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The Research Associations.

THE Report of the Department of Scientific and Industrial Research for the year 1927–28 (Cmd. 3258) devotes considerable attention to the position, in the national economy, of the research associations set up in Great Britain under the ægis of the Department. Since 1918, when the first three associations were established, some twenty-six research associations in all have been formed. Two of them, relating to the glass and cement industries respectively, have been wound up, and of the twenty-four associations still in being, one, the British Iron Manufacturers' Research Association, has not received grant aid from the Department, and its operations were suspended at the close of the first quinquennium and have not, up to the present, been resumed. The British Colliery Owners' Research Association, founded in December 1924, has not received grant aid from the Department, and three other associations (Motor and Allied Manufacturers, Motor Cycle and Cycle Car, and Scottish Shale Oil) ceased to receive Government grants at the end of their first quinquennium.

It will be remembered that the original scheme of the Department of Scientific and Industrial Research provided grant aid from the million fund, set aside by the Government to promote scientific and industrial research, on the basis of annual grants equivalent to the annual subscriptions of members of the associations. The scheme further provided that the grant-in-aid should be limited in each case to the first five years of the association's life. It was assumed or believed that a period of five years would be sufficient to demonstrate effectively that co-operative research was of value to industry, and that, as a result of that demonstration, the several industries that had embarked on the experiment would be willing to shoulder thereafter the whole financial burden of maintaining their respective research associations. In fact, as the report of the Advisory Council to the Department states candidly, "five years proved too short a time for most of the Associations to establish their reputation by the results of their work".

There need be no surprise at this conclusion, for the first two years of an association's life are necessarily spent mostly in setting up the organisation, gathering together the appropriate scientific staff, securing the buildings and equipment, and planning a comprehensive research programme. It would be more than remarkable if, in the remaining three years, the results of any association's

work should be sufficiently striking to convince manufacturers (presumably having little or no previous experience of research applied systematically to their respective industries as a whole) that co-operative research was of such immediate and valuable service to industry that it would be a 'business proposition' for them to bear alone its necessarily high expense. St. Paul may have been amenable to quick conversion, but the average British manufacturer is, shall we say, less impetuous. Indeed, even now, after some ten years' experience of the work of the research associations, the report of the Advisory Council to the Department says: "It cannot be denied that most of the Associations find it difficult to get the financial support they deserve. A subscription to a Research Association is still regarded in many cases as a charitable gift, to be paid with public spirit and private reluctance, and to be withheld when funds are scarce."

At the end of the first quinquennium, therefore, the Department, looking the facts in the face, agreed to a continuance of State aid, though on a smaller scale, for a further period of five years. The scale of grants was not only smaller but also, in general, it was a descending scale, calculated so that at the end of this second quinquennium the grants would sink to zero. The stipulated grant-earning subscriptions were correspondingly based upon an ascending scale so that the total income of the association should remain about the same and the association be self-supporting at the end of this second period of five years. But again, in fact, it was found impossible by many, probably by most, of the associations to fulfil the conditions of this carefully planned, if still heroic, scheme; and the Department, again facing the facts realistically and sympathetically, consented to modify in a more generous direction the conditions on which a number of the associations might continue to receive grants during this second quinquennium. To the associations, however, the problem remained of what was to happen to them on the termination of this second quinquennium. It was doubtful, to say the least, whether the majority of them could become financially self-supporting, on an adequate scale, immediately this second grant period ceased.

Accordingly, nineteen of the research associations during the past year submitted by deputation a reasoned memorial to the Lord President of the Council, the Earl of Balfour, praying for a continuance of financial assistance by the Department on the pound for pound scale. The Lord President was unable, on behalf of the Government, to accept the proposals of the memorialists, but he announced a new policy which goes some way to meeting the difficulties with which the associations are faced. When the existing contracts for the second quinquennium come to an end, each association is to be considered on its merits and a subscription income fixed, which it will be necessary for the association to obtain from other sources before it is eligible for any grant from the Department. Funds obtained from approved sources in excess of this minimum subscription income will be augmented by a grant equal in amount from the Department up to a limit depending on the circumstances of the association.

That, stated briefly, is the substance of the Department's policy, in the near future, with respect to grants in aid of the research associations, and it is further evidence of the willingness of the Department, to which attention has already been directed, to modify and adapt its policy to new facts and changed circumstances. The inflexible attitude of "What we have said we have said" has been wisely left to political heroes. The Advisory Council has been mindful throughout that it has a fiduciary duty to ensure, so far as it may reasonably do so, that scientific and industrial research, in close association with industrial effort, plays its essential part in national recovery.

The next few years will show whether the new policy is sufficient to enable the research associations to weather the difficulties of the long period that must still ensue before the indifference and inertia, in this matter of research, of the general body of manufacturers (more particularly perhaps of those engaged in industries that have been hitherto largely run on rule of thumb) can be overcome. Obviously, very much will depend, in each case, on the minimum subscription income fixed to qualify for grant. The Advisory Council states: "We do not, in any case, intend to fix it lower than an amount which, in our opinion, would be sufficient to maintain the Association in being as a useful nucleus of research. The State's contribution would then be used to assist in transforming the nucleus into a well-nourished adult and productive organisation." The associations must take hope from the biological fact that nuclei are generally small, and that it should be well within their powers to provide the funds necessary to maintain an organisation that can satisfy the Department's idea of a useful nucleus. The Department has of course a duty to the taxpayers not to put the limit too low: it has a corresponding duty to the

cause of industrial research, which its own inclination will prompt it to fulfil, not to put the limit so high as to make it prohibitive.

Before or at this point the question naturally arises whether the work already done by the research associations has justified their foundation and the money expended by them. On this point the Advisory Council—and it is in the best position to know—says categorically: "The main purpose has, in our opinion, already been achieved. Co-operative research has proved its value, it has come to stay, and we agree with the views expressed in the memorial on the importance of consolidating now the financial position of the Associations." The final report of the Balfour Committee on Industry and Trade, issued on Mar. 11, emphasises the importance of progress in scientific research and a clearer line of demarcation between the function of the State and that of industrial undertakings either singly or in co-operation. In particular, the Committee urges that there should be no relaxation or curtailment of the efforts of the Department of Scientific and Industrial Research, and no withdrawal of financial support on the part of the Government.

In connexion with this last recommendation it is worth notice that the late Prof. Alfred Marshall, the distinguished economist, in his "Industry and Trade", first published in 1919, specifically recommended public grants to research associations on other and perhaps unusual grounds. After pointing out that the research associations are "wholly constructive", he says: "But the experience of the ages shows that Associations set up for constructive purposes are in danger of being turned to destructive ends: and therefore it may perhaps be to the public interest that some limited contribution should be made from public funds to the support of such Associations, partly in order to facilitate the intervention of public authority in case an association should develop anti-social tendencies." The reader may find it interesting to make speculations on the character of these "anti-social tendencies" presumed to be latent in the research associations.

There is a great area of British industry occupied by numerous medium-sized and small firms, directed by strongly individualistic owners, too small to enable industrial research to be prosecuted, on any adequate scale, on an individual basis. Despite the modern tendency towards larger aggregations of capital by the fusion of smaller firms, it is likely that a very great field of British industry will continue for long to be represented by these medium-sized or small manufacturing units. For them the only practicable scheme of industrial research, on a sufficient scale, is co-operative research, *i.e.* the organised co-operation of groups of firms to provide the funds and the equipment, both personal and material, for the needed research. In this field it is most important to find for Government action the golden mean between policies of *laissez-faire* and spoon feeding.

Geometry and Relativity.

Philosophie der Raum-Zeit-Lehre. Von Prof. Dr. Hans Reichenbach. Pp. vi + 380. (Berlin und Leipzig: Walter de Gruyter und Co., 1928.) 18 gold marks.

THE appearance of a work on the philosophy of a branch of mathematical physics by a trained philosopher, who at the same time has a thorough knowledge of mathematical and physical methods and principles, is an event as rare as it is welcome. This book by the Berlin philosopher Reichenbach, well known to mathematical physicists by his writings on relativity, is unique and should be in the library of everyone interested in geometry and relativity in their philosophical as well as mathematical and physical aspects, fully deserving a place beside the standard treatises of Bertrand Russell and Whitehead. It is divided into three sections, the first on space (120 pages), the second on time (45 pages), and the third on space-time (155 pages), whilst there is an appendix (42 pages) on Weyl's extension of Riemannian geometry and the geometrical interpretation of electricity, which forms the basis of a recent paper by the same author on Einstein's new field theory of gravitation and electricity. In the brief space available here it is impossible to do full justice to the author's argument, but the following summary may be useful as an indication of the character and scope of this very important work.

In the first section the argument proceeds as follows: there is no pure intuition *a priori*; all intuition is determined by past experience. Non-Euclidean geometry is just as intuitive as Euclidean, but one must not expect to be able to imagine non-Euclidean geometry by means of Euclidean elements. Experience decides which geometry is valid in actual space, but the decision presupposes an arbitrary correspondence definition (*Zuordnungsdefinition*), which defines the unit of length in a given place and permits of a definition of congruence of lengths in different places by means

of transportable rigid measuring rods. Any geometry may be made to agree with the behaviour of actual measuring rods by postulating suitable universal forces, so that the deviations from the selected geometry are made to depend on universal deformations of the measuring rods.

In the second section the author develops rather novel views. Whilst recognising the fruitfulness of the mathematical conception of space and time as a fourfold, he emphasises the point that thereby time does not lose its special character and become a fourth space dimension. The comparison of times, like that of lengths, depends on an arbitrary correspondence definition, which defines simultaneity of events occurring in different places. Order in time is determined by the law of causality, for the effect is later than the cause, and we can distinguish the cause from the effect, because small variations in the former produce small variations in the latter, whilst the converse is not true. The comparison of time-orders in different places depends upon the propagation of signals, and experience shows that the greatest signal velocity is that of light and is finite, so that to every instant of time at a given place there corresponds a finite interval of time at a second place, in which no instant can be connected with the first by a to-and-fro signal. Hence the given instant at the first place may be defined as simultaneous with any one instant of the corresponding time interval at the second place.

In the third section the author first discusses space-time manifolds free from gravitation, pointing out that comparison of lengths in relative motion to one another requires a new correspondence definition, which defines the length of a moving segment as the distance between simultaneous positions of its two endpoints. Experience shows that material structures, like measuring rods and clocks, conform to the relativistic and not to the classical light geometry, so that they measure 'intervals', not spaces and times. Passing on to manifolds with gravitation, the author gives the history of the idea of the relativity of motion from Leibniz to Einstein, pointing out that the very idea of motion is meaningless without a correspondence definition of rest: the relative motion of the earth and fixed stars is itself not an absolute fact, but only relative to systems of co-ordinates realisable by means of rigid bodies. He then analyses in turn Einstein's principle of equivalence and its hypothetical character, his concept of gravitation and its covariance, and his treatment of the rotation problem and idea that every system of co-ordinates requires its own gravitational field and points out the failure of some of the critics to realise that the relation of cause and effect is invariant, not covariant. This analysis of the space-time properties of gravitational fields leads the author to the important conclusion that the combined space-time order is the order scheme of causal sequences and expresses the causal structure of the world.

The final discussion of the general properties of space and time begins with the characterisation of time as that dimension of the space-time manifold which determines the direction of the world lines of things distinguished by the preservation of their identity, which direction is also that of the causal sequences. Then follows a discussion of the number of dimensions of the space-time manifold, ending with the conclusion that the assertion that physical space has three dimensions is on a par with the assertion that matter exists in three states of aggregation: it describes a fundamental fact of the objective world, for which no explanation has yet been found. Finally, the author declares that the reality of space and time follows inevitably from his analysis of the problem.

The appendix begins with the reminder that Riemannian space presupposes congruence definitions realisable by means of rigid measuring rods and clocks, which can be displaced along different paths without violating their properties of congruence. If, however, two measuring rods, congruent at the same place and time, cease to be congruent after displacement to another place by different paths, some displacement law is needed to determine the changes of length and direction due to displacement. This can be supplied by the postulate that a certain vector at one point after displacement can be identified with a second given vector at another point—this correspondence defines a displacement process and determines a displacement space (*Verschiebungsraum*), just as the usual congruence definition determines the 'metric space'.

In order that the two definitions may lead to mutually consistent results, certain conditions must be imposed: we may demand that the displacement law shall have a certain symmetry and thus derive Riemannian space from the most general metric space, or that the displacement of lengths shall be integrable, that is, independent of the path, and thus derive a general Einstein's space, or we may impose both conditions and thus derive Euclidean space. The displacement process can be realised by means of rigid measuring rods and clocks, and then it determines a length displacement and a gravitational field; or it can

be realised by means of an electrically-charged mass particle, and then it determines a directional displacement and an electromagnetic field. But whilst the geometrical interpretation of gravitation given by the length displacement has led to an increase of physical knowledge in the shape of Einstein's theory of gravitation, the geometrical interpretation of electricity given by the directional displacement has not led as yet to any advance in the physical theory of electricity.

Geophysics.

Handbuch der Experimentalphysik. Herausgegeben von W. Wien und F. Harms. Unter Mitarbeit von H. Lenz. Band 25: *Geophysik.* Teil 1. Unter der Redaktion von G. Angenheister. Pp. xiv+699. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1928.) n.p.

GEOPHYSICS, like astronomy, is advanced jointly by observation and theoretical discussion, and direct experimental illustration of its phenomena is rarely possible. The inclusion of this book in a 'handbook' of experimental physics is therefore slightly anomalous, but the volume is none the less welcome. Geophysics is of immense scope, because a wide variety of physical properties have to be examined as regards their distribution over the globe, and in many cases also as regards their variations over long periods of years. Observation is the primary necessity, but devotion to this duty creates difficulty owing to the volume of the data accumulated. The next task, scarcely less important, is to distil the essential facts from this vast material—a laborious process, involving the systematic comparison of data from many stations and, in some cases, heavy computations upon long series of observations to investigate periodic and other changes. The third and, in general, most difficult task is to bring the phenomena thus elucidated into relation with general physics; many hypotheses may have to be examined, sometimes requiring extensive mathematical developments and the extrapolation of laboratory results to extreme conditions of temperature or pressure. Frequently, the hypotheses prove totally at fault as regards order of magnitude, while in other cases judgment must be held in suspense because some of the factors involved are not yet capable of measurement.

Owing to these difficulties, geophysics makes slow progress, but, as in general physics, the discovery of new fields of observation, and the advance of instrumental technique, are throwing light from new directions upon obscure problems, though also disclosing new mysteries for solution. A worker in any special branch of geophysics must, therefore, keep acquainted with the progress made in other branches, as well as with general physics. Unfortunately, there is a dearth of books summarising geophysical knowledge, and the present volume is a useful supplement to those that exist.

This volume is only the first part of the geophysical section of the 'handbook' (as the series of more than twenty-five bulky tomes is curiously called); since no indication is given of the contents of the further parts, it is impossible to judge the balance of the work, or the extent to which the ground will be covered. This first part is devoted mainly to the atmosphere, with the partial exception of the last section, on terrestrial magnetism, which may be intended to achieve the transition "from dizzy heights to solid earth". The first quarter (165 pages) of the book, by A. Defant, deals with the general dynamics and statics of the atmosphere, apart from its tidal and thermal oscillations—an interesting but little-known chapter of geophysics, of which an excellent account (48 pages) is given by J. Bartels. W. Milch summarises the optics of the atmosphere (44 pages), and H. Benndorf the electrical phenomena (128 pages) apart from the aurora, which is described by L. Vegard (94 pages), and the penetrating radiation (K. Büttner, 48 pages). Terrestrial magnetism (158 pages) is dealt with by G. Angenheister and J. Bartels. The book concludes with good indexes of subjects and authors.

Owing to the small scale of the book in relation to the wide scope of the subject, the treatment is necessarily brief and general. Its value must be judged by the extent to which it indicates the main outlines, results and problems of each section, and by the guidance to the literature which is afforded for those readers who wish to follow up any question in detail. In the latter respect the book is somewhat unequal, as is natural in a collective work; in some sections the references are carried up to 1927 or even 1928, the year of publication, while in others there are few so late as 1926, though much of importance has since appeared; a rather long interval seems to have elapsed between the preparation of some of the sections and the publication of the book.

The general treatment is good, notably so in some sections, and the book is well illustrated. Where controversial or uncertain points are touched on, the position is usually explained with proper reserve. Vegard's article on auroræ is the least satisfactory in this respect, since it unduly stresses

his own theory of the auroral spectrum and the upper atmosphere. In an addendum inserted during proof-correction, McLennan's identification of the green auroral line as due to oxygen is admitted, but the remainder of Vegard's theory, postulating an atmosphere above 90 km., composed of frozen nitrogen crystals upheld electrostatically, is maintained. The aurora is still very mysterious, but there are probably few physicists who would accept this solution.

The conditions in the upper atmosphere are touched on in several sections of the book ; Defant and Benndorf seem to favour the view that hydrogen is the main constituent above 100 km., though to the reviewer the balance of evidence seems opposed to this conclusion. On p. 3, Wegener's hypothetical substance geocoronium is mentioned ; surely this speculation might by now have been allowed to lapse into oblivion, being, as it is, totally at variance with modern atomic physics and the evidence of the mass-spectrograph. The work of Lindemann and Dobson on the upper-air temperature is only briefly mentioned, though their conclusions now seem fairly established by confirmatory evidence drawn from the abnormal propagation of sound to great distances, and from the absorption of solar radiation by ozone. But while in a few respects some parts of the book fall short of the thoroughness commonly attributed to German works of reference, it would be wrong to magnify minor faults in a work which as a whole has solid merits and can be recommended as a good general account of the subjects falling within its scope.

Spencer's "Sociology".

Descriptive Sociology : or Groups of Sociological Facts, Classified and Arranged. By Herbert Spencer. *Hellenistic Greeks.* Compiled and Abstracted upon the Plan organised by Herbert Spencer, by the late Sir J. P. Mahaffy and Prof. W. A. Goligher. (Completed by Prof. W. A. Goligher.) Issued by Mr. Spencer's Trustees. Pp. vi+94. (London : Williams and Norgate, Ltd., 1928.) 63*s.* net.

"A LARGE book," said a Hellenistic Greek, "is a large evil." What are we to say of one the dimensions of which are nineteen and a half inches by twelve and a half ? It will go into no ordinary shelf ; it is awkward at best to handle ; the tops of the three parallel columns of small print which fill each page are most inconveniently remote to the myopic. The physical difficulties of the format are doubtless imposed by Spencer's belief, which I do not personally share, in the utility of an elaborate chart of tabulated conclusions. The book in shape and substance is drawn up according to Spencer's plan and, regarded as a monument *in piam memoriam*, it is well and truly constructed.

It would of course be easy, as in all compilations of this scale, to make reviewer's points. A few accents have gone wrong ; there are some misprints; the bibliography does not, as the preface suggests, mention all the works from which quotation is made. In the illustrative passages taken from ancient authors it might be held that for the last period too exclusive reliance has been placed upon Lucian and Plutarch. Some of the moderns who are cited might be thought a little old-fashioned. Did not Rostovtzeff's book appear in time for inclusion among writers on the Imperial period, and why should references be given to the second edition of Dittenberger's "Sylloge", the numbering of which has been superseded by the third ? Again, one might catch some little point : for example, the belief that Prof. Goligher shares with Rohde that oriental influence had something to do with the total veiling of women at Tarsus. The gloss becomes unnecessary when it is realised that what we may call severity in veiling varied in different Greek States, and that the Theban women, for example, in European Greece wore veils which permitted nothing but the eyes to be seen.

These are, however, small and some of them disputable matters. No one who has a professional interest in ancient history will refuse his meed of admiration for the wide knowledge, industry, and patience which Prof. Goligher has expended on his task. At that we might leave it, were we not bound to ask whether the result justifies the very considerable labour which has gone to its achievement. Regarded as a memorial to Herbert Spencer the book might earn a favourable verdict, but regarded as a useful contribution to ancient history the answer must be less confident. Clearly, it is not intended for cursive reading and will not fall easily into the category of a scholarly presentation of the subject to the general public. Of works for the specialist reader there are three useful kinds : either we expect them to contain new matter of fact or theory which is the result of original research ; or, secondly, we look for the presentation of known facts in a new light ; or, thirdly, we are grateful for a handy and complete compilation of facts already known. It is in the last category that the book must claim to stand, and here it must be confessed that it is vastly inferior in content as well as in convenience of format to the great dictionaries with which the

classical student of to-day is so well supplied. From them information more detailed and more complete can be obtained with greater ease and, it may be added, a more structural knowledge of the problems connected with the interpretation of the evidence. W. R. H.

Preston's "Heat".

The Theory of Heat. By Prof. Thomas Preston. Fourth edition, edited by J. Rogerson Cotter. Pp. xix+836. (London: Macmillan and Co., Ltd., 1929.) 25*s*. net.

TO publish a fourth edition of a scientific work thirty-five years after the appearance of the first edition is a high tribute to the author, particularly when, as in this instance, no very fundamental change has been made in the scheme of the book. It is the more notable in experimental science, since Preston could write in 1894 that "It is but a short time since the pursuit of experimental research was regarded merely as a matter of individual curiosity".

