated sources of the atmospherics and those of the thunderstorms located through the normal meteorological observation network. The authors conclude from their investigations that all the atmospherics observed had their origins in lightning strokes occurring generally in thunderstorms,

* G. H. Munro and L. G. H. Huxley: "Atmospherics in Australia. (I)". Radio Research Board, Report No. 5. Melbourne. 1932.

or possibly, in a few instances, in dust storms. Observations of atmospherics have therefore been found to have definite meteorological value as they enable barometric depressions to be located and traced by observing the atmospherics which are generally associated with them.

Information on the diurnal and seasonal variation in the activity of atmospherics covering a period of more than a year is also given in the report. It has been found that the maximum activity of atmospherics occurs in the afternoon from 3 to 4 p.m. in any locality, although this maximum is less marked for sources over sea than for those over land. In Australia, atmospherics are very prevalent over the tropical areas in summer, but in winter, atmospherics arising within the continent are relatively few, those observed being associated with barometric depressions. Towards the end of 1931 two automatic directional recorders, of the narrow-sector type developed in Great Britain, were installed, and with the aid of these instruments more complete information on diurnal and seasonal variations is being obtained.

The report shows that this line of research has been satisfactorily established in Australia on a sound basis, and the results of the continuation of the investigation will be awaited with interest.

Hæmolytic Streptococci*

THE group of micro-organisms known as the hæmolytic streptococci is responsible for a number of acute inflammations in various regions of the body, such as erysipelas, heart disease, and puerperal fever, as well as for such diseases as scarlet fever and certain types of pneumonia. In addition, they are important secondary invaders, attacking those whose resistance is already lowered by some other infection. They spread in the body both by the lymph and the bloodstream and are frequently found on mucous surfaces in apparently healthy individuals. They are only known as parasitic upon the animal body and appear to maintain themselves in a human population like the meningococcus or pneumococcus, namely, by carriers.

Since these organisms are responsible for so many different diseases, it is of interest to inquire whether a particular variety of hæmolytic streptococcus is associated with each different disease. The late Sir Frederick Andrewes devoted seven years to the study of this problem and a report of the investigation, prepared for publication by his colleague, Mrs. Christie, and Dr. Christopher Andrewes, has now been issued.

The hæmolytic powers of *Streptococcus pyogenes*, the typical hæmolytic streptococcus, depend upon the production of a definite toxin which passes out into the medium and disintegrates the limiting membrane of the red blood cells; this soluble hæmolysin will pass through porcelain filters of the coarser type. The living organisms also reduce hæmoglobin or may convert it to methæmoglobin. As a method of separating the different types, it was soon clear that agglutination tests by themselves would prove of little value. It was necessary for an accurate antigenic analysis to carry out quantitative agglutin-absorption tests. Antisera were prepared by injecting an emulsion of the streptococci, killed by exposure to dilute formaldehyde in the cold for some days, intravenously into rabbits, on alternate days for about four weeks. The sera obtained had high titres. In carrying out a test, graduated doses of an emulsion of the organism are added to the same volume of serum. After standing overnight, the tubes are centrifuged and the clear supernatant fluid pipetted off and titrated, that is, its agglutinating power for the strain with which the serum was prepared, is tested. The closer in type the strain used for the absorption of agglutinin is to the latter, the less agglutinin will there be left unabsorbed, and vice versa.

The investigation has shown that these hæmolytic streptococci have such inherent powers of adaptation to their chemical environment as to make it impossible, for the present at any rate, to prepare a permanent systematic classification. The methods used for discrimination between forms of different origin may themselves change the characters of the organisms under observation. Only exceptionally are two strains serologically identical, but very rarely are they entirely dissimilar. In the case of scarlet fever, it appears that no one serological form can be credited as causal agent, though three or four recognisable serological types seem to be quite commonly found in it. An occasional representative of a scarlet fever group was found among the puerperal, surgical and erysipelas strains, but otherwise no distinct types stood out from this mixed group.