Whilst it is not easy to single out any one specific reason for the active survival of "The Theory of Heat", there seem to be in it several outstanding features which have combined to contribute to its continued usefulness. The most essential of these is undoubtedly Preston's singularly clear and accurate style. One wishes, in fact, that the first chapter, with its admirable general introduction to the subject, the seventh, on conduction, and the following one on thermodynamics—which is perhaps the best elementary account that has been written, and of which Preston is said to have been justifiably proud—could be obtained separately for examination purposes by students who have no use for the whole volume. Another reason is in the time at which Preston wrote. The epoch-making work of the end of the century on the electron had still to be done, and there can sometimes be sensed in contemporary writings the feeling that the apparent limitations of the scientific horizon were real.

Preston, whether or not he subscribed to this view, can scarcely fail to have been aware of it—he took the precaution of pointing out that "any theory, however plausible, may ultimately become untenable"—and he could thus write with greater confidence than if he had started a few years later, when he had become interested in the new physics, and was himself engaged in research on the Zeeman effect. It must also be remembered that he was dealing not only with a subject that appeared to be sound theoretically, but also that even then he had to describe experiments that aimed at, and often attained, considerable precision. Again, Preston states that he was attempting "to treat the science of heat in a comprehensive manner", and not "to meet the requirements of some particular class of persons preparing for examinations or engaged in practical pursuits", an ideal which is also realised in Tyndall's earlier "Heat a Mode of Motion" and Kayser's original pygmy "Lehrbuch der Spektralanalyse" of 1883.

Mr. Cotter's revision of the third edition of Preston's book is chiefly on the experimental side. The square brackets which had previously marked off paragraphs which were not parts of Preston's own contribution have been removed. Several condensations and omissions have been made, notably in the description of experiments and in discussions of disputed points which have now lost their interest. In their places are accounts of some more modern investigations, which have been chosen with discrimination—for example, Stock's realisation of Kelvin's proposed vapour pressure thermometers, and Hercus and Laby's determination of Joule's equivalent—and there are several new references to quantum theory at the appropriate places in the text. The book is naturally still far from complete, but it was never intended to be a dictionary of the subject. Mr. Cotter's task has rather been to retain the spirit and scope of the edition of 1894, but at the same time to make some necessary alterations in parts that were obviously out-of-date, and in this he has been entirely successful. K. G. E.

Our Bookshelf.

Anleitung zur chemischen Gesteinsanalyse. Von Prof. Dr. J. Jakob. (*Sammlung naturwissenschaftlicher Praktika*, Band 15.) Pp. vii+81. (Berlin: Gebrüder Borntraeger, 1928.) 7 gold marks.

THE lack of a short but comprehensive work dealing with rock analyses has inspired Prof. Jakob to produce this book, which is intended primarily for the use of students in the laboratory. It may be placed in the hands of a beginner possessing a sound knowledge of general chemistry, and will enable him to carry out a complete analysis.

The author makes a distinction between rock and mineral analyses, each calling for a different method of treatment. In a mineral analysis the object is to attain the most accurate result possible, independent of time; with a rock analysis, on the other hand, it is to produce in the shortest possible time a sufficiently accurate result to represent the specimen. Any two independent analyses carried out on the same powder show points of divergence, and this is even greater in the case of two portions of

the same rock, hence great accuracy of method is not practical and does not justify the time necessary. At the same time, however, Prof. Jakob considers that analyses should be more accurate than many quoted in the literature.

Directions are given for the preparation of the sample, fineness of grinding, etc., depending on the presence or absence of certain minerals and also on the determination to be carried out. The main part of the book deals with the determination of the various oxides, a useful feature of this section being the incorporation of all explanations of processes in the form of footnotes, leaving the text free from interruptions. All analyses must be carried out only after microscopic examination, which serves as a qualitative examination: this is most important, as the method used for the estimation of the sesquioxides, TiO_2 and MnO, depends on the quantity of the oxide present. The concluding section deals with rock analyses in general, in which the author discusses the characters of good and bad analyses; finally, he includes a description of the calculation of an analysis into Niggli values.

Vestiges of Pre-Metric Weights and Measures persisting in Metric-System Europe, 1926–1927. By Prof. Arthur E. Kennelly. Pp. xiii + 189. (New York: The Macmillan Co., 1928.) 2.50 dollars.

As the metric system of weights and measures has now been exclusively adopted by nearly every European country, it is of some interest in connexion with proposals for its adoption by other countries to ascertain, if possible, to what extent its imposition upon the various peoples has hitherto proved effective. The most obvious means of obtaining information on this matter would appear to be the study of the periodical reports and other publications of the respective Weights and Measures Departments. Disdaining, no doubt, such armchair methods, Prof. Kennelly set himself the task of collecting evidence as to the persistence of pre-metric vestiges by personal observation and inquiry in all the principal countries concerned. This he accomplished under the auspices of the Bureau of International Research, during a sabbatical leave of absence granted him by Harvard University from July 1926 until September 1927.

That the arduous but well-ordered programme of the author was carried out with scientific zeal and discrimination is abundantly apparent; that official statements are often susceptible to enlightening amplification from other sources is demonstrated by a comparison of some of the letters received from officials and laymen, respectively, in the same locality. But the net result arrived at, namely, that where pre-metric terms persist they have practically always been 'metricised' or 'sub-metricised' in actual use, does not differ remarkably from the probable conclusions of any person whose pursuits entail frequent contact with administrative publications on weights and measures. Nevertheless, this is a valuable work of reference with regard to the old units, their names, equivalents, and distribution. W. H. M.

Autolycus: or the Future for Miscreant Youth. By Dr. R. G. Gordon. (To-day and To-morrow Series.) Pp. 94. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1928.) 2*s*. 6*d*. net.

ANYONE who has acquainted himself with Dr. R. G. Gordon's larger works on "Personality" and "The Neurotic Personality" will acknowledge the *a priori* likelihood of his writing a useful and authoritative pamphlet on juvenile delinquency, including the way in which society itself does much to produce its quota of pickers-up of unconsidered trifles. He quotes Samuel Butler to the effect that in "Erewhon" a man who catches a disorder is punished, whereas a thief or a rick-burner is sent to a hospital; and the burden of his argument is that Butler's paradox is not so violent as it seems at first sight. We punish the child who marks the wall-paper, instead of giving him materials for the proper exercise of his artistic prowess; we punish the boy who plays football in the street, instead of providing him with a playing-field; and we assume that a girl who has been rescued from a life of infamy is best dealt with by being pitch-forked into domestic service or into a public laundry. Dr. Gordon gives a simple and eminently readable account of the social, educational, psychological, and medical factors involved in the treatment of miscreant youth, and he makes a case for the calmly scientific instead of the emotional and half-revengeful methods which at present hold the field.

The Frog: an Introduction to Anatomy, Histology, and Embryology. By the late Prof. A. Milnes Marshall. Edited by H. G. Newth. (Macmillan's Manuals for Students.) Twelfth edition. Pp. x + 182. (London: Macmillan and Co., Ltd., 1928.) 6*s*.

MR. NEWTH has left this work, which had not been revised since 1912, in its well-known form, but has made a number of useful alterations. He has introduced into the section on technique notes on the use of methylene blue, eosin, and formalin, and has improved the instructions on section-cutting. The suggestion that the female frog should be dissected in saline solution to prevent the great swelling of the contents of the oviducts, the instructions for making and staining a blood-smear, and for the preparation of the frog's bladder to show unstriped muscle, are helpful, and the dorsal dissection of the abdominal region of the frog, for which brief directions are given, affords the student a view of the relations of certain blood-vessels and organs from another aspect, and is useful as a revision exercise. The description of the section of the retina, of the fertilisation and early development of the frog's egg, and of mitosis and meiosis, have been amended, but here and there the editor has carried over from the old edition words not consistent with his present description; for example, the use of the term 'egg' on p. 116. The terms epiblast, etc., might now be replaced by ectoderm, etc. On p. 55 the brief note on the second row of tarsal bones has been omitted.

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.*]

Palæolithic Man in Ireland.

No one ever questioned the possibility that traces of palæolithic man might one day be found in Ireland, in spite of the negative results of excavations, chiefly in caves, carried out over many years by the Royal Irish Academy and the Royal Dublin Society. From time to time individuals have announced their discovery of palæolithic implements, but in every case such reports were open to the gravest scientific objection. It is therefore with very special pleasure that we welcome the news contained in the accompanying statement, that the discovery has at last been made.

The work which has thus been crowned with success was carried out last August, by a party of the Bristol Spelæological Society, under the leadership of Mr. E. K. Tratman. It was financed by the Royal Irish Academy, and some members of that body made the local arrangements and collaborated in the excavation; but the credit of the discovery is due to Mr. Tratman and his colleagues.

A short time ago we found ourselves constrained to adopt a position adverse to a discovery of alleged palæolithic implements on the west coast of Ireland. We have never seen any reason to change our views on this matter: everything that has been written about it, and every visit which we have paid to the site, have only confirmed us in our opinion. Every possible explanation has been sought for our attitude, except the simple and obvious one that we did not, and do not, consider the 'discovery' in question to be more worthy of scientific acceptance than any of its not infrequent predecessors of the same type. We have been accused of upholding preconceived prejudices in the face of evidence. We have been accused of the yet more unworthy motives of personal or national jealousy. We are therefore the more happy in being able to express our complete acceptance of the discovery here announced, and our full appreciation of its importance.

J. KAYE CHARLESWORTH.
A. W. STELFOX.
R. A. S. MACALISTER.
R. LLOYD PRAEGER.

EXCAVATIONS AT KILGREANY CAVE, NEAR DUNGARVAN, CO. WATERFORD, 1928.

IN the summer of 1928 excavations were carried out at this cave under the auspices of a joint committee, consisting of members of the Royal Irish Academy and the Spelæological Society of the University of Bristol. The work was carried out personally by the members of the committee, assisted by students from Trinity College, Dublin, and the University of Bristol.

The excavations gave the following stratification, outside the present cave mouth.

1. Quarry debris from the roof of the former outer chamber of the cave, 0 - 2 ft.

2. Hearth number 1, of late Bronze to early Iron Age date, 2 - 4 ft.

3. A layer of brown earth and stones, with but few finds.

4. Hearth number 2. Part of a polished stone axe came from this, suggesting a very late Neolithic to early Bronze Age date. A number of human skeletons, very fragmentary, came from this level, 4 ft. - 4 ft. 6 in.

5. A stalagmite floor, divided into an upper tufaceous portion and a lower crystalline part. These were separated by a third hearth. The crystalline stalagmite was barren of remains, 4 ft. 6 in. - 9 ft.

6. A layer of loosely piled stones of unknown depth, but reaching to a depth of 12 ft. from the original surface. No remains from this layer.

The surface of layer 5 was intact, all over the area in which it was exposed. Before the task of excavating it was begun, special care was taken to ensure that all the upper deposits had been removed.

Leaning against a projecting piece of the wall of the cave, and originally held in position there by a pile of stones (which had become completely embedded in the stalagmite as this material accumulated), was a human skeleton, in a semi-crouched position, with the left side against the cave wall. As the limbs of the skeleton were traced down, through the stalagmite, to the level of the third hearth, and as there was absolutely no evidence of there ever having been any disturbance of the stalagmite by a burial inserted from above, it is obvious that the skeleton represents a deliberate burial from the level of the third hearth; a fact of first-class importance from the archæological and anthropological points of view: and one also that has important bearing on some of the geological problems of the late Pleistocene period.

The fauna yielded by the tufaceous part of the stalagmite was as follows: wild boar, Irish giant deer (or 'Irish elk'), reindeer, brown bear, wolf, fox, cat, stoat, hare, field mouse, Arctic lemming, birds, and land mollusca. This is a very typical Late Pleistocene fauna.

The presence of the skeleton, and the third hearth actually at the base of the deposit yielding this fauna, is conclusive proof of the presence of man in the south of Ireland in Late Pleistocene times. It is unfortunate that as yet no implements have been recovered, so that we cannot yet place this Late Pleistocene man in his correct division of the Upper Palæolithic cultures.

A full illustrated account of this discovery will be published in the next issue of the *Proceedings* of the Bristol Spelæological Society, now in course of preparation.

E. K. TRATMAN.

Selection Rules in the Raman Effect.

RECENT experimental work by McLennan (NATURE, Feb. 2, 1929) on liquids and by myself (*Proc. Nat. Acad. Sci.*, March 1929) on gases has shown definitely that transitions between vibrational levels of a non-polar molecule such as nitrogen, oxygen, or hydrogen take place in the Raman effect. I have pointed out that this, far from being inconsistent with the well-known selection rules, is exactly what we should expect to happen from the quantum-mechanical theory of dispersion.

The selection rule which works in the Raman effect can be stated as follows: in order that a shift corresponding to the transition $i \rightarrow k$ may be observed, it is necessary that *both* states i and k combine at least with a third state l; the Raman scattering becoming particularly intense when the energy $h\nu$ of the impinging quantum is near to $E_l - E_i$. If $E_l - E_i = h\nu$, we have fluorescence instead of a Raman effect.

The latest results I have obtained on gases, with an improved apparatus, seem to fit very well with this theoretical scheme. I will give here a brief account of them.

I have extended the investigation in the ultra-violet, using the line $\lambda 2536$ of mercury, since the intensity of

the scattered radiation increases very rapidly with the frequency of the exciting light. This proved very successful, the intensity of the Raman lines scattered in gases being sufficient to record them in a large quartz Hilger spectrograph with a 60 hours' exposure. In this way a considerable improvement in resolution has been achieved, as compared with the apparatus previously used for the visible region. An iron arc spectrum has been used as a standard, and under favourable conditions Raman lines have been measured with an accuracy of a frequency unit or better. The dispersion in the λ2536 region was 131 frequency units per millimetre.

The most interesting feature of Raman spectra excited under these conditions in oxygen and nitrogen is the appearance on both sides of the line λ2536 of a number of equally spaced lines, evidently due to rotational transitions. Four or five of them can be measured fairly well.

Now let us see what we should expect the rotational Raman spectrum of such a molecule to be like. Consider first the case of oxygen. Here the electronic bands to which the existence of rotational (and vibrational) Raman transitions is due (in the meaning that the upper levels of these electronic transitions play the rôle of the l state of the above-stated selection rule) are essentially the bands of the Schumann-Runge system, a $^3S \rightarrow {}^3S$ transition. These consist only of a P- and an R-form branch, the lower (normal) electronic state possessing only odd, and the upper only even rotational states. Now consider a molecule in the lowest electronic state, and in the mth rotational state ($m = 1, 3, 5 \ldots$). This state combines only with the $m-1$ and $m+1$ rotational states of the upper electronic level. The first of these combines with the m and the $m-2$ rotational states of the normal electronic level, the second with the m and $m+2$. So, on the whole, the possible Raman transitions from the m rotational states to other rotational states are: $m \rightarrow m-2$, $m \rightarrow m$, $m \rightarrow m+2$. The second of them involves no change in energy—that is, gives scattered light of unmodified frequency. Of the other two, we need only consider what happens in the transitions involving a degradation in frequency ($m \rightarrow m+2$), the others, of course, giving only anti-Stokes's lines symmetrical with respect to the exciting line.

At room temperature, the Boltzmann distribution gives an appreciable amount of molecules for values of m up to ten or fifteen.

Now, we have, for the rotational energy:

$$E_m = \frac{h^2}{8\pi^2 I_0}(m+1)m,$$

so that the Raman shift (in wave numbers) is:

$$\Delta\nu = (E_{m+2} - E_m)/hc = (4m+6)h/8\pi^2 cI_0.$$

We should have a pattern of equally spaced lines, the spacing being 8 times the constant $h/8\pi^2 cI_0$. Only the first line should be spaced 10 times this constant from the exciting line.

The spacing in oxygen is too small to verify this last point, as the first three or four lines on each side overlap with the over-exposed image of the λ2536 line. But it was possible to measure fairly accurately the spacing of the lines. This gave the result $\Delta\nu = 12{\cdot}0 \pm 0{\cdot}5$ cm.$^{-1}$. Ossenbrüggen finds the value $\Delta\nu = 11{\cdot}5$ cm.$^{-1}$, thus agreeing within the limits of experimental error (W. Ossenbrüggen, *Zeit. f. Phys.*, **49**, 167; 1928; R. S. Mulliken, *Phys. Rev.*, **32**, 186; 1928). The triplet separation of the normal state in oxygen (R. S. Mulliken, *Phys. Rev.*, **32**, 880; 1928) is much smaller (2 cm.$^{-1}$), and we do not need to take it into account.

With nitrogen I have obtained a much better plate, on which the rotational components could be measured within a few tenths of a frequency unit. I give in the following table the measured frequencies, the meaning of the calculated values being explained later:

Obs.	Transition.	Calc.	Difference.
39504·4	12 → 10	39504·6	−0·2
39489·1	10 → 8	39488·6	+0·5
39472·5	8 → 6	39472·6	−0·1
39466·6	6 → 4	39456·6	0
39412·6	Exciting line	39412·6	..
39352·6	6 → 8	39352·6	0
39336·6	8 → 10	39336·6	0
39320·5	10 → 12	39320·5	−0·1
39304·4	12 → 14	39304·4	−0·2
39288·4	14 → 16	39288·4	−0·2

Here the spacing of the lines is $16{\cdot}0 \pm 0{\cdot}1$ cm.$^{-1}$. If we assume that alternate rotational levels are missing, and that the electronic bands effective in the phenomenon—in this case the so-called $X \rightarrow a$, $^1S \rightarrow {}^1P$ bands (H. Sponer, *Proc. Nat. Acad. Sci.*, **13**, 100; 1927) consist only of a P- and R-branch, we deduce for N_2 in the normal state $h/8\pi^2 cI_0 = 2{\cdot}00 \pm 0{\cdot}01$ cm.$^{-1}$, which gives for the moment of inertia:

$$I_0 = 13{\cdot}8 \pm 0{\cdot}1 \times 10^{-40} \text{ gm. cm.}^2.$$

We have, so far as I know, no data on which to check this result; but the value seems reasonable. If we had not assumed alternate levels to be missing, we should have found half this value, which is evidently too small.

The measurements in this case are accurate enough to extrapolate the position of the first rotational line. The calculated values in the table are obtained from the formula

$$\Delta\nu = 2{\cdot}00\,(4m+6), \qquad m = 0, 2, 4, \ldots$$

using for m only *even* integral numbers. As satisfactory an agreement as this could not be obtained with a slight change in the constant 2·00 and the use of odd values for m.

So, on the whole, this seems to give support to the hypothesis that in the normal state of N_2 only even rotational states are present, or, at least, they have a higher statistical weight than the odd ones. An investigation of the structure of the $X \rightarrow a$ ultra-violet bands of N_2 would show whether these deductions are correct.

Now, I think we can explain the, at first, rather puzzling fact, that the Raman lines corresponding to vibrational transitions in N_2 and O_2 (respectively 2331 cm.$^{-1}$ and 1554 cm.$^{-1}$) show no rotational structure, but, even with the higher dispersion of the quartz spectrograph, appear as single lines. We have, of course, all the allowed rotational transitions ($m \rightarrow m+2$, $m \rightarrow m$, $m \rightarrow m-2$, for example, in O_2), but we must consider that each of those involving a change in m gives a *different* line; instead, when m is unchanged, the position of the line is nearly independent of m, because of the *very small* change in the constant $h/8\pi^2 I$ between the zero and the first vibrational state. So the line given by *all* the transitions $m \rightarrow m$ has a very high statistical weight, and is practically the only one observed.

I have obtained, also, the Raman spectrum of gaseous hydrogen. It gives two lines excited by λ2536, shifted by 583 cm.$^{-1}$ and 4159 cm.$^{-1}$ respectively. These have already been found in liquid hydrogen and explained by McLennan.

I will make a last remark concerning the Raman spectrum of carbon dioxide. In a recent letter to NATURE (Feb. 9, 1929) I pointed out that the frequency observed in the Raman effect, $\nu = 1284$ cm.$^{-1}$,

is practically coincident with the difference between two frequencies observed in infra-red absorption. Now, I notice that Eucken (*Zeit. f. Phys.*, **37**, 714; 1927), in his theory of the straight-line model of the carbon dioxide molecule, assumes the existence of an 'inactive' frequency, $\nu = 1274$ cm.$^{-1}$, and the validity of the above-mentioned relation, at least to a first approximation. Thus the data on the Raman effect give strong support to Eucken's model of the carbon dioxide molecule.

F. RASETTI.

California Institute of Technology,
Pasadena, California,
Mar. 15.

Floating Mercury on Water.

IN a letter in NATURE of Mar. 16, Mr. N. K. Adam describes the floating of small globules of mercury on a water surface, even when the latter was considerably contaminated. He concludes that for equilibrium to be possible, the mercury-air tension must have been reduced by the order of one or two hundred dynes. It is not necessary to suppose such a decrease. It appears that the part played by curvature of the surfaces in determining conditions for the equilibrium or the spreading of one liquid on another has been neglected. Experimentally, we have the observations of Burdon (*Proc. Roy. Soc.*, **38**, 2, 154; 1926), who found that water would spread over the surface of a large, clean mercury drop, but that its progress was stopped when the curved edge of the drop was reached, where acceleration 'downhill' would be expected.