The general conclusion is that this group of organisms is in a state of constant flux in which it is difficult to find any firm foundation for a permanent systematic classification: success is probably unattainable by purely serological methods of investigation. The dangers of the hæmolytic streptococcus to human life appear to arise from this instability of behaviour: it has a special facility in adapting the refinements of its living chemistry to the particular host environment in which it finds itself. Progress would seem to lie in a deeper knowledge of the exact chemical events involved in this reaction between the host and the invading organism.

* "The Hæmolytic Streptococci: their Grouping by Agglutination". By Frederick W. Andrewes and Ethel M. Christie. Medical Research Council, Special Report Series, No. 169. Pp. 73. (London: H.M. Stationery Office, 1932.) 1*s.* 3*d.* net.

University and Educational Intelligence

CAMBRIDGE.—At King's College the following have been elected to fellowships: A. G. D. Watson, scholar and Harold Fry student of the College, and E. S. Shire, Reginald John Smith student and formerly scholar of the College.

THE use of sound films as an aid in the teaching of physical science is being tested in the University of Chicago with a series of twenty films of which the first two, entitled "Oxidation and Reduction" and "The Molecular Theory of Matter", have been produced under the supervision of the professors of chemistry and physics of the University. Three others on "Energy and its Transformation", "Electrostatics" and "The Velocity of Light" are in preparation. Similar series of twenty films each are to be produced dealing with biological science, social science and the humanities. The technical work is in charge of Erpi Picture Consultants and further particulars can be obtained (according to an article in the January issue of *School Life*) from the University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill.

Calendar of Nature Topics

Varieties of Agricultural Crops

There is no simpler method of improving output than by sowing a good variety of seed instead of an inferior one. It is the first step in raising the standard of farming in new or undeveloped areas, and has given striking results when soil improvement by fertilisers would have been impracticable. Moreover, a new variety may enable the limitations imposed by climate to be overcome. A rapidly maturing strain of wheat extends the wheat area by making the most of a short growing period, a drought-resisting variety brings in areas of low rainfall. Choice of seed is usually the most practicable method of mitigating the effects of plant disease caused by fungus or insect pests ; this is particularly the case with crops of low value per acre which will not bear the cost of spraying. Immunity of particular varieties to disease is very rare, but when it occurs, as for example to the wart disease of potatoes, it is exploited to the full. More usually it is a case of a more or less marked degree of resistance, and then the aim of cross-breeding is to unite the disease resistance of one strain with the valuable agricultural qualities of another. The problem is never a simple one, for very many attributes are involved. It is further complicated by the fact that resistance to one disease may be associated with susceptibility to another.

Much is being done in Great Britain to improve existing varieties and introduce new ones. With crops already highly developed, spectacular improvements are unusual ; the gain in yield or quality is generally small and special field technique is required in order to establish the extent of the improvement, and the agricultural areas in which the new strain may be substituted for the older kinds. Stiff-strawed varieties of cereals, high quality wheat and barley, beetroots rich in sugar, mangolds of high dry matter content, have all been developed in this way. A special case of raising varieties to suit a particular environment may now be in sight. There is no shortage of potential soil fertility in the form of cheap synthetic nitrogen compounds. An outcome of this might be the development of varieties specially suited to unusually rich soil conditions and able to effect an economical conversion of mineral fertilisers into farm produce.

Potatoes in the Fens

Potato planting is now in progress in the great black plain south of the Wash, probably the most sharply defined agricultural area in England. Even the town dweller, as the train carries him through Ely, March, or Peterborough, can scarcely fail to realise that here is something quite distinct from the 'country' as is usually understood. At this season, we see on all sides the black soil laid up in ridges, the bright red farm-carts serving gangs of women with seed potatoes for planting, and the horse-drawn ridgers covering in three rows of sets at once. Those who regard farm work as a leisurely and ill-organised occupation, should spend a few hours on a fenland farm in mid-April. The work proceeds with astonishing smoothness and rapidity and a very high standard of workmanship is attained.