The familiar criterion for spreading is derived, sometimes from the consideration of the three 'tensions' involved and the possibility of constructing a Neumann triangle, but more often from the point of view of surface energy. Spreading will occur if the advance of the liquid brings about a decrease in the total surface energy. Let T_1, T_2, T_{12} be the tensions involved, and let the increase in area when the liquid 1 advances a small distance A to B be S (Fig. 1*a*). The increase in energy is then $T_1 S + T_{12} S$ and the decrease is $T_2 S$. Then for spreading, $T_2 S > T_1 S + T_{12} S$ or

$$T_2 > T_1 + T_{12}. \quad . \quad . \quad . \quad (1)$$

But suppose now that the surface of the lower liquid 2 is curved, as in Fig. 1*b*. Here the decrease in energy

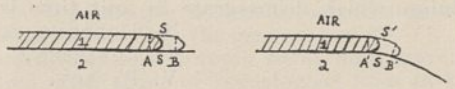

FIG. 1.

is still $T_2 S$, but the increase is now $T_1 S' + T_{12} S$ —where S', the increase in area of the liquid-air surface of 1 is *not necessarily equal to* S. Then the condition for spreading becomes

$$T_2 > T_{12} + T_1 \frac{S'}{S}. \quad . \quad . \quad . \quad (2)$$

If S' is greater than S, it is quite possible that even if condition (1) is fulfilled, that is, spreading occurs on a plane surface, (2) is not; spreading is stopped by the curvature.

Using the figures given by Mr. N. K. Adam for the uncontaminated liquids, spreading would be stopped if the ratio S'/S were greater than 1·4 : 1, so that spreading may have been stopped by the curvature (0·5 mm. diameter) without the considerable lowering of the tension stated.

Yet for the curved surface as for the plane, the condition that the Neumann triangle cannot be drawn is still (1), and from the point of view of the equilibrium of tangential forces at the interfaces, it is difficult to see how curvature can enter into the problem. It seems to me that this is another indication of the many that the conception of three tangential forces at a point—and of Neumann's triangle—is wholly inadequate to represent the forces involved in capillary phenomena.

It may be noted that in Coghill's work on lenses of oil floating in water (*Tech. Paper* 262, Bureau of Mines, Washington, 1923) the measured interfacial angles did not agree with those calculated from the Neumann triangle.

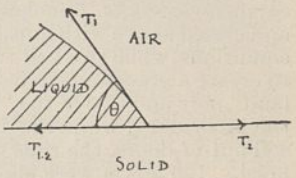

FIG. 2.

It must have been often remarked that in the case of a liquid in contact with a solid, for example, the three tensions alone are, to any student of elementary mechanics, not in equilibrium, though few text-books mention that other forces have been omitted or explain what these forces are. If the 'tensions' do not give an adequate representation here, why can we assume that they are sufficient in other problems? Theoretically unsound, the Neumann triangle has no experimental usefulness—and the 'spreading coefficient' used by Hardy and Harkins is limited in its application to plane surfaces.

C. A. C. BURTON.

University of Toronto,
April 5.

IN a letter appearing in NATURE for Mar. 16, Mr. N. K. Adam describes floating mercury droplets. These droplets are minute (0·5 mm. in diameter), and Mr. Adam evidently regards them as fluid throughout supported by the surface tension of the water.

In a letter to NATURE for July 2, 1903, p. 199, I described the production of mercury bubbles floating on water. These might be any size up to 2 cm. in diameter, and were supported not by surface tension but by flotation, as might be seen from the fact that they floated even when the water-film was continuous over them. Measurements of the weights of mercury forming these bubbles and estimations of the thicknesses of their skins were given.

HENRY H. DIXON.

School of Botany,
Trinity College, Dublin, Mar. 17.

Hibernation of *Lucilia sericata*, Mg.

SINCE the hibernation of the Muscidæ affords such general interest, it is felt that recent observations on this phenomenon as exhibited in the particular species *Lucilia sericata*—the most important entomological pest of sheep in North Wales—are worthy of note.

It should be explained that my interest in the hibernation of *Lucilia sericata* arose as a result of a survey of 'Maggot Flies' attacking sheep in North Wales in 1928, which showed that *sericata* was the only species concerned.

All larvæ used during these observations were taken by farmers direct from infested sheep. When received, at almost daily intervals throughout the season, they were placed in the insectary in cages containing a piece of fresh meat on soil. From May 5 until Sept. 8, the period which elapsed between the receipt of the larvæ at the laboratory and the date of emergence was fairly constant—on the average 21 days. The majority of the larvæ received on Sept. 8 and 10, however, had not pupated by Oct. 10. Instead, many remained quiescent in the soil at the bottom of the cages, while

others had entered empty pupa cases. Further, it was noted that not a single larva of the ten subsequent batches—the final batch being received on Oct. 27—had pupated.

On Oct. 15, 720 such larvæ, received from various sources, were available for hibernation observations and were used in the following experiments. Six earthenware pots, 5 inches deep, were filled with soil and closed above with muslin ; four represented arable conditions, while two had turf placed on top of the soil to create a grassland environment. One of the ' grassland ' pots and two of the ' arable ' pots were placed in the laboratory, while the duplicates were sunk in the soil out-of-doors, the rims of the pots being at ground level. 120 larvæ were allowed to drop on to the surface in each of the pots ; all had burrowed out of sight in about 15 minutes. A week later larvæ were found at the bottom of each pot.

Periodic examination of the out-of-door pots showed that the larvæ remained thus buried and in a quiescent state throughout the winter ; the mean daily temperatures (taken just above the pots) for the months concerned being: Oct., 59·85° F.; Nov., 51·09° F.; Dec., 43·58° F.; Jan., 41·77° F.; Feb., 43·76° F.; Mar., 52·98° F.; April, 57·3° F.

On Feb. 14, with a minimum temperature of 16° F., the soil was completely frozen, yet the quiescent larvæ when disturbed proved to be viable. No activity was observed in the pots until the period Mar. 20–26 (mean daily temperature, 53·86° F.), when it was noticed that the larvæ were making their way towards the surface. They eventually came to rest at a level approximately $\frac{1}{4}$ in. below the surface. On April 2 the first pupa was found, and by April 10 the majority of the larvæ had pupated. The first fly emerged out-of-doors on April 27.

Observations on the indoor series gave similar data, except that the flies emerged at an earlier date ; the first being found on April 10. The mean temperature throughout the winter was more or less constant at 51° F. (since the last week in March it has risen about 9°). The humidity was maintained by daily watering of the pots.

The hibernation of *Lucilia sericata* has not, so far as I am aware, formed the special study of a previous worker. Mention is made in some works of the difficulty experienced in getting the larvæ to pupate in the autumn, but there is no suggestion that the insect overwinters in the larval stage. Records from S. Africa and New South Wales show that adults have been trapped throughout the year, while in the United States research has indicated that *sericata* overwinters in the larval and pupal stages.

From the observations here mentioned it would appear that the normal mode of hibernation of *Lucilia sericata* in North Wales is in the larval stage. Further, while the return of the larvæ to the surface after overwintering and prior to pupation obviously facilitates emergence, it should be pointed out that at this time they are more open to control methods than at any other stage after leaving their host.

W. MALDWYN DAVIES,
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Cosmic Radiation and Radioactive Disintegration.

DR. L. R. MAXWELL, in NATURE of Dec. 29, 1928, gives an account of experiments intended to show the influence of cosmic rays on the speed of radioactive disintegration of polonium. According to Perrin, the radiation may be regarded as a possible cause of radioactive changes. The detailed study of cosmic rays, carried out lately by numerous investigators, and the determination of their probable wave-lengths, combined with the ideas of Perrin, involuntarily led us to think that the cosmic rays may be the real cause of radioactive processes. The frequency of cosmic rays is of such magnitude that their quanta ought to be sufficient to disintegrate the nucleus.

At our request, Mr. E. Halfin, in June of 1926, performed some experiments with radon analogous to those of Dr. Maxwell. The activity of two nearly equal quantities of radon was carefully measured, and thus the exact value for the ratio of the activities of two chosen samples was obtained. Immediately after, one sample was let down to the bottom of the Gulf of Finland to a depth of about 20 feet and the other sample was left in the laboratory. After several days the first sample was taken out, and the comparison of the activities of two samples was repeated in the laboratory. These experiments have shown that, within the limits of possible errors, the speed of disintegration of the sample of radon which was kept under the water did not appreciably change. The error of the corresponding measurements in any case did not exceed 1 per cent. Our experiments with radon and Dr. Maxwell's experiments with polonium show that the cosmic rays do not affect in appreciable degree the speed of disintegration of either radon or polonium. These facts lead us to the conclusion that the disintegration of the two elements investigated is not, at least entirely, due to the action of cosmic rays.

It would not be correct though, on this ground, to deny any influence of the rays on radioactive processes. As a matter of fact, the total intensity of the cosmic radiation is so small that it is quite possible that it affects in some way a very minute number of radioactive atoms, and its action cannot be detected, especially in the cases of radioactive atoms of short life.

The cosmic rays, furthermore, may perhaps give a start to the disintegration process in the radioactive family and actually cause the disintegration of the first element in the family, for example, uranium. Experiments with this element (observation of the growth of activity of uranium X_1) might throw some light on the last question. In this case the total intensity of cosmic rays might be sufficient to account for the radioactive process, as the number of atoms of uranium which disintegrate in unit time is very small.

N. DOBRONRAVOV.
P. LUKIRSKY.
V. PAVLOV.

Leningrad.

The Structure of the CH_4 Molecule.

IN a recent investigation of the ionisation processes in methane, Hogness and Kvalnes (*Phys. Rev.*, **32**, December 1928), using a mass-spectrograph method, find that at 14·5 volts only CH_4^+ ions are formed, but at 15·5 volts two processes occur ; either stable CH_4^+ ions are formed or unstable CH_4^+ ions which dissociate spontaneously into CH_3^+ ions and neutral hydrogen atoms, the probabilities of the processes occurring being approximately equal over a wide range of pressure.

Two models have been proposed for the CH_4 molecule, one having a C^{4-} central ion of neon-like character, the other having a C^{4+} central ion, but neither of these models will explain the results quoted above. If the four chemical bonds in methane consist of pairs of shared electrons, each pair being formed by an L electron of the carbon atom and a hydrogen

electron, then a simple explanation can be given, for since there are two 2_1 and two 2_2 electrons in the carbon atom, two of the bonds will differ from the other two, that is, two of the pairs of electrons will be differently bound from the other two. Two ionisation potentials would therefore be expected having approximately equal probabilities of excitation. This assumes that the ionisation potential of either of the two electrons forming a bond is the same. That two of the bonds in methane differ from the other two is in agreement with Mrs. Lonsdale's view that the carbon atom has two different kinds of valencies (*Phil. Mag.*, **6**, p. 433 ; 1928), and is also supported to some extent by the observation of Cabannes and Gauzit (*Jour. de Phys.*, **6**, p. 182 ; 1925), that methane has a small depolarisation factor, an indication of small optical anisotropy. Experimental evidence also tends to show that models of the methane molecule having either a C^{4-} or a C^{4+} central ion are incorrect (cf. T. H. Havelock, *Phil. Mag.*, **3**, p. 444 ; 1927 ; **4**, p. 721 ; 1927).

G. W. BRINDLEY.

Physical Laboratories,
University of Leeds,
April 26.

The Constitution of Oxygen.

DR. F. W. ASTON has remarked (NATURE, **123**, 488 ; Mar. 30, 1929) that he finds no positive ray evidence for the existence of isotopes of oxygen, and he states that if 0^{18} exists, as concluded by Giauque and Johnston (NATURE, **123**, 318 ; Mar. 2, 1929), it must be in a proportion less than 1/1000 of 0^{16}.

Giauque and Johnston based their result on data published by Dr. Dieke and myself (*Proc. Nat. Acad. Sci.*, **13**, 670 ; 1927). Further evidence bearing on the question has now been found, confirming the existence of 0^{18}, and also the limiting proportion set by Aston. From spectrograms made with low solar altitude it has been possible to augment the A' band of oxygen from 26 lines, as formerly described, to 73 lines. About one-half of these belong to the alternate system of doublets which are to be expected from the unsymmetrical molecule 0^{16}–0^{18}, while the rest of the new lines are extensions of the previously recognised system of doubtlets. The observed positions of the lines of this band agree with those calculated for the isotopic molecule, and the new data thus decisively confirm the existence of 0^{18}.

Intensities of the isotopic band lines have been compared with those of homologous lines in the A band by so choosing the lengths of air-path as to make the two bands appear alike when registered with the same spectrograph. From the ratio of the air-paths it was found that the A band is 1250 times as intense as the A' band, and, approximately at least, this represents the relative abundance of the molecules 0^{16}–0^{16} and 0^{16}–0^{18}. More complete discussion will be found in a forthcoming paper in the *Proceedings of the National Academy of Sciences*.

HAROLD D. BABCOCK.

Mount Wilson Observatory,
Pasadena, California,
April 15.

Selective Absorption by Excited Mercury Vapour.

OUR attention has been directed to a paper by M. M. Ponte on the selective absorption by excited mercury vapour (*Comptes rendus*, **187**, 37-39, July 2, 1928) giving results of photometric measurements on the prominent lines in the arc spectrum of mercury. M. Ponte refers to a paper by us on the same subject (*Proc. Roy. Soc.*, A, **100**, p. 149 ; 1921), but does not notice a paper by Turner and Compton (*Phys. Rev.*, **25**, 606-612 ; 1925). He finds that the absorption diminishes as the current term number of the line in a series exhibiting absorption increases ; a similar result has been recorded by Turner and Compton (loc. cit.).

In the latter part of his paper, M. Ponte records his observation of the reversal of the green line and six of its satellites and of 4358, but not of the two yellow lines. In this connexion we have to point out that in a paper published by us in 1924 (*Proc. Roy. Soc.*, A, **105**, 520-531), not referred to M. Ponte, we have described, among others, experiments proving the reversal of the green line and all its satellites except one, namely, − 0·237, of the line 4358 and four of its satellites, of the two yellow lines, and two of the satellites of 5769, namely, + 0·044 and − 0·050. The device of using the broadened lines from a high pressure source as a background for the formation of the reversal lines produced by an absorbing column at low pressure suggested by M. Ponte has been mentioned by us in the same paper. M. Ponte's method of exciting the absorbing column by maintained high frequency oscillations is of special interest.

E. P. METCALFE.
B. VENKATESACHAR.

Central College,
University of Mysore,
Bangalore, India, April 3.

Raman Effect in Atomic Hydrogen.

IN the paper on the dispersion of hydrogen-like atoms published in the *Proc. Nat. Acad. of Sci.*, **14**, 253 (1928), I have obtained a solution of the Schrödinger wave equation, for a hydrogen atom in the field of radiation of frequency ν, of the form

$$\psi = e^{2\pi i E t/h}[\psi_0 + e^{2\pi i \nu t}u_1 - e^{-2\pi i \nu t}u_2],$$

where ψ_0 is the solution of the unperturbed equation, while u_1 and u_2 are small quantities which are functions of co-ordinates only.

The Raman effect for atomic hydrogen comes out of this solution naturally. If one calculates the matrix elements corresponding to components of the electric dipole moment, one obtains terms containing factors $\exp 2\pi i(\nu - \nu_1)t$, $\exp 2\pi i(\nu + \nu_1)t$, and $\exp 2\pi i\nu_1 t$ respectively, where ν_1 is the frequency of absorption lines. In addition to the ordinary transitions, the transitions with a change of azimuthal quantum number by ± 2 are now permitted. Details of the investigation will be published elsewhere.

BORIS PODOLSKY,
(National Research Fellow).

University of California,
Berkeley, California,
April 15

Ozone Absorption during Long Arctic Night.

A LETTER from Prof. R. W. Wood on this problem (NATURE, April 27, p. 644) calls for some comment. Prof. Wood's contention that my observations of ozone absorption in December last (cf. NATURE, Feb. 9, p. 207) are not decisive because the atmosphere above my station was sunlit at noon, overlooks the important fact that *this sunlight had all been filtered through the atmosphere, and at grazing incidence, such as to have its activating constituents effectively removed.* On account of the crude equipment the results are, however, provisional in nature, and this and allied problems will therefore be pursued next winter with an improved telescope.

S. ROSSELAND.

University Observatory,
Oslo, April 29.

Iron Manufacture and Heat Generation.[1]

By Prof. HENRY LOUIS.

THE date and even the place of the first use of iron by mankind have never been determined; it appears to be generally held that iron was first produced in workable quantity on the southern flanks of the Caucasus, and the date assigned is usually somewhere about 3000 B.C., though for my purpose both the place and the exact or even the approximate date are matters of secondary importance. My main object is to indicate that the history of iron manufacture shows it in the light of a consequence of the ever-increasing power which mankind gradually learnt to exercise over the production of heat, and I hope to be able to show that the history of iron and the history of heat generation have gone hand-in-hand throughout the ages, and that the former has been absolutely dependent upon the latter. It is certain that, before iron came into use, the metallurgy of bronze was already highly developed. Articles of bronze of the Later Bronze Age show that the art of bronze-founding had already reached a high stage of perfection. The art of making cored castings was undoubtedly known, and it seems probable that even the *cire perdue* process had been invented.

No doubt the simple reduction of metallic iron from its ores would have been well within the capabilities of these primitive metallurgists, but from the simple reduction of the metal to its fashioning into any useful form is quite a far step. Oxide of iron is reducible to the metallic state at a very low temperature, not exceeding 500° C., but the iron so produced is more or less pulverulent and useless for all practical purposes. To weld it into

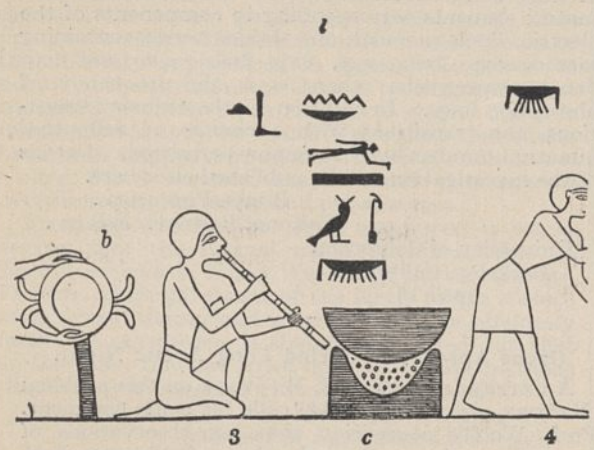

FIG. 1.—Blowing up the fire by the mouth blowpipe (Egypt). From Wilkinson's "The Ancient Egyptians".

a coherent mass capable of useful application requires not only a considerably higher temperature, but also for articles of any size a considerable body of heat, and this would apply equally to the forging of meteoric iron. The only information that we have as to the early means of producing the necessary heat is derived from Egyptian mural paintings. All the earlier ones—for example, one from the frescoes of Beni-Hassan (Fig. 1), said to date from about

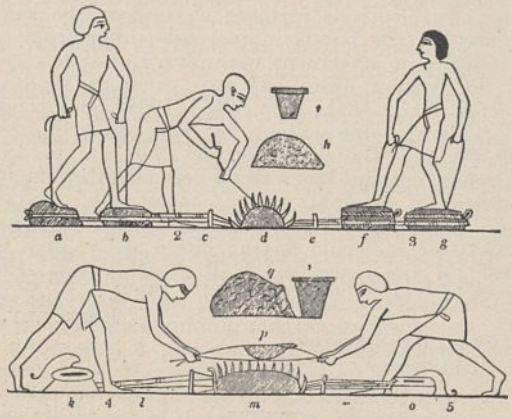

FIG. 2.—The earliest known form of bellows (Egypt). From Wilkinson's "The Ancient Egyptians".

a, *b*, *k*, *o*, the leather case.
c, *e*, *l*, *n*, the pipes conveying the wind to the fire.
d, *m*, the fire.
h, *q*, charcoal.
k and *o* are raised as if full of air.

2500 B.C.—show men blowing up a fire beneath a crucible by means of mouth blowpipes made of reed and tipped with clay, and it is evident that with such rudimentary appliances only very small pieces of iron could be produced.

The first known representation of any mechanical means for producing a blast is from the walls of a tomb of the period of Thothmes III., supposed to be from about 1500 B.C. This primitive bellows (Fig. 2) apparently consists of a flat pot covered with skin, in the centre of which is cut a hole that can be closed at will by the heel of the operator, which thus forms a valve, the skin, when released by the heel, being pulled up by a cord in the worker's hand. It is interesting to note that this identical type of bellows is still used in India by certain tribes for the purpose of iron manufacture, the only improvement in more than 3000 years being the use of a couple of light bamboos which act as springs to pull up the hide cover. A photograph of a native lad working these bellows (Fig. 3), taken a few years ago by the late Mr. Seymour Wood, shows the method; moreover, these bellows have been figured in full detail by Dr. John Percy in his classical work on the "Metallurgy of Iron and Steel".

The position at a tolerably reliable date can be well estimated from the British Museum excavations at Djerabis on the Euphrates (the Charchemish of Biblical times); as recorded in Biblical writings, this place was attacked and captured by Nabuchadnosor, King of the Babylonians, in 604 B.C. The finds consisted of broken swords and spear-heads, all of bronze, and of numerous arrow-heads, both of bronze and of iron; there was also found a beautifully finished bronze mould

[1] From the presidential address delivered to the Iron and Steel Institute on May 2.

for casting the bronze arrow-heads, and it is particularly noteworthy that these bronze arrow-heads are far superior in execution and finish to the iron ones—the iron ones being all tanged, whilst most of the bronze arrow-heads are socketed.

It is therefore evident that at this date, even in the centre of the highest civilisation of the time, skill in working iron had not reached anything like so high a level as that of the bronze-worker; the finds are, of course, not conclusive evidence that no larger weapons of iron were in use at the time, but I think that the conclusion may fairly be drawn that they must have been far scarcer than the bronze weapons, and that the difficulty of working even moderately large pieces of iron had by no means been fully overcome, and that whilst small articles of iron could be made readily enough, there must still have been difficulty in producing the larger articles which required a considerable body of heat. This emphasises the essential point which I want to bring out, that the means of generating the requisite heat must have been the controlling condition in the manufacture of iron. Furthermore, as is well known, whilst iron reduced at a low temperature, even from impure ores, is sufficiently pure not to be brittle, it must necessarily be very soft, and it may readily be supposed that a well-made bronze sword was for quite a while superior to a soft-iron one. This difficulty must have persisted until a much later date in northern Europe, since the Norwegian sagas more than once record that a warrior had a sword so soft that he had to stop to straighten it underfoot in the course of the conflict.

On the other hand, it is quite certain that in the countries bordering on the Mediterranean, where the knowledge of metallurgy was much older and civilisation was much further advanced, temperatures high enough to cause some carbon to combine with the iron and thus make relatively low carbon steel or steely iron had been attained at a very much earlier date, as is evident from the oft-quoted passage in Homer's Odyssey; from this it is obvious that steel or steely iron capable of being hardened by quenching was known in Homer's time, though the carbon content could not have been excessive, seeing that the metal so treated was not too brittle to prevent its being used as an axe; yet there must have been enough carbon present to cause perceptible hardening by quenching, seeing that Homer states that such quenching gives strength to the iron. On the other hand, Homer's frequently repeated epithet for iron "wrought with much toil" shows that the manufacture of iron was still in an elementary stage; it will be remembered that Homer certainly wrote before 800 B.C.

It could, however, not have been very long after the beginning of our era before, with the employment of larger furnaces and, therefore, the production of a greater body of heat, a true steel was produced, and this would, of course, be the case more readily when manganiferous ores happened to be employed instead of ordinary iron ores. Thus both Horace and Ovid refer in their poems to the high quality of Noric iron. The Noric kingdom corresponded to the region now known as Styria and Carinthia, and it is quite probable that this Noric iron was made from manganiferous spathic iron ores of the Styrian Erzberg of Eisenerz. Jars, who visited the Erzberg in 1758, directs attention to the fact that steel was readily produced by smelting certain of these ores. Similar ores appear also to have been worked in Spain, and they, too, must have produced steel or steely iron, and we have evidence that some at any rate of this material consisted of iron combined with sufficient carbon to be capable of being appreciably hardened by quenching. It must be remembered that the above statements as to the use of iron refer only to the region which at that early date was the centre of human civilisation; it is generally held that iron was not introduced into Britain until 500 B.C., and that its manufacture did not commence in these islands until about a century later.

FIG. 3.—Bellows as used in India.

Before Cæsar's invasion, iron was certainly being made in the south of England, though the Brigantes in the north appear still to have been in a Stone Age. Before Cæsar's time, iron currency bars were in use in southern Britain—a fact which would seem to imply that, although iron was being made, it was still scarce and comparatively valuable. The manufacture of iron continued in Britain throughout the Roman occupation. The largest

mass of Roman iron found in Britain, if not in the world, is the mass discovered at Corstopitum, near Corbridge, in Northumberland, described by Sir Hugh Bell. Its date is considered to be between A.D. 350 and 380, and its weight was about 3 cwt. It is quite clear that the method of iron production throughout all this period was always the same—namely, direct reduction by charcoal in furnaces probably not more than 3 ft. or 4 ft. high, and blown by bellows worked by man-power, in which the temperature was only high enough to produce soft malleable iron, or, at the best, with suitable ores a steely iron or a steel. Apparently this method of iron-making must have continued during the next thousand years or so; probably furnaces were steadily increasing in size, larger lumps of iron were being made, and probably steely iron or even steel was produced at will. The art of letting down or tempering steel must also have been discovered, and the technique of iron working, as distinct from the extraction of iron, made immense strides.

An invention that must have contributed no little to the increase in the size and power of the medieval furnace was that of mechanical blast production. Agricola, whose well-known work is dated 1556, figures and describes in much detail the construction of a bellows with valves of quite modern type, worked by a water-wheel, and it is on record that such bellows were in use at Göllnicz in 1435. A natural result of the increase in the height and power of the furnace and of the attendant higher heats thus generated was the production of white cast iron, and it is tolerably clear from Agricola's writings that this was known in his day. No doubt this unexpected result of the higher furnace temperature must have been a disagreeable surprise to the early metallurgist, who found in his furnace a lump of this hard, brittle, useless material instead of the mass of malleable iron or steel which he hoped to produce. In the course of time, however, he would discover that this useless metal could have its pristine malleability restored to it, or, as he expressed it, the iron could be 'freshened' by heating it in another (or possibly the same) furnace. When this technical stage had been reached, the iron-worker no doubt soon learnt to appreciate the advantage of a continuous process in which the metal could be made to flow out from his reduction furnace, over a discontinuous process in which the lump of metal had to be dragged out of the furnace either by tearing down the furnace front or by lifting the lump bodily out of it. This step would lead to a still further increase in furnace and bellows capacity, and this in turn would bring about a further increase in furnace temperatures, with the again unexpected result of producing grey cast iron, as soon as the temperature became high enough to reduce sufficient silicon. It would soon be found that such iron ran very fluid and was admirably adapted for making castings.

Apparently one of the very earliest forms of iron castings was the iron stove plate, which originated in Germany. The oldest known cast-iron stove plate is dated 1497 and was from the Eifel, which appears to have been one of the earliest centres at which castings of this kind were made. No doubt it took the early founders some time before they learnt to adapt their bronze-founding technique to this new material, very much in the same way as in our own time iron-founders have had to learn to modify their methods for the successful production of steel castings; but the superior qualities of articles made of cast iron would be a sufficient incentive to urge these early workers to find out how to overcome their difficulties. Once this was done, a demand for such pig iron would arise and the blast-furnace making charcoal iron was evolved. The next step was the substitution of coke for charcoal, thus attaining the production of still higher temperatures; it is, by the way, interesting to note that the first coke furnaces still used bellows worked by a water-wheel, just as in Agricola's time, and that these continued in use up to the middle of the eighteenth century. About that date they were, however, replaced by iron blowing cylinders, capable of generating a more powerful blast, and, therefore, of producing higher temperatures, whilst Neilson's invention of the hot-blast in the year 1828 enabled still higher temperatures to be attained in the blast-furnace.

The next stage was the production of mild steel in the Bessemer converter and the Siemens open-hearth furnace, to be followed by the important modification of Thomas and Gilchrist, which we know as the basic process. Necessarily, these processes involved the use of still higher temperatures than had hitherto been attained, and finally we reach the production of alloy steels in the electric furnace with its capacity for generating still higher temperatures.

I do not wish to imply that each one of these successive stages immediately and definitely put an end to all use of the earlier processes. Quite the contrary is the case, for there are many examples of the old and new methods working side by side. Even to-day in India and in many other similar countries the direct process is still in use. Again, although Abraham Darby successfully made pig iron with mineral fuel so far back as the year 1735, charcoal blast-furnaces are still in operation in Sweden and various other parts of the world, and there was even one still at work in Great Britain at Backbarrow, near Ulverston, until Dec. 17, 1925. In spite, however, of this overlapping of processes and of the survival of the older methods alongside of newer ones, the line of progress is quite unmistakably defined.

It will, I hope, be admitted that this rapid review of the history of iron manufacture is correct, at any rate, in its main features, and that my contention that the power to produce high heats has throughout been the controlling factor, is well founded; I want to make it clear that I consider that the various stages of iron manufacture and of the generation of ever higher temperatures are not two independent concurrent parallel lines along which the development of human civilisation has

travelled, but that they are distinctly related as cause and effect. This being true of the past, what can we say as to the future? Just as there is a lower heat limit below which iron capable of being usefully applied in the arts could not be produced, so there must be an upper limit, and I suggest that this limit is reached when our furnaces are capable of generating a temperature sufficient to volatilise the iron; it seems fairly obvious that heats higher than this cannot well be usefully employed. Such heats are, however, now readily attained in the electric furnace, and it would therefore seem that from this point of view the limiting condition has already been reached by the metallurgist. On the other hand, there seems but little inducement to increase the quantity of output, seeing that our potentialities of production appear to be now actually ahead of the world's requirements, and that there is every indication that even our present appliances will enable us to keep pace with any future demands.

I emphatically do not mean to imply that we have reached finality in the metallurgy of iron, but I do hold that future progress will have to be along different lines. Fortunately, we are already able to see what direction this progress must take. Recent advances have all been in the direction of improvement in quality and in the attainment of properties in which ordinary iron by itself is deficient. In other words, the future of the metallurgy of our metal will be directed, not by the crude methods of trial and error of the past, but by the application of principles developed by the methods of scientific research. For something like four centuries Great Britain has led the way in the great improvements in the iron industry along the old lines which I have been describing; we are, however, also the inventors of the science of metallography and of alloy steel; we may, therefore, fairly claim that even in modern scientific methods we are equally leading the world in the metallurgy of iron, and there is every reason to presume that the great work which members of the Iron and Steel Institute have done in the past in developing that iron industry which is the basis of our modern civilisation will still continue in the future, although, as I have suggested, that work will be carried on by means of modern methods and be based upon entirely different principles.

Progress of the Great Barrier Reef Expedition.

By Dr. C. M. YONGE, Balfour Student, University of Cambridge

IN the three months which have elapsed since the last report, the work of the Great Barrier Reef Expedition, in all its branches, has made excellent progress. Naturally, the weather conditions have not been so favourable as they were in the winter; heavy rains and humid heat, with wet bulb readings so high as 86° F., have been experienced, but work has been interfered with far less than was anticipated. The most serious drawback has been the state of the tides, the day low tides being very poor, which necessitated much collecting by night. On the other hand, sea work has proceeded without a hitch in spite of the previous gloomy accounts of the storminess of the summer months.

A great loss has been experienced in the departure from Low Island on Dec. 12 of Mr. and Mrs. F. S. Russell and Mr. G. Tandy, who were compelled, owing to the termination of their leave of absence, to return to England. Dr. T. A. Stephenson has succeeded Mr. Russell as second in command, while Mr. A. P. Orr has taken over charge of the boat party, Mr. J. S. Colman carrying on Mr. Russell's work on zooplankton. There is, unfortunately, no professional botanist to succeed Mr. Tandy, though Miss Glynne is expected for two months later in the year; meanwhile Mrs. Stephenson is doing what she can to continue the collection of algæ. Mr. M. Spender, of the geographical section, is now with us permanently, while Miss E. A. Fraser, of University College, London, and Dr. S. M. Manton, of Cambridge, join us shortly. Both will work in co-operation with the reef party under Dr. Stephenson.

The regular plankton and hydrographic observations at the station 3 miles east of Low Island have been continued with scarcely an interruption; a further station has been worked in Trinity Opening, all from the *Luana*; while on two occasions the powerful motor launch *Merinda* has been hired from Cairns for work beyond the Barrier. For the hauling in of nets and hydrographic gear from deep water a friction winch with a small motor has been purchased, and this renders work both easy and relatively speedy.

At the inside station Mr. Orr reports that temperature has risen steadily to 29° C. at the surface and 28·8° C. in deeper water, while salinity has fallen and continues to fall as a result of the heavy rains. On several occasions there has been a definite gradient in temperature and salinity, accompanied by a fall in oxygen saturation in the deepest layers, though without any production of phosphate, but this has never lasted more than a week at a time or ever been considerable enough to withstand a wind of more than 20 miles per hour. The hydrogen ion concentration has remained steady throughout. Observations made at a depth of 600 metres beyond the Barrier showed that temperature was constant down to 50 metres, beyond which it fell rapidly to 10·9° C. at 600 metres. Below 50 metres, *p*H value and oxygen saturation sank and phosphate content rose. On Linden Bank, a coral formation beyond the Barrier and covered with 34 metres of water, the conditions were very similar to those inside the Barrier. The turbidity of the water is far less beyond than within the Barrier.

Miss S. M. Marshall and Mr. Colman are continuing routine work on the phytoplankton and zooplankton respectively. As the lack of nutrient salts in the water indicates, there has been no

significant change in the numbers of the phytoplankton within the Barrier, while the numbers have been found even smaller in the open sea stations, there being little difference in type save for a few oceanic flagellates rarely found inside. The only notable change observed in the zooplankton occurred during the three weeks at the end of November and the beginning of December, when spatangid plutei appeared quite suddenly in vast numbers, the coarse silk townet catching just under 300,000 in a half-hour haul. It may be noted that dredging has revealed the presence of great numbers of a species of *Lovenia* in the mud around Low Island, one haul of the Agassiz trawl bringing in a catch estimated at about 20,000. Salps and Larvacea continue to fluctuate in an apparently irregular manner, and also copepods, which usually comprise numerically more than half the catch. On one occasion when planulæ were being extruded from *Pocillopora* on Low Island, some 3000 similar planulæ were caught in the coarse silk net. Again, on another occasion the numbers of *Cavolinia* rose from an average of less than 50 to 1200.

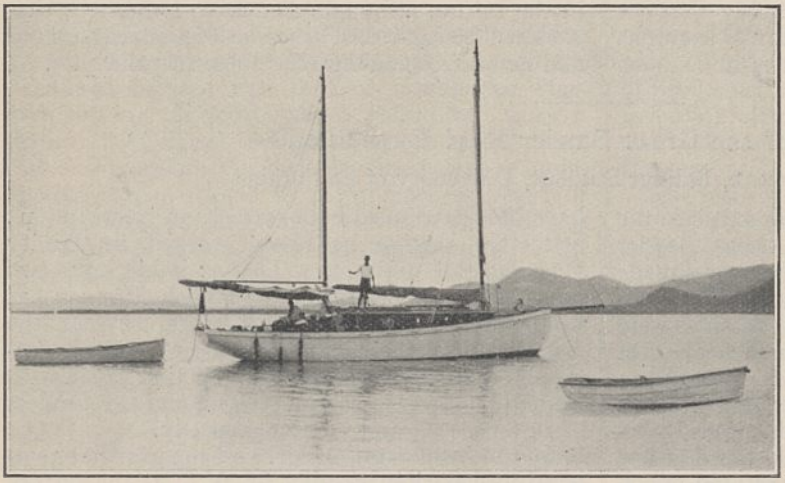

FIG. 1.—The *Luana* at anchor between Snapper Island and the mainland.

Work over the reef flat by members of the boat party has been continued. Mr. Orr made a detailed study of a coral pool at spring tides, and found that, though there were very considerable changes in the hydrogen ion concentration, excess base, and temperature, there was no precipitation of calcium. There was a very low night tide and the oxygen saturation fell to 18 per cent, rising during the day to 230 per cent. In the mangrove swamp the oxygen content and *p*H value fell both by day and night during the low tides, instead of only during the day as in the coral region. Miss Marshall finds that the numbers of the phytoplankton in the anchorage remain low, such slight fluctuations as there are being without apparent cause. The zooplankton collected by Mr. Colman weekly has become progressively poorer in numbers and variety, though spatangid plutei and *Cavolinia* appeared at the same time as at the three-mile station.

Other work by members of the boat party has included the exposure, by Mr. Orr, of jars for the collection of sediment, in selected areas on the reef flat and in the lagoon. These are collected weekly, and show clearly that the quantity of sediment is dependent on wind force and on the position of the jar, the sediment being mainly organic detritus mixed with some sand after stormy periods. The results from the various jars have so far been quite consistent and lend no support to the theory that abundant sediment is inimical to coral growth. Miss Marshall has done interesting work on the oxygen exchange of the planulæ of *Porites*, and found that, though their algæ produce a considerable amount of oxygen even at this stage, this does not balance the loss of oxygen due to respiration, also that more is produced in sunny than in dull weather.

Dr. T. A. Stephenson has completed a new type of experiment for observing the growth rate of corals. By the aid of the diving helmet, a number of colonies have been marked in particular ways *in situ*, working in about 12-20 feet of water. It may be suitably mentioned here that this helmet has proved of great value, particularly in connexion with Dr. Stephenson's work, but also in the collection of Mr. Orr's sediment jars and of corals for experimental purposes. Dr. Stephenson has continued his routine observations on the gonads of *Favia* and *Symphyllia*, and has made further progress with the ecological survey. Both *Pocillopora* and *Porites* have given off abundant crops of planulæ; numbers of these have been collected and reared, detailed observations being made as to the formation of young colonies from settled planulæ. He has been engaged on manifold constructional activities on the reef flat, particularly in connexion with the rearing and collection of planulæ and the observation of the spawning of reef animals. He has also made a new aquarium consisting of concrete tanks through which water runs continuously, this being particularly useful in connexion with Mrs. Stephenson's work on the reproduction of reef animals, which has been continued on the lines previously reported and also extended by the examination of various kinds of spawn collected on the reef.

The work on animals of economic importance now occupies practically the entire time of Mr. F. W. Moorhouse. Although his farm of *Trochus* was unfortunately destroyed by stingrays, the previous six months had shown that the average increase in diameter of specimens ranging from 2 cm. to 6 cm. was no less than 2 mm. per month, giving a yearly increase of about 2·5 cm. Growth is continuous, and no disturbance rings are found on normal shells. He has been able to confirm these figures by the measurement at each full

moon of some 600 animals taken at random, the measurements being graded into groups of 0·2 cm. and the results recorded graphically. He has now 360 sponge fragments planted out. Some are suspended from lines, others are confined in 'houses' to test the effect of the elimination of direct sunlight. Regeneration of the fragments is remarkably rapid, the supporting cord being overgrown completely or partially in two days and the whole cut surface being overgrown in ten days. The growth rate of the local oysters is being studied, while weekly gonad examinations of *Trochus niloticus*, *Holothuria atra*, and two species of edible oyster have been made regularly, artificial fertilisations being successful in all save the first. He continues to take the temperature of the water in the anchorage twice daily, and this has risen as high as 33° C., very near the lethal temperature of corals. During the recent low spring tides the temperature over the flat has risen above 35° C. and a great many corals have been killed.

Assisted throughout by Mrs. Yonge and Mr. A. G. Nicholls, I have been able to make very material progress with my work. Little further work has been done on the feeding mechanisms of corals, but it has been found that *Favia* and *Galaxea* can digest planktonic organisms of 2-3 mm. in length completely within twelve hours. The symbiotic algæ of corals possess a well-developed cellulose wall, have extensive reserve of fat, but no pure starch. A number of suitable corals have been fed with a variety of substances and polyps fixed after appropriate intervals with suitable fixatives, for the later determination of the site and mode of absorption.

The monthly experiments on the change of oxygen content in the water surrounding corals kept for similar periods in light and darkness have been continued, and confirmatory experiments on the length of time which corals can survive sealing in jars in the sea have been carried out. A large light-tight box with a detachable lid, containing a small trap door, has been cemented down on the reef flat, the object being to obtain data on the effect of continued darkness on the oxygen content and hydrogen ion concentration of the water surrounding the corals and clams (which also contain algæ) placed in the box.

Work on the digestive enzymes of corals has been almost completed, extracts of the mesenterial filaments of *Lobophyllia*, and fluid from the cœlentera of large *Fungia* being studied. In the former there is a powerful protease, of which the optimum hydrogen ion concentration has been found, an extremely weak lipase, and enzymes capable of digesting—very slowly—starch and glycogen but no other carbohydrate; the temperature of destruction and the optimum hydrogen ion concentration of the former have been determined. Apparently the extract has no action on the symbiotic algæ. Enzymes in the cœlentera of *Fungia* are confined to protease, apparently the only extracellular enzyme.

Most interesting results have been obtained from the experiment on the effect of starvation and feeding on similar corals kept in light and darkness. The starved corals receive twice filtered sea water twice daily, while the others receive unfiltered water to which is added every other night the results of a townetting. *Fungia*, *Favia*, *Psammocora*, and *Galaxea* have all given good results, and demonstrated that fed corals continue in perfect condition in both light and dark, paling somewhat in the latter owing to the death of the algæ, but starved corals quickly begin to shrink in the tissues, undamaged algæ being extruded in great numbers and the tissues consequently turning pale. This happens in both light and dark. Newly settled planulæ of *Pocillopora* were placed in light and darkness, in both cases fed, and after six weeks those in the light had abundant algæ, especially in the tentacles, while those in the dark, apparently just as healthy, were pure white with transparent tentacles. The only conclusion to be drawn from these results, taken in conjunction with the experiments on the feeding and digestive enzymes of corals, is that the algæ are not and cannot be used as food by the corals.