The black land is capable of growing good crops of potatoes on its own resources, but is considerably helped by superphosphate. Indeed, the fenland farmer must be the most systematic user of superphosphate in Great Britain, for many of them recognise no other manure.

Having got his potatoes in, the farmer's chief anxiety is the extent to which his crop will be reduced by 'blight' which, although controlled by spraying, may seriously damage the crop in certain seasons, and the price of potatoes in the following winter. These two considerations are not unrelated, however, for a reduced crop generally means higher prices, although not necessarily sufficient to compensate for the lower yield.

In spite of considerable fluctuations in returns, the potato crop has no serious rival in this district. Sugar beet affords a useful alternative, and is widely grown, and carrots, celery, and mustard occupy some potato land. Cereals are extensively grown to balance the acreage, and the straw, which is particularly luxuriant in this fertile district, finds a special use in covering potato clamps during the winter.

Sperm Whales in the North Atlantic

Sperm whales are now relatively scarce animals, and the experience of the modern whaling stations which worked from the northern and western islands of Scotland, was that few sperms were captured in these waters and that they were invariably solitary bulls, truants from the schools. But in the great days of whaling, there were recognised about a dozen 'whaling grounds' for sperms in the North Atlantic, visited by the whalers during fairly definite seasons. Sperm whaling was not a seasonal trade, as was the fishing of the right whale from British sea-ports, for the sperm whalers were fitted out for a voyage of from two to four years duration and caught whales wherever they could be got. Therefore the appearance of whalers year after year at a fairly regular succession of places suggests definite movements or migrations on the part of the whales. When Charles H. Townsend plotted on a world-map the positions and dates of captured sperm whales recorded in the hundreds of log-books fortunately preserved in New Bedford Public Library, U.S.A., he found that April marked the opening of sperm-whaling in the North Atlantic. With few exceptions, the records above lat. 25° N. point to the presence there of sperm whales from April to September; in the Sargasso Sea they occurred in the summer of the northern hemisphere ; between lat. 25° N. and the equator they were taken mainly during the October to March season ; and along the coast of South America and towards the Cape of Good Hope the catches were largely made during the same season—summer in the southern hemisphere.

Young Barnacles Change their Coats

In the seas of western Scotland, the latter half of March is marked by the appearance in the plankton of myriads of the nauplius larvæ of barnacles (*Balanus*)—about a month later than the corresponding event in southern England. For a time the larvæ may be so numerous as to form the predominant constituent of the plankton, suggesting that the countless barnacles which whiten shore rocks spawn profusely and almost simultaneously, to the immediate benefit of the many shore animals which feed upon such organisms. In April, and particularly in

the latter half of the month, the nauplii moult for the last time and assume the new cyprid form, which soon attaches itself by head and antennæ and glues itself by secretion from the cement gland to rocks, stones, shells, piles of piers or whatever object may be on the spot. Then in this, which Darwin called the "pupa stage", some of the juvenile structures are lost and the free-swimming larva is transformed into the immobile adult. This is why fishermen haul their boats from the sea during the month of May and scour and scrub their hulls, for the newly settled brood of barnacles is still easily removable, whereas in a week or two more they would form a firm encrustation. In the days of sailing ships the attachment and growth of vast numbers of barnacles, sessile and stalked, during a long voyage, materially obstructed the way of the ship.

Societies and Academies

London

Geological Society, March 8. D. A. Bryn Davies: The Ordovician rocks of the Trefriw district, North Wales. The area described extends from Trefriw and Dolgarrog in the Conway valley south-westwards to Capel Curig. The Glanrafon beds are correlated with the beds immediately underlying the Snowdon volcanic suite in Snowdonia, and with the beds of the same name underlying the volcanic suite at Dolwyddelan. The Crafnant volcanic series is considered to represent an incomplete development of the Snowdonian suite, the bedded pyroclastic and probably also the upper rhyolitic series being absent. In the neighbourhood of Dolgarrog, the Crafnant series is faulted against a thick development of pumice-tuff and spilitic agglomerate overlain by rhyolite-tuff and rhyolite. These are regarded as contemporaneous with the Crafnant series, but representing, in part at least, the products of a different centre of activity. The fauna of the Llanrhychwyn Slates, comparing closely with that of the Lower Cadnant Shales of Conway, places the underlying volcanic series in the Llandeilian, and indicates its correlation with the upper part of the Conway Volcanic series. V. Wilson: The Corallian rocks of Yorkshire. (1) The Howardian Hills. Three divisions of the Corallian are recognised and their stratigraphical relations are dealt with in detail. The important rôle played by the spicular remains of the lithistid sponge *Rhaxella perforata* Hinde in the building up of the Lower Calcareous Grit is recognised for the first time. Calcareous, and many varieties of siliceous, spicules are described, and their distribution is discussed. Though perfect lithological continuity exists between the Lower Calcareous Grit and the overlying Osmington Oolite series, the absence of any representatives of the Hambleton Oolite series and the Middle Calcareous Grit containing fossils characteristic of these two divisions is considered to indicate the existence of a non-sequence in this area. In the later stages of the Osmington Oolite period reefs became established, and numerous facies deposits accumulated from the erosion of the reefs. As the Lower Calcareous Grit passes gradually into the Oxford Clay below, so the Upper Calcareous Grit gradually gives place to the overlying Kimeridge Clay in the North Grimston district, there being no unconformity such as was formerly supposed.

Paris

Academy of Sciences, March 6 (*C.R.*, 196, 653–732). The President announced the death of Magnus de Sparre, *Correspondant* for the Section of Mechanics. E. Mathias: Contribution to the study of fulminating matter. The phases of its explosion by cooling. René Lagrange: Poncelet's theorem and a class of cyclids. Glagoleff: Effective and general construction of the Cremona transformation in the plane and in space. Jacques Winter: An application of Schrödinger's theory of perturbations to a problem where the degenerescence persists up to the nth approximation (Mathieu's equation). Henri Cartan: Groups of pseudo-conformal transformations. N. Aronszajn: The decompositions of uniform functions. Mlle. Estradère: The oxidation of some hydrocarbons. A study of the oxidation of hexane, cyclohexane and cyclohexene under conditions favourable to the production of explosions. M. Kéfféli: The suppression of rolling and pitching. J. Delsarte: Spherical evolution. Pierre Vernotti: The best method of assuring a thermal isolation. Th. V. Ionescu and Mme. Irène Mihul: The absorption of energy in ionised gases. L. Dunoyer and P. Paounoff: A state of working of photoelectric cells containing gas. G. Ribaud: The measurement of the total factor of transmission of the coloured filters used in heterochrome photometry. A. Hautot: The structure of the K line of boron. This line has been described as having a width of 3 A. (Söderman) or 5 A. (Prins). With a spectrograph of high dispersion it has been found to be double, the two lines being 1·25 A. apart. Pierre Bricout: A magnetic apparatus for the determination of thicknesses. The continuous and automatic measurement of the thickness of thin sheets or the diameter of fine wires is a problem of interest both in the laboratory and the works. The method described is applicable if the magnetic permeability of the specimen is practically equal to that of air: variations of 0·1 micron can be detected. K. Boratynski and A. Nowakowski: The modifications of phosphoric anhydride. The crystalline modification has a specific gravity of 2·284 at 20° C., 2·207 being that of the amorphous modification. Augustin Boutaric and Jean Ratelade: Rhythmic precipitation in stretched gels. A. Portevin and P. Bastien: Contribution to the study of the physical and mechanical properties of the magnesium-aluminium-copper alloys, rich in magnesium. R. Cazaud: The influence of the degree of cold hardening produced by wire drawing on the limit of fatigue of mild steel. Georges Fournier and Marcel Guillot: The relation between the absorption of the β-rays by organic compounds and the molecular structure of the latter: halogen derivatives. Paul Baud: The soda factory of Nicolas Leblanc. A. Travers and Lu: The separation of phosphoric, arsenic and vanadic acids from aluminium. The vanadium is removed by heating to 400° C. in a current of gaseous hydrochloric acid. Félix Trombe: The preparation of metallic neodymium free from iron and silicon. The metal is prepared by electrolysis of the chloride, after removal of oxychloride by prolonged heating in dry hydrochloric acid. The metal is heated in a high vacuum at 1200° C. to remove potassium: it contains about 0·02 per cent of iron, less than 0·05 per cent of silicon and only spectrographic traces of calcium. R. Truchet: The oxidation of the true acetylenic