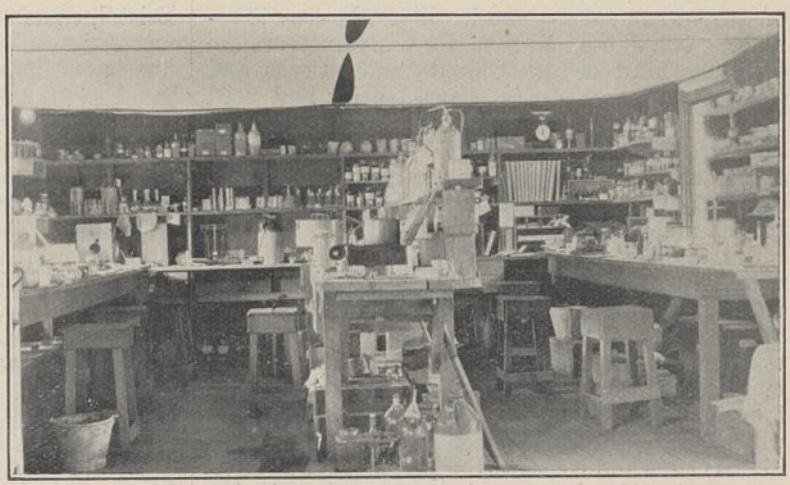

FIG. 2.—Interior of laboratory. Plankton bench on left, chemical bench in centre, director's bench on right.

Mr. A. G. Nicholls has not yet been able to record a second spawning of the pearl oyster, though several small spat from the November spawning have been found. Measurements for growth rate have shown an increase of about 0·5 cm. in diameter in 30 per cent of cases. His work on calcium has shown that the calcium content of the sea water from the inside station has been remarkably steady, and that there is a noticeable diminution of calcium in water in which corals have been kept for periods of seven and fourteen days. Mr. G. W. Otter continues his work, previously outlined, on boring organisms.

Mr. Spender, who had the assistance of Mr. E. C. Marchant until Jan. 9, has been busily engaged on his large-scale map of the island, a slow and laborious task. Owing to the humidity causing distortion of the drawing paper, he has to plot all points by co-ordination. He has taken several traverses with the tacheometer between triangulation points, the fringe of the island being almost completely mapped, and hopes to fill in the central detail by plane-tabling later. He is running level traverses of a precise order across the flat.

A preliminary bore with a hand plant has been made in the centre of the sand cay, 13 feet of casing being sent down, and although a level below that of the 'beach rock' was reached, nothing but sand was encountered.

The tide gauge has been put up after great labour, entailing the erection, with the assistance of a member of the lighthouse staff, of three 30-foot mangrove poles in the form of a tripod. This is giving excellent and most interesting results, and it is now possible to refer any point on the island to mean sea-level, while sounding operations are also possible.

At the time of writing, the work of the Expedition is being greatly extended by the hiring of a powerful Townsville launch, the *Magneta*, for plankton, hydrographic, and dredging cruises as far north as Cook's passage north of Cooktown.

Obituary.

Col. E. Lester Jones.

THE untimely death of Col. E. Lester Jones, on April 9, meant a loss to the scientific world of a friend and ally whom it will not be easy to replace. Col. Jones had been for fourteen years the directing head of the United States Coast and Geodetic Survey, and in that capacity had used his talent and energy to promote scientific work and investigation. Much of the increased activity and interest in hydrography, geodesy, seismology, and terrestrial magnetism may be traced directly to his influence.

Just as it is not possible to gauge the ultimate value of any single scientific discovery, just so is it out of the question to attempt an immediate appraisal of the importance of any one man's life work in the interests of science. A hint of the monument Col. Jones builded for himself may be found in the splendid organisation the destinies of which he guided for fourteen years. The United States Coast and Geodetic Survey, pioneer Government scientific bureau, is to-day functioning efficiently; it is well organised, well equipped, and making rapid forward strides. For this, the credit must inevitably gravitate toward the man who led, ever encouraged, and efficiently aided its scientific staff.

Col. Jones was born at East Orange, New Jersey, on April 14, 1876. In addition to extended study abroad, he held an A.B. degree and an honorary A.M. degree conferred by Princeton University, and was commissioned a hydrographic and geodetic engineer. In 1913 he was appointed deputy commissioner of the Bureau of Fisheries, holding that position until being appointed the directing head of the United States Coast and Geodetic Survey by President Wilson in 1915.

In addition to his administrative work with this latter bureau, he was the American member of the International Boundary Commission appointed to fix the boundary between the United States, Alaska, and Canada. He had also been a member of several important Government and scientific missions. One of the last of these was his appointment as a delegate to the twelfth International Geographical Congress held at Cambridge last year.

Dr. Charles Beavis.

THE sudden death of Dr. Charles Beavis on April 17 at his residence, Naishcombe House, Wick, Bristol, came as a great surprise to those who had recently seen him, apparently in the best of health and full of life and vigour. He was born at Hampstead on May 3, 1869, and educated at Atherstone Grammar School. At the age of seventeen he went to Coblenz, then to Bonn, where he read chemistry, physics, and mineralogy under Kekulé, Anschutz, Klinger, Bendes, Clausius, and Hertz. He afterwards proceeded to Würzburg, working under Emil Fischer, and in 1892 took the degree of Ph.D. (Magnam Laudem). He returned to London and worked for seven years with Dr. Quirin Wirtz, during which time he took his F.I.C. in 1897. In 1899 he went to Wick to start a fine colour department in the Golden Valley Ochre and Oxide Co., becoming manager in 1902, taking over the business in 1904. Although records of published original work are not available since his graduation, Dr. Beavis had publicly identified himself with chemistry and the intricate problems of modern colour manufacture, and for many years took keen interest in the Colour Makers' Association of the United Kingdom, of which he was the first and only chairman.

WE regret to announce the following deaths:

Prof. John W. Harshberger, professor of botany in the University of Pennsylvania and president in 1926 of the American Ecological Society, aged sixty years.

Dr. F. C. Madden, C.M.G., Dean of the Faculty of Medicine, Egyptian University, Cairo, an authority on bilharziosis and schistosomiasis, on April 27, aged fifty-six years.

Dr. August von Schmidt, formerly director of the meteorological-geophysical section of the Württemberg State Statistical Bureau at Stuttgart, on Mar. 21, aged eighty-nine years.

Sir George Syme, K.B.E., president of the College of Surgeons of Australasia and chairman of the Royal Commission on Health, Commonwealth of Australia, aged sixty-nine years.

Dr. Ludwig Wittmack, honorary professor of botany in the University of Berlin and author of the section on the Bromeliaceæ in Engler and Prantl's "Pflanzenfamilien", on Feb. 2, aged eighty-nine years.

News and Views.

THE nineteenth May Lecture of the Institute of Metals was delivered on May 7 by Sir Oliver Lodge, who chose as his title "Some Ideas about Metals". A large part of the lecture was devoted to the subject of metallic conduction, a theme selected by two of his predecessors, by Sir J. J. Thomson in 1915, and by Prof. H. A. Lorentz in 1925, but by no means exhausted even now. Adopting the 'electron gas' hypothesis as to the nature of metallic conduction, Sir Oliver Lodge discussed in a fascinating manner the phenomena of thermo-electricity and the Hall effect, suggesting the lines along which a solution of outstanding difficulties may be pursued. Great significance is attached to the results obtained by Kapitza in intense magnetic fields, and it is conjectured that a flow along magnetic lines of force, indicated by ether theory but too slow to be observed by existing means, might be detected if such intense fields could be extended over a considerable region instead of being concentrated in a very small space. The earlier part of the lecture, however, was of wider scope, and dealt in a reminiscent vein with some of the anomalies of discovery in physics, such as the failure to recognise a new phenomenon through excessive deference to existing views and the happy results sometimes derived from the exercise of boldness in experiment or speculation. A wide range is covered by the lecture, and the student of the history of physics will find an illuminating survey of some aspects of the growth of the Bohr atom, among many thumb-nail sketches of the physical discoveries of the present generation, from the hand of a master of exposition who has himself been in close contact with such discoveries over the most interesting period in the whole history of the science.

SCIENCE SERVICE, of Washington, D.C., announces that fourteen Americans and five foreigners were honoured at the concluding session of the annual spring meeting of the National Academy of Sciences, either by election to membership or to the foreign associateship. Prof. Arnold Sommerfeld, of Munich, known for his work on the quantum theory of spectra, who attended the scientific sessions of the meeting as a guest, was one of the newly elected foreign associates. The others included Richard v. Hertwig, professor of zoology and comparative anatomy in the University of Munich; C. de la Vallée-Poussin, professor of analytical mechanics at the University of Louvain; Willem de Sitter, of the Observatory of Leyden, Holland; and Prof. F. O. Bower, formerly Regius professor of botany at the University of Glasgow.

THE new members of the National Academy are Dr. Roger Adams, professor of organic chemistry at the University of Illinois; Irving W. Bailey, associate professor of botany, Bussey Institution, Boston; Dr. A. F. Blakeslee, botanist at the Carnegie Institution's station for experimental evolution at Cold Spring Harbor, N.Y.; Dr. James B. Conant, associate professor of chemistry, Harvard University; Dr. Bergen Davis, professor of physics at Columbia University; Dr. C. J. Davisson, physicist at the Bell Telephone Laboratories, New York, whose recent work on the wave nature of electrons has proved a most important advance in physics; Dr. Joel H. Hildebrand, professor of chemistry at the University of California, Berkeley; William Hovgaard, professor of naval design at the Massachusetts Institute of Technology; Dr. Albert W. Hull, research physicist at the General Electric Company's Research Laboratory at Schenectady, N.Y.; Frank Leverett, geologist of the U.S. Geological Survey and lecturer in glacial geology at the University of Michigan, Ann Arbor; Dr. Paul W. Merrill, astronomer at the Mt. Wilson Observatory, Pasadena, California; Dr. David H. Tennent, zoologist at Bryn Mawr College, Pennsylvania; Dr. George H. Whipple, dean of the School of Medicine and Dentistry and professor of pathology at the University of Rochester, N.Y.; and Dr. Clark Wissler, curator of ethnology at the American Museum of Natural History, New York, and professor of anthropology in the Institute of Psychology at Yale.

ON Feb. 13 last, Mr. Frederick Chapman, palæontologist to the National Museum, Melbourne, retired from the State service, and the National Museum Committee has passed a resolution recording appreciation of the services rendered by him since his appointment on Mar. 12, 1902. During his twenty-seven years of tenure, Mr. Chapman has arranged, and illustrated with his own pen and brush, the two extensive galleries of fossils in the Museum; identified 22,000 fossil specimens for visitors; and registered about 14,000 exhibited specimens. He has determined and labelled 7200 specimens in the reference collection of Australian fossils; and, apart from routine work, has described many hundreds of types. He is a member of the Australian Research Council and lecturer in palæontology at the University of Melbourne. In March last he was elected president of the Royal Society of Victoria. At present Mr. Chapman is attached to the Commonwealth service as Federal palæontologist, directing the examination of bore-cores, a work with which he is especially acquainted, for forty years ago he was helping the late Prof. J. W. Judd, of the Royal College of Science, to examine the borings from Meux's Well and from Richmond near London, whilst only last year he published a work on the Sorrento Bore. Mr. Chapman's work is familiar through his writings on Foraminifera and on Australasian fossils and the recently published guide book to the Fossil Galleries at the Museum.

THE Central Electricity Board, in accordance with the provisions laid down in the Electricity Supply Act of 1926, has published a report of its work up to January 1929. It will be remembered that the function of the Board is to co-operate with the supply industry in Great Britain in reducing production costs to a minimum and concurrently to increase the availability of the supply. The method of doing this which has been adopted is to interconnect the more efficient stations by a network of high pressure trans-

mission lines, called the grid, and operate 'selected' stations in the most economic way. The report indicates that good progress has been made in these directions. Many difficulties have been tactfully overcome. In central Scotland the Grampian Electricity Supply Company feared that the scheme would be prejudicial to its interests since it had counted on getting much of its revenue by supplying several industrial districts which will be connected with the grid. The Board, recognising the importance of developing the water power of the country, has promised to take a load not exceeding a maximum demand of 12,000 kilowatts from the company.

THE report goes on to state that in south-east England the demand has increased so rapidly that three additional stations had to be selected by the Central Electricity Board. The difficulties that were expected to arise owing to the standardisation of the frequency of the supply in central England and North Wales have been carefully considered, and in several cases the Board has given permission for schemes at a lower frequency to be completed, as the savings under the scheme would not have justified the higher expenditure. The total value of the work contracted for under the Government scheme up to the end of last year exceeds eight million pounds. In Scotland the erection of towers in the Clyde Valley will be completed this month. In south-east England towers are being built between Bedford and Little Barford, and forty-six out of seventy-three are now erected. One very satisfactory feature is that many landowners have facilitated the work and co-operated with the Board in preserving the amenities of the countryside by choosing the most suitable sites for the towers.

AT a recent meeting of the Council of the Institution of Professional Civil Servants the announcement of the appointment of a Royal Commission on the Civil Service, with the wide terms of reference indicated by Mr. Churchill in the House of Commons, was considered. While welcoming such a Royal Commission, the Council is of opinion, however, that such an inquiry can only discharge the task imposed upon it satisfactorily provided that professional and scientific men of standing and administrative experience are appointed to serve on the Commission. In its view, the problem of the structure of Civil Service organisation must be approached afresh in relation to the functions which should be accorded to the 'technical expert' in the administrative machinery of the modern State. An approach from the traditional Civil Service point of view is considered unlikely to lead to those fundamental changes which are rendered necessary by modern conditions.

IN a reprint of certain articles published in the *Journal* of the American Society for Psychical Research during 1928, and now issued under the title of "The Thumbprint and Cross-Correspondence Experiments made with the Medium Margery during 1927 and 1928," Dr. Mark W. Richardson and his associates have collected some of the more striking episodes in the later history of the development of the alleged supernormal phenomena occurring with the Boston medium, Margery (Mrs. L. R. G. Crandon). The paper is divided into two sections, one dealing with the thumb impressions upon dental wax which have so far been traced to no living person; and the other to the series of cross-correspondences between Margery and other mediums, which have the merit of simplicity, and possess a degree of accuracy which would be regarded with suspicion if it represented any kind of scientific result. There is little doubt that, merely considered as a question of mechanical production, the thumb prints are of some interest. Unlike the prints which engage the attention of the police, the Margery impressions are made in wax, and are therefore capable of more detailed examination and analysis than are those of two dimensions. Moreover, the fact that these wax impressions are said to be negative *and* positive together with 'mirror' images of both these series serves to illustrate the complexity of the problem.

THESE wax originals are open to inspection in Boston, and it is clear that an examination of them would be more satisfactory than of the photographs here included, excellent though the latter undoubtedly are. Hence any detailed criticism would be out of place, although it ought to be said that in the account there are certain suspicious incidents which again are not absent in the records of the cross-correspondences. Here we have broadly what is claimed to be the transmission of an idea independently chosen and presented which is reproduced at approximately the same time by two or more mediums at widely separated distances. Such a claim lends itself to scientific scrutiny, and it would appear that, under much stricter conditions than those described in this paper, it might be possible to test these phenomena in a manner free from those objections which usually prevent any adequate examination of supposed 'psychic' manifestations.

THE Right Hon. W. Ormsby Gore, Under-Secretary of State for the Colonies, recently gave an address before the Royal Scottish Geographical Society on the "Development of our Tropical Dependencies", and the lecture has now been published in the Society's magazine. He points out that in the true equatorial territories the combination of high rainfall, perpetually humid atmosphere, and comparatively high temperatures, provides all the circumstances necessary for constant and rank vegetable growth. On the north and south, these regions are bounded by great torrid deserts with a rainfall lower, and a temperature far higher, than those found in the true equatorial belt. The wealth of the tropics lies mainly in the production of certain foodstuffs and raw materials, which are becoming of increased importance year by year. Despite the bountiful and productive nature of the true equatorial regions, there is, however, an extraordinary sparseness of human population. A variety of causes retard development, among which the more important are tropical diseases, the ravages of mosquitoes and tsetse flies which attack man and animals, and the prevalence of plant diseases. For

the development of the tropics, further research work in tropical medicine and veterinary science is all important. In agriculture, also, research is vital, since immune varieties of higher yielding strains of particular crops are urgently required. Mr. Ormsby Gore considers that it is in the fields of economic botany, plant genetics, and soil science that the economic conquest of the tropics has its future. In tropical agriculture, medicine, and veterinary science the main problems now to be faced are not so much the cure of diseases as and when they arise but rather the eradication of disease and the maintenance in health of men, animals, and plants.

THE first number of *Human Biology*, a new magazine with a definite and specific aim, has made its appearance from the Institute for Biological Research, under the editorship of Prof. Raymond Pearl. Its object is to publish in readable English original articles in all fields of human biology, including physical and general anthropology, anthropometry, vital statistics, human heredity and eugenics, prehistory, human anatomy, sociology, constitutional pathology, and psychobiology. There was need for such a work, for not only has it become increasingly apparent that humanistic researches must all wander into biological fields, but also the publication of papers on human biology found their way into many and scattered journals, and lost the value of a massed attack. The first part—the journal is to be a quarterly—contains a varied series of papers, dealing with subjects from human evolution to biological philosophy and medicine. All the articles are stimulating in their suggestiveness, but a perusal of some suggests that the editor is to have a hard task to capture the standard of thorough and entertaining readableness at which he aims through his contributors. There are no book reviews, but a list of new books and memoirs received at the editorial office is printed as a bibliographical guide. There is a niche for *Human Biology*, and this it promises to fill very satisfactorily.

DR. FRANK B. JEWETT, of New York, who has recently been honoured by the American Institute of Electrical Engineers, gave an address on Dec. 29 last to the American Association for the Advancement of Science, which has appeared in a recent issue of *Science*, on leadership in industrial research. As one of the founders of the Bell Telephone Laboratories, and as one who has been engaged for the last twenty-five years in finding and encouraging others to do scientific research in industry, his paper deserves consideration by scientific and technical professors. He has worked all his life to promote co-operative research, not with any idea of banishing the individual inventor, especially if that inventor happens to be a genius, but in the belief that co-operation provides a new method of research. In both scientific and industrial research the men who succeed are driven to work by insatiable curiosity about natural laws and not mainly by a desire for personal wealth. Looking back over his successes and failures in selecting young men for industrial research during the last twenty-five years, Dr. Jewett says that the majority of his successes were secured by attaching one-third weight to his own personal appraisement and two-thirds to that of experienced professors under whom the candidate had worked. His failures were mainly due to paying too little attention to the professorial opinion and to attaching too much weight to those whose judgment he should have distrusted. In order to promote the peace of mind and the continued productivity of the research worker, it is necessary to encourage him by a sympathetic understanding of the work he has done and the obstacles he has to overcome. We are human beings dealing with each other, and no hard-and-fast rules can be applied to workers in the field of research any more than in any other field of activity.

A FURTHER Circular (No. 6) has been issued by the secretaries of the International Congress of Forestry Experimental Stations to be held in Stockholm next July, which has been referred to in previous issues of NATURE. So far, about a hundred applications to attend the Congress have been received and fifty papers have been presented to be read, the latter chiefly from Europe and the United States. It is proposed to set up an organising committee, consisting of one representative from each country, which will deal with questions concerning the organisation of the Congress and the revived International Association of Experimental Stations. This Committee will have the power to summon experts to its meetings, which will not clash with the general meetings of the Congress, to assist in the solution of such problems as may arise; small executive sub-committees will be appointed when deemed necessary. Delegates submitting papers are requested to send in a précis of their papers at once, in order that such summaries may be printed and thus be in the hands of delegates before the meetings at which the papers are read. It is further announced that the period of application to attend the Congress has been extended to June 1, although the date of giving notice regarding attendance at the excursions to take place before and after the Congress meetings was left at April 30. The meetings in Stockholm will take place on July 22–27. The first meeting of the organising committee will be held in the afternoon of Sunday, July 21, and this will be followed by a garden party at the beautifully situated College of Forestry at Stockholm, to which all delegates are invited. The proceedings of the Congress will open on July 22, and the programme of the first two days' meetings is given in the circular. The last meetings of the Congress will be held on Saturday, July 27, when resolutions will be submitted, the election of a president, and the time and place of the next meeting, and the appointment of an executive committee of the Association will be discussed.