hydrocarbons by selenious oxide. The preparation of α-acetylene alcohols. The oxidation of the hydrocarbon $CH_3.(CH_2)_4C{\equiv}CH$ with selenium dioxide gave the secondary alcohol $CH_3.(CH_2)_3.CH(OH).C{\equiv}CH$. The next homologue, octyne, behaved in a similar manner on oxidation. L. Royer: The orientation of certain crystals by hydrargillite. A peculiarity in the orientation of crystals deposited in contact with macled calcite. L. J. Spencer: The origin of tectites. Michel and Lacroix have suggested that tectites are formed in the atmosphere from meteoric materials composed of silicon and the light metals, fused by the heat developed by friction with the air. The author suggests an alternative hypothesis according to which meteorites of meteoric iron impinging on desert sand have developed sufficient heat to melt the sand into a silica glass. This accords with the high percentage of silica found in tectites (see also Nature, 131, 117, Jan. 28, 1933). F. Blondel: The average amount extracted from copper minerals. A. Marin and P. Fallot: The connexion of the dislocations of Punta Piscadores with those of the limestone chain of the Rif. C. E. Brazier and L. Génaux: Some remarks concerning the earthquake of March 2, 1933. Discussion of the results obtained on the seismograms at the Observatory at Parc Saint-Maur. Ch. Maurain: Remarks on the preceding communication. The amplitudes of the movements of the ground recorded during the earthquake of March 2 last are probably the greatest ever observed in the Paris region for movements of seismic origin. Henry Hubert: The climates of the French tropical domain. Zb. Sujkowski: The presence of Radiolaria of the Phæodaria group in the lower Carboniferous of Poland. René Vandendries and Harold J. Brodie: The sexual radiations in the Fungi. Mlle. M. L. Verrier: The eyes and vision of *Cerastes vipera* and *Vipera aspis*. Mme. Andrée Drilhon: Phosphorus and moulting in crustaceans. Mme. Hufnagel and Marcel Joly: The action of the X-rays on the metamorphosis of insects. Robert Sorel: Tincture of iodine and asepsis. The author questions the utility of tincture of iodine used as a preliminary wash for the skin in surgical operations, especially if lengthy. It appears to act as a varnish, and results as good can be obtained with a varnish not containing an antiseptic.

Forthcoming Events

Monday, April 24

University of Cambridge, at 12—(Rouse Ball Foundation Lecture).—Prof. B. L. Van der Waerden: "The Aims of Modern Algebra".

Royal Geographical Society, at 5.30—(Film).—R. J. Flaherty: "South Pacific Pictures".

National Institute of Industrial Psychology, at 6—(at the London School of Economics, Houghton Street, W.C.2).—Mrs. W. Raphael: "The Selection and Training of Office Staff".

Royal Society of Arts, at 8—(Cantor Lectures).—W. Augustus Steward: "Goldsmiths' and Silversmiths' Work—Past and Present" (succeeding lectures on May 1 and 8).

Tuesday, April 25

Eugenics Society, at 5.30—(at the Rooms of the Royal Society, Burlington House, Piccadilly, W.1).—Symposium on "Eugenics and Religion". Speakers: Capt. G. H. L. F. Pitt-Rivers and the Rev. A. H. Gray.

Gresham Lectures in Astronomy, at 6—(at Gresham College, Basinghall Street, E.C.2).—A. R. Hinks: "The Star Map of the Future" (succeeding lectures on April 26, 27 and 28).