IN a recent issue of *Science*, Prof. Knight Dunlop has a paper on the outlook for psychology, presented before the New York meeting of the American Association for the Advancement of Science. He reviews the present situation with special emphasis on what he calls the laboratory method, believing that the laboratory is the centre of true psychological activities. It is dis-

appointing that such a subject should be treated so generally; he asserts, but presents no evidence, that the laboratory method has justified itself and contrasts it with the mental test movement and the psycho-analytic movement, both of which he looks upon as in a state of eclipse. One cannot help feeling either that the position of psychology in the United States is radically different from what it is in Britain, or that Prof. Knight Dunlop is comparing the best work of the laboratory with the worst and most uncritical of the practical movements. There is no inherent opposition between the laboratory method and scientific method pursued in the field for practical purposes. The laboratory worker in psychology, as in any other science, can pursue knowledge for the sake of knowledge, regardless of possible practical applications, but he can also receive his stimulus to work from the practical side and pursue his research scientifically with a practical aim. The mental tester in his domain and the doctor in his, were confronted with serious problems. Neither of them could wait until, if ever, the laboratory worker bestirred himself to help him. Because both movements have had over-enthusiastic exponents and reckless theorisers, one cannot look upon them as discredited. So also has the theory of evolution. Perhaps in England less was expected of either mental testing or psycho-analysis, and therefore they have been kept in better perspective. In the latest edition of Osler and M'Crae's "Modern Medicine", there occurs the statement: "Psycho-analysis is of the greatest service for the strictly psychogenic cases", and the mental test is used not as a method of universal validity, but as a convenient measure of differentiation.

THE effect of the erection of overhead power lines on the beauty of the countryside has been much discussed in the Press. Electrical engineers are, however, more concerned at present with the possible interference these high voltage lines may produce with telephone lines, radio transmission, and broadcast reception. Dr. R. L. Smith Rose has been experimenting, on behalf of the Radio Research Board, at the National Physical Laboratory on this subject and has arrived at definite conclusions. These are given in the *Wireless World* for May 8. American experience has shown that if the radio reception station be farther than about half a mile from a high-tension overhead line, no interference or disturbing effects will be experienced. The station itself may, without causing interference, be supplied with power from the overhead system. Experiments were made by Dr. Smith Rose to find out the effects of high voltage spark discharges on a sensitive radio receiver in the neighbourhood. When a spark or arc discharge initiated by a voltage of about 850,000 and carrying a current of about half an ampere took place, then if the receiver were less than 200 yards from it, disturbance ensued. This effect was only serious when long drawn arcs occurred at frequent intervals, a phenomenon which would very rarely happen on transmission lines. When the distance was so great as 600 yards, the interference was negligible. The distance, therefore, of half a mile which is customarily chosen for other reasons ensures that the disturbing effects produced by 'man-made static' are negligible.

TEST transmissions of the new Marconi broadcasting station at Bratislava, Czechoslovakia, have been carried out and satisfactory reception has been reported, generally on three-valve sets, from all parts of the British Isles. The new station comprises a Marconi 12-kilowatt broadcasting transmitter, Type P.A.5, employing the principle of low-power modulation. Its wave-length is 277·8 metres (1080 kh.), and among its special features is the half wave-length ærial, the first of its kind to be used in the broadcast band of wave-lengths. The station, which is situated about three miles to the east of the town, replaces an old broadcasting station of ½-kilowatt power. It is connected by land line with up-to-date studios in the centre of Bratislava, Prague, and Brno.

THE Fourth World's Poultry Congress is to be held at the Crystal Palace on July 22–30, 1930. It is being organised by the English Ministry of Agriculture and Fisheries in conjunction with the Scottish Department of Agriculture and the Ministry of Agriculture for Northern Ireland. The official host is the Government, and Their Majesties the King and Queen and H.R.H. the Prince of Wales have consented to become its patrons. National committees have been formed in most countries for the purposes of organising national exhibits, and of selecting papers to be read at the Congress. The business activities of the Congress will consist of paper-reading sessions, national displays of live-stock, and commercial exhibits. Whilst most that is to be heard and to be seen will deal with the democratisation of information relating to poultry-keeping, there are to be in addition special paper-reading sessions devoted to the presentation and discussion of original scientific contributions in genetics, dietetics, pathology, and husbandry. This Congress is expected to be no less successful than the last, which was held at Ottawa in 1927, when 3000 delegates and 200,000 members of the general public attended.

A FORMIDABLE and very widely spread insect pest of fruits, namely, the Mediterranean fruit fly (*Ceratitis capitata*), has recently, and for the first time, secured a footing in the United States. We learn from recent *Daily Science News Bulletins*, issued by Science Service, Washington, D.C., that its discovery in citrus orchards in Florida, over an area of about 40 square miles, has led to the planning of energetic measures of repression. The fly was first found on April 6 and its identity established soon afterwards. Specimens were then rushed by air mail to Washington and the identification confirmed. It is stated that within one week of the date of discovery, 75 entomologists and plant experts were on the ground, and the battle of extermination has begun!

THE Bakerian Lecture of the Royal Society will be delivered by Prof. E. A. Milne, Rouse Ball professor of mathematics in the University of Oxford, on June 6, the title being "The Structure and Opacity of a Stellar Atmosphere".

AT the annual meeting of the members of the Royal Institution, held on May 1, the following officers were elected :—*President :* The Duke of Northumberland ; *Treasurer :* Sir Robert Robertson ; *Secretary :* Major Charles E. S. Phillips.

THE President of the French Republic has, on the recommendation of the Association Technique Maritime et Aéronautique, conferred the Legion of Honour upon Mr. Robert W. Dana, secretary of the Institution of Naval Architects.

THE first Pedler Lecture of the Chemical Society will be delivered by Prof. W. H. Perkin, Waynflete professor of chemistry in the University of Oxford, on Thursday, May 30, at 5.30 P.M., the title of his lecture being "The Early History of the Synthesis of Closed Carbon Chains". The lecture will be given in the hall of the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. Tickets of admission will not be required.

'NATIONAL Baby Week' is to be celebrated this year in Great Britain on July 1–7. The National Baby Week Council desires that special attention should be directed to three problems : (1) The practical measures that can be taken to combat maternal mortality, morbidity, and disability ; (2) what local authorities and parents can do to lessen the incidence and dangers of infectious diseases among young children ; and (3) the teaching of parentcraft and hygiene to school children. Particulars may be obtained from the Secretary, Miss Norah March, 117 Piccadilly, W.1.

A PUBLICATION grant of £2500 is receivable by the Royal Society from H.M. Government during the current year. The grant is available for assisting the publications of other scientific societies, as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grant will be adjudged by the Council of the Royal Society at its meeting early in July, but should be received before the Council meeting of June 13. Applications from societies will be received by the secretaries of the Royal Society ; those from individuals must be brought forward by members of Council.

THE second meeting of the Internationale Gesellschaft für Sexualforschung will be held in the house of the British Medical Association, Tavistock Square, London, on Aug. 3–9, 1930. It may be assumed that, as was the case in Berlin, the papers presented for discussion will fall into the following groups : biology ; physiology, pathology, and therapeutics ; psychology, pedagogy, ethics, æsthetics, religion ; demography, statistics, social and racial hygiene ; sociology, ethnology, and folk-lore. All arrangements are in the hands of Prof. F. A. E. Crew, The University, West Mains Road, Edinburgh, to whom all those who are interested are requested to write.

THE cheap popular series of books which have long been a feature of publishing enterprise fall into two main divisions ; those which have long attained the rank of classics, and those which provide expositions, brief but authoritative, of new problems, or of problems which have assumed new forms or a new importance. Of the latter kind of cheap series, "Benn's Sixpenny Library" is one of the most remarkable (London : Ernest Benn, Ltd.). To mention three examples, rather wide apart as to subject matter, from a number of volumes which have recently reached us—Dr. Cyril Norwood on "The English Educational System", Mr. E. N. Fallaize on "The Origins of Civilisation", and Lord Monkswell on "Railways"—is to convey some idea of the comprehensiveness of the series. Many of the volumes dealing with scientific subjects have been noticed separately in NATURE. As at present arranged, the series is to run to some two hundred and fifty books, of which we have already received about a hundred and fifty. The undertaking is one which deserves, and we trust is commanding, success.

A CORRESPONDENT in Tanganyika has directed attention to an error in the provenance of the wooden dolls described in NATURE of Mar. 9, p. 388, where they are attributed to West Africa. This should be East Africa, as the Wamakonde, by whom the dolls were made, are native to Portuguese East Africa.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A soil analyst in the West of Scotland Agricultural College —The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (May 24). An assistant lecturer in chemistry and an assistant lecturer in biology at the Brighton Technical College — The Secretary, Brighton Technical College, 54 Old Steine, Brighton (May 25). An assistant at the Forest Products Research Laboratory, Princes Risborough, for work on the identification and structure of wood—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (May 25). Temporary assistant chemists at the Government Laboratory—The Government Chemist, Clement's Inn Passage, W.C.2 (May 25). An assistant master to teach mathematics at the Toxteth Junior (Day) Technical School—The Director of Education, 14 Sir Thomas Street, Liverpool (May 25). A part-time demonstrator in chemistry at King's College of Household and Social Science—The Secretary, King's College of Household and Social Science, Campden Hill Road, W.8 (May 29). A demonstrator in the mechanical engineering branch of the Military College of Science, Woolwich—The Assistant Commandant, Military College of Science, Woolwich, S.E.18 (May 31). A pathologist and curator at the Royal London Ophthalmic Hospital—The Secretary, Royal London Ophthalmic Hospital, City Road, E.C.1 (May 31). An assistant lecturer in physical chemistry in the University of Sheffield—The Registrar, The University, Sheffield (June 3). A demonstrator in the department of physiology of Middlesex Hospital Medical School—The School Secretary, Middlesex Hospital Medical School, London, W.1 (June 5). A professor of mechanical engineering at the College of Engineering, Guindy, Madras — The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (June 8). A research chemist in the department of Coal Gas

and Fuel Industries of the University of Leeds—The Registrar, The University, Leeds (June 9). A lecturer in civil engineering in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (June 11). Two research fellows in the Department of Chemical Technology of the Imperial College of Science and Technology for work in connexion with the carbonisation of coal, gaseous combustion or catalytic reactions—The Registrar, Imperial College of Science and Technology, South Kensington, S.W.7 (June 15). Three assistants in the Research Department, Woolwich, under the Directorate of Explosives Research—The Chief Superintendent, Research Department, Woolwich, S.E.18. An examiner in the Aeronautical Inspection Department, Air Ministry, Kidbrooke, S.E.—The Secretary (I.G.), Air Ministry, W.C.2. A temporary woman lecturer in geography at the Warrington Training College, temporarily at St. John's College, Battersea—The Principal. An assistant in the Public Health Laboratories and Bacteriological Department of the University of Durham College of Medicine—The Registrar, University of Durham College of Medicine, Newcastle-upon-Tyne.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF MAY 9.—Unfortunately, the news from the official British parties at Alor Star and Patani are very disappointing. At the latter station nothing could be done owing to thick clouds. At the former the clouds were thinner, and some plates were exposed, but it is feared that they will be of little value.

Fortunately, the parties in Sumatra and the Philippines had better conditions. Iloilo (Philippines) was occupied by American and German parties from the Naval Observatory, Washington, and from Hamburg. There were also two English observers, Dr. R. L. Waterfield and Mr. W. Lloyd. There was a little high cirrus cloud here, but it does not appear to have interfered much with the observations; there was a fine flag-shaped prominence, which the Americans humorously compared to the 'Stars and Stripes'. The corona was of maximum type and had six-pointed streamers; Dr. Waterfield reports that it was brighter and more extensive than that of June 1927, but the darkness during totality was not so great. He states (*Daily News*, May 11) that the infra-red plates overcome thin clouds and give the corona a harder outline, but no greater extension, than ordinary plates. A kinematograph film was exposed during totality by the Washington party, but this had not then been developed.

Some of the parties in Sumatra report some interference by cloud, while others enjoyed very good conditions. Prof. J. A. Miller, of Swarthmore Observatory, who probably holds the record for the number of eclipses he has observed, took coronal photographs with a camera of 65-feet focus; comparison of his plates with those taken in Iloilo will reveal any coronal changes that may have taken place in an hour. Prof. E. F. Freundlich, from Potsdam, has telegraphed that he obtained successful results. He was studying the Einstein bending of light, a problem on which he was engaged even in pre-War days, before the publication of the general theory of relativity. This is the third totality that has been successfully observed in Sumatra in the present century; the others were 1901 and 1926.

Since the above was written, a Reuter telegram received from Dr. Jackson at Alor Star reports as follows: Developed plates better than anticipated. Transparencies equal to that of Giggleswick. Several beautiful prominences, one 150,000 miles long, 100,000 miles high, with coronal arches. Apparatus for velocity in the corona satisfactory.

THE PLEIADES.—At the meeting of the Royal Astronomical Society of May 10, the George Darwin Lecture was delivered by Prof. Ejnar Hertzsprung, of Leyden Observatory. He chose as his subject the Pleiades, and began with describing the methods by which the stars of the cluster could be discriminated from background stars by photographic determinations of their proper motions. Slides were shown of the proper motions of each magnitude of stars from the third to the fifteenth. The brighter ones are all cluster stars; it is only in the case of the faintest stars that any doubt arises as to which belong to the cluster, and even here there are only one or two doubtful cases.

Prof. Hertzsprung then proceeded to divide the stars into the spectral classes, which was done for the fainter stars by their colour indices. There are no red or yellow giants, the brightest stars being of type *B*, and the faintest being red dwarfs. Prof. A. S. Eddington remarked after the lecture that the resulting diagram of spectral type and absolute magnitude brought out the 'main sequence' more vividly than he had seen before, since it was the first time that such a large number of stars, all known to be at the same distance, had been studied. The globular clusters are too remote for the dwarf stars in them to be seen. The colour indices of the non-cluster stars in the region were also determined; there was some reason to think that they were rather redder than the average, which might possibly be caused by the presence of the nebulosities round the principal stars.

Prof. Hertzsprung adopted the parallax of the cluster as 0·0065″, which is smaller than some other estimates, which go up to 0·01″. He ascribed the proper motion almost entirely to the motion of the solar system.

MEASURING THE HEAT OF THE STARS.—The May *Scientific American* contains an account by Prof. H. N. Russell of the very delicate measures of stellar heat made by Messrs. E. Pettit and S. B. Nicholson with the 100-inch reflector at Mount Wilson. The wires of the thermocouple are about one-thousandth of an inch in diameter and weigh 1/600 of a grain. Betelgeuse is the star that gives us the most heat, but even this only raises the temperature of the wire on which it falls by 1/60 of a degree, and produces a current of one seven-millionth of an ampere. This, however, suffices to move the spot of light reflected from the mirror of the galvanometer through 18 inches. Some stars invisible to the naked eye give a measurable displacement. The next in order after Betelgeuse are Antares, Sirius, Canopus, Gamma Crucis, Arcturus, Alpha Herculis, Aldebaran, Mira at its maximum. It is noted that a very red star, such as Alpha Herculis, sends us 50 times as much heat as a white star of the same visual magnitude, in spite of the fact that the surface temperature of the first is only 2300°, that of the second being 6000°. The article contains a picture of the thermocouple used by Dr. W. W. Coblentz for measuring the heat received from the planets.

Research Items.

THE RELIGION OF MENTAWEI.—Mentawei Islands, lying west of Sumatra, owing to political conditions, have received more attention from Dutch and German than from English-speaking ethnologists. They were, however, visited in 1926 by Mr. Edwin M. Loeb, as a research scholar of the University of California, and he has now published an account of the religious organisation of the Pageh group of islands in the *Publications in American Archæology and Ethnology*, vol. 25, No. 2 of that University. He deals more especially with the *punen* system. The *punen* is the community religious festival (as distinct from the *lia* or family festival) which is attended by all members of the *uma*, the communal house. The festival is of long duration, sometimes lasting for years. It takes place at the building of a new communal house, the choice of a new priest, the making of a new field, the spilling of blood in the village, an epidemic, and so forth. The main ceremonial acts are the slaughter of pigs and chickens, the sacrifice of their livers and haruspication. The souls of the dead members of the *uma* are invoked to return, and imitative dances are held, and towards the end of the festival monkeys, deer, and sea turtle are hunted. All men sleep in the *uma* and sexual intercourse is taboo. The religious beliefs of the Mentawei Islands are animistic. They believe in nature spirits, souls, and ghosts; but the nature spirits, with a few exceptions, are not given names. They are the spirits in the sea, the jungle, and so forth. The exceptions are a god who causes earthquakes, the original meaning of his name being 'grandfather'. It is on account of this god that a human sacrifice used to be offered at the building of the *uma*. Other specially designated gods are two water spirits, the first being propitious if due sacrifices are offered and no ritual sin has been committed, and the second is evil. The soul cult is specially directed to the preservation of health and long life, while ghosts are the bringers of disease to whom prayer is offered for purposes of witchcraft, and to whom sacrifice is made only when they have entered a village bringing sickness, to induce them to go away.

THE REGENT'S PARK MEDUSA.—Prof. C. L. Boulenger and W. U. Flower (*Proc. Zool. Soc.*, Part 4, 1928) record observations on the freshwater medusa, *Craspedacusta* (*Limnocodium*) *sowerbyi*, which reappeared in the *Victoria regia* tank in the Royal Botanic Society's Garden in Regent's Park in 1928 (see also NATURE, July 14, 1928, p. 58). The youngest specimens—about half a mm. in diameter—agree in structure with the description of American examples of the medusa of *Microhydra ryderi*. The latter is therefore merely the young stage of *C. sowerbyi*. The description given of *Microhydra germanica* shows that it corresponds with the young forms of *C. sowerbyi*, and the Chinese species *Limnocodium kawaii* is also a synonym. The Japanese *C. iseanum* is clearly differentiated by the structure of its sense organs. The living *C. sowerbyi* passively sinks in the water, the velum hanging downwards from the umbrella margin and the tentacles floating upwards, the lip of the oral opening of the elongate manubrium being widely extended so as to catch organisms. In addition to this 'tow-net' method of feeding the medusa can feed on bottom-living forms, for the stomach has been recorded filled with *Arcella*. The authors consider that the increase in size of the mouth and the large manubrium of *Limnocnida* show that this genus has become more perfectly adapted to the tow-net method of feeding, but the radial canals are shortened and the sex-cells remain in the manubrial ectoderm, that is, in the primitive position in which they first appear in the young *Craspedacusta*.

THE MUSKRAT IN EUROPE.—In 1905 the American muskrat (*Fiber zibethicus*) was introduced into Bohemia on an estate near Prague, where it was hoped that it would breed and help to supply the demand for musquash fur which was then in fashion. The experiment succeeded better (or worse) than was expected, for the colony burst out of control and soon mid-Bohemia was overrun. About 1914, Bavaria and Saxony were invaded; in 1924 Silesia; and in 1928 the outposts were still spreading (Hj. Broch in *Naturen*, January 1929). The extent of the conquest may be judged by the fact that in 1921, 60,000 to 80,000 muskrat skins were sold in Berlin at prices which compared favourably with those obtained for American skins. Such an invasion could not but have its ill-effects. The muskrats, largely vegetarians, have attacked corn, potatoes, kohlrabi, turnips, and carrots. They have extended their carnivorous diet to frogs and fish, and the damage caused by their burrows to road and railway works has not been negligible. Strenuous measures have been adopted against the pest in the affected countries; in Bavaria special muskrat catchers have been appointed. The whole story is but another illustration of the danger of introducing animals in casual and unconsidered ways to new countries, and it strongly supports Dr. Broch's plea that there should be no relaxing of the law forbidding the importation of live muskrats into Norway.

ANIMAL HYPNOSIS.—J. ten Cate (*Biol. Zentralbl.*, Bd. 48, Heft 11) discusses the problem of animal hypnosis. Czermak (1856) found he could produce complete immobility in the newt by suddenly seizing with forceps a leg or the tail. Similar immobility after a sudden strong stimulus is met with in other animals, especially in insects, and is known even in a few mammals. But there are other cases in which the hypnotic condition is brought about by much weaker stimuli lasting for a longer period, for example, in consequence of holding the animal, by the suppression of the reactions of flight, defence and turning over, by transient pressure on definite parts of the body, by continuous gentle contact, etc. Hypnosis in these cases appears only under quite definite conditions and its origin is by no means so simple as has been assumed. The author describes experiments with the skate, the cockroach, the salamander, the rabbit, and the octopus, in which hypnosis was produced by the action of definite stimuli. He proceeds to refer to the condition of the musculature and to discuss the origin of hypnosis in animals. He concludes that in the vertebrate series the significance of the cerebrum for the realisation of the condition of hypnosis becomes the more important according to the higher grade of development of the central nervous system. Among the invertebrates the general rule appears to be that the higher the animal the more significant are its cerebral ganglia in regard to the origin of hypnosis.

CHROMOSOMES OF MAIZE.—A useful study of chromosome numbers in many different varieties of maize has been made by Randolph (*Memoir* 117, Cornell Univ. Agric. Expt. Station), who used the iron-aceto-carmine method. All the different types of maize, including dent, flint, pop, and sugary, were examined,

including both meiotic and somatic chromosomes, and the chromosome counts in 338 plants were determined. In accordance with previous work, the typical diploid number was found to be 20 in all varieties. But plants with a higher number were found in two sugary and two starchy varieties, and in certain other cultures. In the exceptional cultures the numbers ranged from 21 to 28, but were constant in each individual, with rare exceptions. The chromosomes vary in length from about 2 microns to 4·5 microns, and the extra chromosomes were of the smaller size. Segmentation, fusion, duplication through non-disjunction, and hybridisation are discussed as methods by which the additional chromosomes may have arisen, but further studies are necessary before the exact method can be determined.

SOFT-WOOD IMPORTS INTO NEW ENGLAND.—Much has been read of the threatened famine in soft-wood coniferous timber supplies, and the matter is admittedly one deserving the closest attention. The intricacies of the question are very considerable, both in the Old and the New Worlds. A point bearing on this matter was discussed by Mr. Franklin W. Reed, of the National Lumber Manufacturers' Association, at the recent New England Forestry Conference (*Daily Science News Bulletin*, Science Service, Washington, D.C.). Mr. Reed stated that shipping lumber to New England, traditionally a forested region, seems like carrying coals to Newcastle; yet lumber is being shipped into the State and no tariff wall can keep out the invading lumber, for it is American lumber from the Pacific north-west. It comes into the New England market, partly because the digging of the Panama Canal has made intercoastal freight rates cheap, and partly because the Pacific lumbermen have been caught in an economic trap of overproduction and have to dispose of their product at abnormally low prices in order to maintain their establishments. "The present unfavourable condition, from the point of view of the New England producer, will end", said Mr. Reed, "when the excessive exploitation of the virgin stands of the Pacific coast is ended, either through agreement among the lumbermen or through exhaustion of the more easily accessible timber." Although New England may look with equanimity to such exhaustion, it would prove a serious matter for wider United States and world markets. In the meantime, however, New England timber owners and lumberers are advised to consider the possibility of exporting hardwood products to the Pacific States via the Panama Canal. This section, it is pointed out, though possessing a surplus of soft-woods, has almost no hardwood resources and is now importing oak from Japan. It appears possible, therefore, that an exchange of New England birch, beech, and maple for Pacific Coast soft-woods might prove an economic possibility.

WATER-COOLED MERCURY VAPOUR LAMPS.—The Lummer and Straubel mercury vapour lamp, which furnishes a very bright light-source of small extent and proves most useful in spectroscopic work and as a subsidiary to devices for obtaining monochromatic light, has the disadvantage that it requires to be cooled in a current of water. In the *Rendiconti* of the Royal Lombardy Scientific and Literary Institute for 1928, Dr. Luigi Piatti, of the University of Pavia, describes a simple arrangement, which both prevents the lamp from coming into action unless the water is flowing and extinguishes it automatically if the water supply fails. Moreover, the arrangement is such that the electric circuit in which the lamp is inserted is kept well insulated from the cooling water.

FUNDAMENTAL CONSTANTS.—Prof. A. S. Eddington's theory of the relation between certain of the fundamental constants, to which several references have been made in NATURE this year, lends particular interest to two new numbers which have been published recently. H. Feder, working in the late Prof. Wagner's laboratory at Würzburg, who has remeasured Planck's constant h by a method based on the excitation of the continuous X-ray spectrum, now finds for it a value of $6{\cdot}547 \pm 0{\cdot}003 \times 10^{-27}$ erg. sec. H. D. Babcock, of the Mount Wilson Observatory, has revised a previous estimate of the specific charge of the electron (e/m) which he had made from the magnitude of the Zeeman effect for a number of spectral lines of known spectral types, and gives as its value $1{\cdot}7606 \pm 0{\cdot}0012 \times 10^{7}$ e.m.u./gm. In each case the changes called for in the older standard values are less than one part in a thousand, although it has to be remembered that the former method presupposes a knowledge of the actual charge on an electron (e), and the latter a knowledge of the velocity of light. The accounts of the two investigations are published in the *Annalen der Physik* (vol. i. No. 4), and in the January issue of the *Astrophysical Journal* respectively.

QUANTUM MECHANICS.—Dr. P. A. M. Dirac has reviewed some of the more recent developments of quantum theory very lucidly in the introductory paragraphs of a paper in the issue of the *Proceedings of the Royal Society* for April 6, on the properties of many-electron systems. Quantum mechanics is defined as "the general theory of all quantities that do not satisfy the commutative law of multiplication". Dr. Dirac considers that the general theory is now almost complete, apart from the question of the exact form in which relativity considerations have to be introduced. The latter, however, are only of importance where high-speed particles are concerned, and so the underlying physical laws necessary for the mathematical formulation of a large part of physics and the whole of chemistry may be regarded as completely known: the difficulty is only that insoluble equations are frequently encountered in the applications of these laws to specific systems. Dr. Dirac has given a sketch of the history of the spinning electron which brings out clearly the nature of the problem presented by the interaction of the orbital electrons of atoms and of molecules, and the way in which the impasse which this presented was removed by recognition of the fact that the electrons are actually indistinguishable one from another, and so can change places without our knowledge. This 'exchange' type of interaction leads also to satisfactory theories of homopolar valency and of ferromagnetism. Dr. Dirac's main object in this paper has been to take the ideas and results of group theory, which has been used extensively by German theoretical physicists, and to translate them into the more general and apparently simpler language of quantum mechanics, a transformation which appears to have the additional advantage that it often enables a simple physical meaning to be attached to an otherwise abstract theorem.

GRID CONTROL IN ARCS.—I. Langmuir and A. W. Hull have contributed a paper to the March number of the *Proceedings of the National Academy of Sciences* of the United States, from which it would appear that considerable developments in the use of enclosed arcs may be expected in the near future. The principle underlying the construction of the new tubes is the combination of grid control of the current from a hot cathode with conduction through an ionised gas, with the essential reservation that a

circuit can be made by raising the potential of the grid, but cannot be broken by again lowering it; a negative grid in a strongly ionised medium simply attracts to itself a thin sheath of positive ions, which act as a perfect electrostatic shield to the main body of the discharge. To stop a current flowing, the anode potential must be reduced to the neighbourhood of the ionising potential of the gas, and hence the grid does not affect the instantaneous value of the anode current, but only its average value. The action of the grid, once a discharge has been started, is in fact the same as that of the small exploring electrodes that are now used in the investigation of many types of gaseous discharges. More details of the arc tubes are being given by Dr. Hull in a series of articles in the *General Electric Review*. Perhaps the most remarkable feature of the first of these—in the April number—is the shape which is now being given to the electron-emitting surfaces of the cathodes. The bare filament type has been almost abandoned, and there has been substituted an elaborate structure of appropriately coated ribbons or vanes, in the design of which special care is taken to ensure that the emitting surface is efficiently insulated thermally. These tubes have already been made in metal, as well as in glass.

BREEZE AND CLINKER AGGREGATES.—Concretes made from furnace residues as aggregates often develop cracks within a short time of setting, and the causes of such failures have been investigated at the Building Research Station. The experimental methods employed and the results obtained are described in detail in *Technical Paper, No. 7*, by F. M. Lea (London: H.M. Stationery Office). Many breezes and clinkers contain combustible matter and even unburnt coal, and it is this material that is, in general, responsible for failure. The absorption of moisture and the oxidation of the coal cause swelling movements which may continue over a period of some days, and are particularly noticeable during the setting period and early life of the concrete. The presence of more than 40 per cent of combustible material in the breeze invariably results in a low-grade concrete, and the properties of the concrete improve as the combustible content decreases. Failure due to the presence of sulphur or its compounds appears to be rare, and up to 0·4 per cent of sulphur as sulphate and 0·75 per cent in other forms, is permissible. Other impurities do not appear to cause failure.

A METHOD OF PRODUCING SOUND STEEL INGOTS.—In a paper read before the Iron and Steel Institute on May 3, Sir Charles Parsons and H. M. Duncan described an experiment carried out on a large scale to produce steel ingots of exceptional soundness. The mould used consists of a strong steel casing lined with specially shaped firebricks and is closed by a cover similarly constructed and a bottom chill of steel or cast iron of large dimensions. Through the cover are openings for the pouring of the steel, the escape of gases, and for the insertion of oil burners to keep the surface of the steel hot. In this way the metal is constrained to solidify from the bottom upwards, and not, as in the ordinary ingot, from the sides inwards. The ingots produced, weighing as much as 20½ tons, are, as would be expected, very free from axial unsoundness and fairly free from segregation. The height of the ingot is small compared with its diameter. For purposes of handling in forging, a stalk must be cast on to the ingot after it has just set. The mechanical tests given by such an ingot are distinctly better than those from a normal ingot of similar weight, particularly as regards specimens cut transversely. In the typical ingot discussed, with a height of 45 in. and a diameter of 70 in., the typical V segregates of the normal ingot are absent, or shown only in a series of basin-shaped white markings on the sulphur print. In this ingot the oil burners had been concentrated on the centre of the top surface, but since then better results have been obtained by arranging the burners around the sides of the mould.

AREA-COMPUTING SCALE.—A useful device for computing the approximate area of plane figures of irregular shape is issued by Messrs. G. Cussons, Ltd., Technical Works, Manchester. It consists of a celluloid rectangle with graduated radial markings designed to give the required area in square inches to two decimal places. As a substitute for Simpson's and other computing rules it should prove very serviceable in certain circumstances, since it needs only to be laid on the paper. Special scale markings have been included to ensure full accuracy in limiting cases where this might otherwise be lost. The instrument is stoutly made but transparent, whilst the markings are distinct and the figures clearly legible. Explicit instructions for use, and easily grasped, are given in a circular accompanying the area-computing scale, and a number of illustrations are included. The theory of the instrument has been given by Mr. R. W. K. Edwards in the *Proceedings of the Royal Society*, vol. 73, and elsewhere.

EFFECT OF NITROGEN PEROXIDE ON COMBUSTION.—In vol. 73 of the *Proceedings of the Manchester Literary and Philosophical Society* (1928–29), Prof. H. B. Dixon and W. F. Higgins record further observations of the ignition temperatures of gases determined by their 'concentric tube' method whereby the influence of surfaces is practically eliminated. The abnormal behaviour of ether vapour was confirmed, and a discovery of interest was the remarkable accelerative effect of small quantities of nitrogen peroxide on combustion, as shown by a considerable depression of the ignition temperatures of ether and hydrogen in air. One part of nitrogen peroxide in 12,000 of air caused a depression of 30° in the value for ether in air; 1 part of nitrogen peroxide in 200 of air brought the ignition temperature of hydrogen down to 455°. These observations may be correlated with the recent observation of H. W. Thompson and C. N. Hinshelwood that nitrogen peroxide in suitable small proportions accelerate the union of hydrogen and oxygen at temperatures just below ignition. They emphasise also the rôle of peroxides in accelerating combustion reactions of several types.

ILLUMINATION IN BUILDINGS.—Article No. 18 of volume 19 of the *Scientific Proceedings of the Royal Dublin Society* deals with the measurements of the ratios of the illumination at various points within buildings to the illumination from the sky at points outside, made by Drs. W. R. G. Atkins and H. H. Poole. The measurements were made by means of photoelectric cells and galvanometer deflections, so that they involve no visual comparisons of brightness. They are expressed in terms of the 'daylight factor,' that is, the ratio of the illumination of a small horizontal surface inside a room and outside where it receives light from the whole sky, but no direct sunlight. The daylight factor in a well-lighted dwelling room is about 1 per cent, and close to a window may be 7 per cent. In an ancient church it sank to 0·2 as the mean value for about thirty different points, at some of which it was only 0·03. The authors point out that with such low factors it is not worth while to fit glass transparent to ultra-violet light in windows which do not receive direct sunlight.

Permian Diptera from Warner's Bay, N.S.W.

By Dr. R. J. TILLYARD, F.R.S.

OF the myriads of species of insects which swarm upon this earth, none is of such absorbing interest to mankind in general as the two-winged flies grouped together in the great order Diptera. This order is, by common consent, admitted to be one of the most highly specialised within the class, if not actually *the* most highly specialised of all. Yet, while no undoubted fossils of the order Lepidoptera, for example, are known older than the early Tertiary, definite, though somewhat obscure, dipterous types are known from the European Lias. We know, however, that the Lepidoptera must have existed for millions of years as obscure and very small types similar to *Micropteryx* and its allies, and that these in their turn had a common origin with the Caddis-flies or order Trichoptera. Ancient representatives of this latter order also occur so far back as the Lias, and I have previously given reasons why the common stem of the two orders Lepidoptera and Trichoptera must be regarded as having arisen from an extinct side-branch of the older order of Scorpion-flies or Mecoptera, which goes back, geologically, almost unchanged to the Lower Permian and probably also to the Upper Carboniferous.

More recent researches into the origin of the Diptera indicate clearly two outstanding facts; (*a*) that they are, of all existing orders, the most closely allied to the Mecoptera, and (*b*) that they must have had origin from the Mecoptera by way of a type, or types, closely resembling the hypothetical common ancestor of the Lepidoptera and Trichoptera, but retaining the markedly mecopterous character of an unbranched first cubitus in the forewing, whereas this vein is always branched in the other two orders. A number of forms clearly belonging to this ancestral group, which I have elsewhere called the order Paratrichoptera, but which Dr. Crampton prefers to call Protodiptera, were described by me from the Upper Trias of Ipswich, Queensland (*Proc. Linn. Soc. N.S.W.*, p. 199; 1919). Later on, through the discovery of the older insect fauna of Belmont, N.S.W., of Upper Permian age, these forms were linked directly with the true Mecoptera by way of the two fossil genera *Belmontia* and *Parabelmontia*, which I placed in the new order Paramecoptera (*Proc. Linn. Soc. N.S.W.*, p. 234; 1919; and p. 286; 1922).

Fossil-hunting at Belmont has always been a very arduous task, because of the hardness of the rock and the extreme rarity of the fossils. A good average would be about one wing for three days' hard labour! Under such conditions it never seemed likely that a full knowledge of the Upper Permian insect fauna could be obtained. The late Mr. John Mitchell, who discovered these beds, had always in mind the possibility of finding an extension of them somewhere around the shores of Lake Macquarie. With the aid of Mr. T. H. Pincombe, he succeeded in exploring a number of localities with the same geological horizon, and finally they opened up the rich fauna of Warner's Bay, on the shores of the lake above mentioned.

The Upper Permian of Warner's Bay has now yielded several hundred specimens, most of which still await description. Apart from abundant Homoptera and two problematical remains of Odonata, the fauna is *entirely holometabolous*, consisting of the dominant order Mecoptera and the orders Paramecoptera, Neuroptera Planipennia, Protocoleoptera, and Coleoptera. The extensive representation of the order Mecoptera has brought to light so many new types that it is now found advisable to include the orders Paramecoptera and Paratrichoptera as suborders of that order, by means of a very slight extension of its accepted definition. *With this extension accepted*, it would be scientifically correct to state that the three orders Diptera, Trichoptera, and Lepidoptera *have been evolved from mecopterous ancestors.*

The most interesting fact about the Warner's Bay Beds, as contrasted with the neighbouring Belmont Beds of the same age, is the abundance of very small insects. This is particularly noticeable in the Homoptera and Mecoptera. In the latter order there are large numbers of tiny, fly-like Mecoptera, closely allied to the existing Australian family Nannochoristidæ. Some of these are practically complete specimens, and the more slender of them appear to have had hindwings in various stages of reduction, though their habit of dying with all four wings closely folded together makes the working out of the hindwing a very difficult task.

Bearing in mind the fact that four-winged Paratrichoptera are known to have lived in Australia right up to Upper Triassic times, while the oldest known true Diptera are Liassic, it did not seem very probable

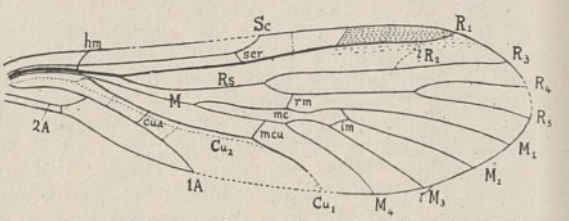

FIG. 1.—*Permotipula patricia* n.g. et sp. Forewing. Length 5 mm. Upper Permian of Warner's Bay, N.S.W. Discovered by Rev. A. J. Barrett, 1928.

that we should ever discover true Diptera at Warner's Bay. But I have had the possibility in mind for some years, remembering that Protocoleoptera are found alongside true Coleoptera in the same beds, and Protodonata alongside true Odonata in the Lower Permian of Kansas. Every small Mecopteron has been carefully studied in the hope of finding something more definitely dipterous than any hitherto known. But, until quite recently, the search was unavailing.

When I returned to Australia in October last, my friend the Rev. A. J. Barrett, who had become interested in the Warner's Bay Beds, sent me a small parcel of fossil insects which he had found there. Looking through these, I found the distal two-thirds of a small wing which seemed to me so obviously dipterous that I at once proceeded to study it in detail. To my great joy I found that both obverse and reverse impressions had been saved, and that in one of these the basal portion of the wing was covered by a small piece of rock. It is a risky matter to attempt to uncover hidden portions of fossils in this cherty shale; but I took the risk. A lucky stroke removed the overlying piece, and succeeded in exposing the complete wing, with only minor damage. To my astonishment, not only was this found to be truly dipterous, with an unexpectedly petiolate basal portion, but it must also be definitely classified as Tipuloid, and distinctly more advanced than such living forms as the Tanyderidæ, which have retained the original four-branched radial sector (*Rs*).

Fig. 1 shows this remarkable wing, which is just 5 mm. in length. The missing portions of the costa, apex, and posterior margin, and of the apical part of the first cubitus, are indicated by broken lines;

otherwise the wing is complete. The wing is of the greatest interest, because any student of venation would certainly classify it as dipterous and nothing else, and yet *we do not know whether the insect to which it belonged had four wings or only two*! Also, it is the oldest known dipterous type of wing by many millions of years.

To facilitate discussion, it would be advisable to name the wing at once. At Mr. Barrett's request, I name it after my wife, as *Permotipula patricia* n.g. et sp. The wing must be classified in the superfamily Tipuloidea, in a new family Permotipulidæ characterised by the slight degree of petiolation, the short 2*A* and the elongate median cell (*mc*), and in a new genus *Permotipula* distinguished by the form of *Sc*, the positions of *rm* and *mcu*, the extreme narrowness and irregularity of *mc*, and the sessile origin of both median forks from that cell. A full analysis of the venational characters and a comparison with known archaic forms of Diptera will be published elsewhere. The figure itself is sufficient diagnosis of the species.

This discovery appears to indicate that the tendency towards lengthening and narrowing of the wings, which is marked enough to have been commemorated in the very name of the ancestral order, Mecoptera, ran to two successful specialisations. The first of these, the family Bittacidæ, retained all four wings, and so remains classified to-day as a family within the Mecoptera. The second evolutionary effort, acting on much smaller and more insignificant types allied to the Nannochoristidæ, produced the true Tipuloid Diptera, or two-winged analogues of the Bittacidæ. From such small and obscure forms as the one now discovered, the great order Diptera must have originated, with all its multitude of new types, just as the even greater order Lepidoptera must also have originated from small and obscure types resembling *Micropteryx* and its allies. For a correct understanding of the larval forms of these two great orders, maggot and caterpillar alike, we must go back to the ancient polypod larva of the true Scorpion-flies.

The Department of Scientific and Industrial Research.

A PERUSAL of the Report of the Department of Scientific and Industrial Research for the year 1927–28 (Cmd. 3258. London: H.M.S.O.), which includes a summary review of the work carried out under the various research organisations of the Department during the year, will provide the reader with abundant evidence of the wide range of the activities and responsibilities of the Department. The position of the research associations formed under the ægis of the Department is discussed elsewhere in this issue (p. 749). The National Physical Laboratory and the Geological Survey have been for some years under the general direction and control of the Department; and there are between forty and fifty research boards and committees, dealing with such diverse subjects as chemistry, fabrics, engineering, metallurgy, physics, radiology, building, architectural acoustics, heating and ventilation, food, forest products, fuel, atmospheric pollution, national coal resources, water pollution, adhesives, dental investigations, gas cylinders, illumination, lubrication, and X-rays. To attempt to give, in a reasonable allowance of space, a condensed compendium of what the report has to say on all, or even most, of these activities, is obviously impossible, and we must be content to select, more or less at random, some features of interest.

There are 36 pages devoted to a summary of the main features of the work of the nineteen research associations still in receipt of grant aid from the Department. The Wool Research Association has introduced this year a new woollen ring spinning frame which, it is claimed, is capable of producing two and a half times as much yarn per spindle as the standard frame, and of giving a superior yarn. It is the outcome of an exhaustive analysis by the latest scientific methods of the exact functions of every part of the existing 'Standard' machine; an analysis which showed clearly the directions in which simplicity could be effected without destroying practical efficiency. Reference is made to the new lead alloy introduced by the Non-Ferrous Metals Research Association as a result of investigations undertaken in co-operation with the Research Department, Woolwich. It has a strength, weight for weight, some 40 per cent greater than the ordinary commercial lead which is used for lead pipe, and, because of its freedom from the defect of a peculiar type of cracking, it is being used as a covering for electric cables. The remarkable, but not surprising, statement is made that "the Association has hitherto failed, in spite of many efforts, to arouse any interest in it among manufacturers of lead pipe and sheet". This is but another instance of the many that could be given to illustrate the lag between the completion of a research and the application of its results to large-scale industrial practice.