Institution of Civil Engineers, at 6.—H. G. E. Cherry: "The Influence of Earthquakes on Structural Design". F. W. Furkert: "The Effect of Earthquakes on Engineering Structures". J. J. Booth: "The Design of an Earthquake-Resisting Structure: The Dominion Museum, Wellington, New Zealand".

Wednesday, April 26

London School of Economics, at 5.—Prof. A. W. Marget: "The Natural Rate of Interest" (succeeding lectures on April 27 and May 3 and 4).

Royal Society of Arts, at 8.—Dr. W. H. Gibson: "Future Developments in the Flax and Linen Industries".

Thursday, April 27

London Mathematical Society, at 5—(at Burlington House, Piccadilly, W.1).—Prof. B. L. van der Waerden: "Hypercomplex Numbers".

Institution of Electrical Engineers, at 6—(Twenty-fourth Kelvin Lecture).—Sir Frank E. Smith: "The Travel of Wireless Waves".

Friday, April 28

Association of Economic Biologists, at 11.45—(in the Botany Lecture Theatre, Imperial College of Science and Technology).—Dr. S. Dickinson: "The Nature of Saltation in *Fusarium fructigenum*". At 2.30, Special General Meeting. At 2.45, Dr. C. B. Williams: "Observations on the Desert Locust in East Africa"; A. M. Massee: "The Strawberry Tarsonemid Mite".

Society of Chemical Industry (Chemical Engineering Group), at 6.45—(at the Waldorf Hotel, Aldwych, London, W.C.2).—Annual General Meeting. The Right Hon. Lord Melchett: "Modern Economics and Unemployment".

Royal Institution, at 9.—Dr. James Gray: "The Muscular Movements of Fishes".

Faraday Society, April 24–25—(at the Royal Institution, Albemarle Street, London, W.1).—General Discussion: "Liquid Crystals and Anisotropic Melts".

Official Publications Received

Great Britain and Ireland

Wool Industries Research Association. Report of the Council, 1932–33. Pp. 39. (Leeds.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1495 (T. 3187): Improvement of Airscrew-Body Performance by Radial Vanes. By F. C. Johansen. Pp. 27+8 plates. 1*s.* 6*d.* net. No. 1496 (T. 3315): Acceleration of an Aeroplane upon entering a Vertical Gust. By L. W. Bryant and I. M. W. Jones. Pp. 16+15 plates. 1*s.* net. (London: H.M. Stationery Office.)

Other Countries

University of California Publications in American Archæology and Ethnology. Vol. 33, No. 2: The Eastern Kuksu Cult. By E. M. Loeb. Pp. v+139–231. (Berkeley, Calif.: University of California Press.) 1 dollar.

The University of Colorado Studies. Vol. 20, Nos. 2 and 3. Pp. 115–263. (Boulder, Colo.) 1 dollar.

L. S. Ornstein: a Survey of his Work from 1908 to 1933. Dedicated to him by his Fellow-Workers and Pupils. Pp. iv+121. (Utrecht.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions, Vol. 82: Interne Gezeiten-Wellen. By O. Pettersson. Pp. 26+viii. (Copenhague: Andr. Fred Høst et fils.) 1.75 kr.

Isotyphs: showing the Prevalence of Typhoons in Different Regions of the Far East for each Month of the Year 1932. By T. F. Claxton. Pp. 2+12 plates. (Hong Kong: Royal Observatory.)

Council for Scientific and Industrial Research. Pamphlet No. 37: The Sheep Blowfly Problem in Australia. Report No. 1. (N.S.W. Department of Agriculture: Science Bulletin No. 40.) Pp. 136+6 plates. (Melbourne: H. J. Green.)

Colony of Mauritius. Annual Report of the Royal Alfred Observatory for the Year 1931. Pp. 4. Miscellaneous Publications of the Royal Alfred Observatory. No. 13: The Cyclone Season 1930–31 at Mauritius. By M. Herschenroder. Pp. 6+22 plates. (Mauritius.)