The report directs attention to the surprising statement in the inaugural address of the president of the Institution of Locomotive Engineers, in September 1927, that locomotive engineers have "not at their disposal any facilities for trying out experimental scientific research", and that there is no existing organisation in Great Britain which is available generally for the accurate testing of the performance and thermal efficiency of a locomotive. The Advisory Council, as the result of recent conferences on this subject, foreshadows the establishment of a national organisation for locomotive research.

On the subject of low temperature carbonisation the report states that "several processes are now being operated on a scale large enough to provide reliable data by which the possible limits of commercial success can be judged". A subsidiary company of the Gas Light and Coke Company, for example, is erecting plant to try out on a commercial scale the experimental retorts developed at the Fuel Research Station. Other investigations, connected with fuel research, to which brief reference is made, are those on metallurgical coke, which are being carried out by the Federation of Iron and Steel Manufacturers in co-operation with the Department; on the use of pulverised fuel in the mercantile marine; and on the economical use of coal.

The Empire Marketing Board has provided a sum of £18,500 for the period up to Mar. 31, 1929, which has enabled the Director of Food Investigation to initiate a new programme of research on the preservation and transport of fish. Attention has been paid, in the first place, to those investigations likely to yield results capable of adoption by the existing fishing fleets, and, in particular, to an investigation into the possibility of landing in first-rate condition an increased proportion of the fish caught. "Preliminary investigations carried out during the summer of 1927 showed, rather unexpectedly, that the flesh of fish is not inherently of a highly perishable nature, but that, on the other hand, the natural rate of deterioration is profoundly affected by secondary environmental factors." Aberdeen has been selected

as the location of a research station for the fundamental researches needed.

In summarising the work done, and being done, on cement and concrete research, attention is directed to the fact that there are two main differences between concrete and steel, which are in themselves sufficient to account for the many anomalies observed by engineers when applying to concrete the standard methods of test to determine the strength of steel. The first of these differences is the normal expansion and contraction of the material as the moisture in the surrounding atmosphere varies, and the second is the gradual flow of concrete under load. Investigations on the measurement of adhesion stresses, and of stresses introduced in the steel of reinforced concrete by the shrinkage of cement, have been undertaken at the Building Research Station and "have already been productive of data of much importance".

Coming to the Department's activities that relate to what is usually called 'pure science', we may note that the grants for researches, research workers, and students for the year ended Mar. 31, 1928, amounted to £31,346 net. The grants made under this head during 1927–28 were in number 186, and the grants refused 118, as compared with 214 and 213 respectively for the previous year. The researches so assisted in the year under review include, among others, the work carried out by Sir William Bragg and his collaborators on the X-ray examination of materials; and investigations on magnetic phenomena by Dr. P. Kapitza and his collaborators.

Age-Hardening of some Aluminium Alloys.

SOME physical properties of five typical aluminium alloys containing copper, magnesium silicide, or both, have been examined by Dr. M. L. V. Gayler and G. D. Preston, and the results were presented at the March meeting of the Institute of Metals. From this experimental work the following conclusions regarding the causes of the age-hardening of such materials are reached.

On prolonged annealing it is known that the precipitation of $CuAl_2$ or Mg_2Si, or both, depending on the composition of the alloy, occurs. The changes of density which occur during ageing, together with the accompanying changes in the lattice parameter, suggest that a similar precipitation from the solid solution takes place during the earlier stages of this process. X-ray analysis shows that, in addition to the change of parameter, the crystals in the aged material are in a disturbed state which is gradually relieved as the heating is continued. This distortion of the space-lattice is accompanied by an increase of the electrical resistance and is believed to be caused by the formation of minute particles of the precipitated compounds. The precipitation of the dissolved substance from the supersaturated solution entails, first the rejection of the atoms of the dissolved metal from the lattice of the solid solution accompanied by the possible formation of molecules, a process which entails a profound disturbance of the lattice. In the second stage, which may follow closely upon the first and probably largely overlaps it, a 'coagulation' of these rejected atoms or molecules takes place, resulting in the formation of minute crystallites. This coagulation process, except perhaps in its earliest stages, by removing the dissolved metal from the matrix, will tend steadily to lessen the distortion of the lattice, and thereby to diminish the hardness and the electrical resistance.

It is interesting to note that if the age-hardening is due to the precipitation of a metal, and not a compound of that metal, the hardening effect is small; for example, the iron-copper alloys. This would be expected on the basis of the theory outlined above, since it would cause less distortion of the lattice, no formation of molecules being required. If the formation of a compound involves the combination of atoms of the solute with those of the matrix, a greater distortion of the lattice will occur and the hardening be greater. When, however, the compound is formed by the combination of two or more different solute atoms, then still greater distortion is to be expected and marked increase of hardness results. Thus the ageing of an alloy with 4·5 per cent of copper due to the formation of $CuAl_2$ is relatively much less than that of one with 1·08 per cent of Mg_2Si.

Although up to the present the existence of lattice distortion has been inferred on general grounds, the new evidence from the X-ray spectra of aged alloys provides complete confirmation and shows, by the broadening of the lines, that this disturbance occurs to a marked extent which varies with the degree of hardness and electrical resistivity attained at the successive stages of the process. In the later stages of the ageing, when 'coagulation' has become appreciable and the precipitated substances have formed small distinct crystallites, the electrical resistance begins to fall again, the hardness diminishes, and the lines in the X-ray spectrum become less diffuse. F. C. T.

University and Educational Intelligence.

CAMBRIDGE.—Dr. A. B. Appleton has been reappointed University lecturer in anatomy, and Mr. G. E. Briggs has been reappointed University lecturer in botany.

Grants have been made from the Gordon Wigan Fund to Prof. J. E. Marr, Prof. J. Stanley Gardiner, Mr. F. T. Brooks, and Prof. J. Barcroft.

Dr. H. R. Dean, professor of pathology in the University, has been elected Master of Trinity Hall.

A Syndicate was appointed in May 1928 to report on the position of mineralogy in the studies of the University. This Syndicate has now reported to the University, and has made the following recommendations:

(1) Two new departments should be created in place of the existing Department of Mineralogy, namely, a Department of Crystallography and a Department of Mineralogy and Petrology; (2) the Department of Mineralogy and Petrology should be closely associated with the Department of Geology, but should also work in co-operation with the Department of Crystallography; (3) the head of each of the new departments should be a professor, and the minimum additional staff of each department should be one lecturer and one demonstrator; (4) a new building should be erected for the Department of Mineralogy and Petrology adjacent to the Sedgwick Museum; (5) the premises of the existing Department of Mineralogy should be assigned to the new Department of Crystallography; (6) crystallography should become a subject in Part I. of the Natural Sciences Tripos, but should carry a smaller maximum of marks than the existing subjects; (7) mineralogy and petrology should form part of the subject of geology in Part I. of the Natural Sciences Tripos, either as an alternative to palæontology or in addition at the candidates' option, and that in the latter case mineralogy and petrology together should carry the same additional maximum of marks as that allotted to crystallography; (8) that both crystallography and mineralogy and petrology should be included in Part II. of the Natural Sciences Tripos, but that their relation to the other subjects, or to possible subdivisions of them, should be determined by the appropriate University bodies; (9) subject to the adoption of the above recommendations, the existing subject of

mineralogy in the Natural Sciences Tripos should be discontinued.

LONDON.—Presentation Day at the University was on May 8, the ceremony taking place in the Albert Hall, the Vice-Chancellor, Sir Gregory Foster, presiding. The report of the Principal (Dr. Franklin Sibly), the last to be presented under the old constitution, records continued progress. The number of candidates for all examinations attained for 1928 a record of 34,941, comparing with 11,937 in 1913. This number includes 3383 candidates for first degrees and 508 for higher degrees, a total of 3891, of whom 2357 were internal and 1534 external. In the last year before the War, the numbers were 900 internal and 907 external. The roll of internal students now comprises 9886 names. Referring to the obligations of the Bloomsbury site, the Principal reported that four purposes had so far been approved—an administrative block, the Library, a Great Hall, and premises for the Union Society; in addition, eleven other purposes have been provisionally approved, including an Institute of Slavonic and East European Studies, towards which an offer of £35,000-£45,000 had been received and accepted from the government of Czechoslovakia, and provision for the teaching of the History of Art, for which Lord Lee of Fareham is collecting a fund.

The Vice-Chancellor, in welcoming the men and women who had become bachelors during the year, and those who had received higher degrees, appealed to the graduates to join Convocation and to use their voting powers when occasion arose. "These things", he said, "in the past had been left to a small minority." The University has a body of 170 professors, 80 readers, and about 830 recognised teachers. Next year the Union Society would have a Union House for the promotion of social life and the maintenance of their interest in University affairs. Referring to the new statutes for the University, the Vice-Chancellor said that the colleges and schools are now more closely federated with the University than before, and the symbols of this are the newly created Collegiate Council and the modification of the constitution of the Senate which has made it a more homogeneous body than hitherto; and the growth of the financial responsibilities has involved the creation of the University Court to deal mainly with finance.

MR. F. S. MARVIN will be conducting a history course at Danzig in the first week of August and has secured the co-operation of several scientific workers as well as historians and those interested in international affairs, which should make the twelve lectures as useful and comprehensive as any that have preceded them in the 'Unity' series. The general topic is "The World of To-day", or "Progress in Ten Years of Peace". Mr. Marvin proposes to deal with general international relations since the War, and Rear-Admiral J. D. Allen, an expert on armaments and naval matters, will treat of that aspect of progress. Prof. Doris Mackinnon, of King's College, London, will lecture on "Where we stand in Biology", and Mr. L. L. White (author of "Archimedes", etc.) is coming from Berlin to speak on the position of the physical sciences. Other aspects will not be neglected and, as Danzig is a home of internationalism, it is hoped to secure the co-operation both of German and Polish speakers and listeners on education, art, and literature. The Baltic trip offers in itself great attractions to visitors, and is too little known in England. Danzig, to which passages may be booked direct from London, is the best centre. Full particulars may be obtained from the honorary secretary, Mrs. Innes, 29 High Oaks Road, Welwyn Garden City, Herts.

Calendar of Patent Records.

May 18, 1804.—Gas lighting has a well-authenticated history before the work of Frederick Albert Winsor, whose patent for an apparatus for making gas for lighting and heating was granted on May 18, 1804, but it was Winsor who first advocated the public use of gas lighting, and its supply and distribution from a central source. Pall Mall was lighted by him in 1807, and the forerunner of the Gas Light and Coke Co. was formed a few years later.

May 20, 1800.—An early reaping machine was that for which a patent was granted to Robert Meares on May 20, 1800. A large pair of shears is fitted to a frame mounted on wheels. Long handles are fitted to the shears and by these the apparatus is propelled and the shears operated. Wires are arranged to guide the fall of the crop as it is cut.

May 22, 1813.—William Brunton's 'steam horse' for propelling or drawing carriages upon roads or railways by means of levers or legs worked by a steam engine and acting alternately or conjointly against the ground, was patented on May 22, 1813. The engine worked successfully on the Newbottle colliery tramline and drew coals up an incline of 1 in 36, but was eventually wrecked by an explosion.

May 22, 1834.—Baron Heurteloup patented on May 22, 1834, a self-priming gun in which a long tube of detonating powder was contained in the stock and was moved forward into position by each fall of the hammer. The hammer cut off the fragment of the tube required and then detonated the powder. In 1836 Heurteloup petitioned the Privy Council for a confirmation of the patent as he had discovered that a similar arrangement had been previously patented in France in which a straw filled with detonating powder was used, though the action was different, the gun was not self-priming, and the patent had apparently never been put into practice. The petition was granted and the patent confirmed.

May 22, 1847.—Sydney Smith of Nottingham solved the problem of the safe application of steam power by inventing and making the first efficient steam-pressure gauge, the steam acting on a flexible diaphragm connected through mechanism with the needle of a dial. The patent is dated May 22, 1847.

May 23, 1829.—The accordion—the intermediate between the mouth-organ and the concertina—was the subject of the Austrian patent granted on May 23, 1829, to Zyrill Demian and his two sons Karl and Guido, organ makers of Vienna. The patent was originally for two years only, but was extended for another three years in 1831.

May 24, 1834.—The chain-grate mechanical stoker was first devised by John George Bodmer, and was included with other forms of the mechanical stoker in his patent No. 6616, sealed on May 24, 1834. Bodmer described in his specification apparatus of the endless-chain type, but his preferred form consisted of a number of separate carriages which were intermittently pushed forward and one by one discharged at the back end, to be returned rapidly to the front and fed with fresh coal for another passage through the furnace. It was left to John Juckes, seven years later, to perfect the endless-chain type and introduce it into industry.

May 24, 1847.—The fish-plate joint now in universal use for the rails of railways was invented by W. Bridges Adams, and was patented by him and Robert Richardson on May 24, 1847. Until its adoption, rails were butt- or lap-jointed together in wide chairs.

Societies and Academies.

LONDON.

Royal Society, May 9.—**R. H. Fowler** and **P. Kapitza**: Magnetostriction and the phenomena of the Curie point. Various physical consequences of Heisenberg's theory of ferro-magnetism are discussed. The phenomena require the interaction integral, called by Heisenberg J_0, to increase with the volume of the crystal at least over a small range of value, covering the normal value for iron.—**C. G. Darwin**: A collision problem in the wave mechanics. In the quantum theory the motion of matter can be regarded as a wave motion, but this motion is interpreted in terms of particles in order to describe what is observed. In an ideal experiment of this kind depending on collisions between two free bodies, the particle-like behaviour is given just as successfully by the wave theory. Thus the interpretation can sometimes be postponed.—**J. A. Gaunt**: The relativistic theory of an atom with many electrons. The total angular momentum of the atom, suitably defined, has the same properties as in the non-relativistic theory. The inner and magnetic quantum numbers, and their selection rules, can therefore be taken over into the new theory.—**R. de L. Kronig**: The quantum theory of dispersion in metallic conductors.—**N. F. Mott**: The interpretation of the wave equation for two electrons. As required by the relativistic equation proposed by Eddington, the results of the two separate experiments required to locate each electron are independent.—**G. I. Taylor**: The criterion for turbulence in curved pipes. Coloured fluid is introduced through a small hole in the side of a glass helix through which water is running. C. M. White's conclusion from resistance measurements, that a higher speed of flow is necessary to maintain turbulence in a curved pipe than in a straight one, is verified.—**H. J. Phelps** and **R. A. Peters**: The influence of hydrogen ion concentration on the absorption of weak electrolytes by pure charcoals. Hydrogen ion concentration influences adsorption upon purified charcoal of various organic acids and bases and of some amino acids in varying degrees, sometimes showing a relationship to the degree of ionisation.—**R. K. Asundi**: The third positive carbon and associated bands. The third positive carbon bands, the 3*A* bands and the so-called Wolter spurious bands, have been photographed. A complete vibrational analysis of the three systems shows that they have the same final electronic state.—**F. J. Wilkins**: The kinetics of the oxidation of copper (1).—**C. E. Eddy, T. H. Laby**, and **A. H. Turner**: Analysis by X-ray spectroscopy.—**M. C. Johnson**: The adsorption of hydrogen on the surface of an electrodeless discharge tube.—**A. Elliott**: The absorption band spectrum of chlorine.—**H. W. Thompson** and **C. N. Hinshelwood**: The influence of nitrogen peroxide on the combination of hydrogen and oxygen.—**H. T. Flint**: The first and second order equations of the quantum theory.—**S. Bhagavantam**: The magnetic anistropy of naphthalene crystals.—**A. H. Wilson**: Perturbation theory in quantum mechanics (2).—**C. G. Lyons** and **E. K. Rideal**: On the stability of unimolecular films (1, 2, and 3).—**P. A. M. Dirac**: Quantum mechanics of many-electron systems.—**O. W. Richardson** and **P. M. Davidson**: The spectrum of H_2. The bands analogous to the parhelium line spectrum (3 and 4).—**H. E. Hurst**: The suspension of sand in water.—**D. Brunt**: The transfer of heat by radiation and turbulence in the lower atmosphere.—**W. G. Bickley**: Hydrodynamic forces acting on a cylinder in motion, and the idea of a 'hydrodynamic centre'.—**M. L. E. Oliphant**: The action of metastable atoms of helium on a metal surface.—**J. Hargreaves**: The effect of a nuclear spin on the optical spectra.—**M. N. Saha** and **Ramash Chandra**: New methods in statistical mechanics.

Linnean Society, April 18.—**G. Claridge Druce**: A botanical tour in Cyprus. The botanical history of Cyprus is a long one. Theophrastus mentions some of its products, Dioscorides alludes to its Origanum oil, and Drummond in 1754 was the first to record a definite endemic species, *Quercus alnifolia*; a second, *Onosma fruticosum*, was found by Labillardière in 1787; *Putoria* and the *Cedrus* had also thus early been noted. Its true scientific exploration was began by Sibthorp in 1787 accompanied by his artist, Bauer, the discoverer of *Pinguicula crystallina*. The new species were published chiefly by Boissier. T. Kotschy visited the island three times between 1840 and 1862 and brought up the number of species to 1050. Mr. A. Lascelles (now Sir Alfred), when he was judge there, and his sister, Miss Lascelles, made considerable collections in 1900–2. The author verified some of the earlier records and added *Lamprothamnium papulosum* J. Groves, a great extension in the north-east.—**G. S. Carter** and **L. C. Beadle**: Respiratory adaptations among fishes of the swamps of the Paraguayan Chaco. As previously shown, the fauna is normally exposed to great lack of oxygen. The fishes may obtain a further supply of oxygen from the well-oxygenated surface-film of the water, and the air above the water. Of the twenty species collected in the swamps, eight breathe air and the remainder make use of the surface-film by means of accessory organs. Most of the excretion of carbon dioxide is carried on in the gills, but the absorption of oxygen takes place almost entirely in the accessory organ. This is due to the evolution of the accessory organs for life in a medium poor in oxygen, and not for migration out of the water. It is suggested that in the evolution of the vertebrates, aerial respiration was evolved in waters of this type as an adaptation to lack of oxygen while the fish was purely aquatic, and that this development opened the way to the later changes definitely associated with the migration.

BRUSSELS.

Royal Academy of Belgium, Oct. 13.—**P. Stroobant**: The meeting of the International Astronomical Union at Leyden, July 5–13, 1928. A general account of the work done at the meeting.—**D. V. Jonesco**: A theorem of Lord Kelvin (2).—**Victor Van Straelen**: The triassic crustacean decapods and the origin of a phylum of Brachyura.—**Henri Fredericq**: The chronaxy of the muscles of insects. From the measurements given, the motor muscles of the wings of the dragon fly, humble-bee, and blowfly must be considered as organs of moderately rapid function. This idea, which is in contradiction with accepted ideas, can be explained, with Jarolimek, if it is admitted that these muscles do not act directly on the wing.—**Henri Fredericq**: The chronaxy of the invertebrate heart (cephalopods and decapod crustaceans). The bathmotrope action of the visceral nerves of the octopus.—**J. E. Verschaffelt**: The determination of surface tension by the method of separating discs. A discussion of the theory of the method and experimental figures for water, benzene, nitrobenzene, carbon tetrachloride, and aniline.—**E. Delporte**: Discovery and observations of minor planets at the Royal Observatory of Uccle.—**Em. Vincent**: Observations on the layers penetrated at the No. 2 pits of the Eysden coal-pit, near Maaseyck.—**Armand Duchesne**: The influence of the thermometer mass on the measurement of a constant tem-

perature or of one varying with time. Experiments are described which support the contention that the temperature of a superheated vapour or of a gas can only be measured accurately with a thermometer of negligible mass.

Nov. 3.—**P. Stroobant**: A new calculation of the flattening of Saturn.—**E. Delporte**: Discoveries and observations of minor planets at the Royal Observatory of Belgium.—**Henri Fredericq**: The action of the faradisation of the nearer portions of the ganglion nerve chain of the lobster on the chronaxy of the distant portions.—**Victor Van Straelen**: A new prosopon from the Diois Hauterivian and the Cretaceous 'Dromiacea' in general.—**D. V. Jonesco**: A theorem of Lord Kelvin (3).

LENINGRAD.

Academy of Sciences (*Comptes rendus*, 1929, No. 1)—**S. Kostytschew and V. Berg**: The forms of calcium compounds in vegetable tissues. The bulk of calcium in vegetable tissues is in the form of salts, mainly of oxalic, phosphoric, and carbonic acids; some of it is in complex combinations with organic substances, or in the form of salts absorbed by the colloid substances of the protoplasm. No difference in the forms of calcium compounds found in leaves and in the organs devoid of chlorophyl was found.—**N. Gutkova**: A mineral of the keffekilite group from the Tertiary deposits of the Crimea.—**A. N. Kiritshenko**: Contribution to our knowledge of the genus *Aphelochirus* (Hemiptera, Naucoridae). A list of 22 species of the genus is given and their distribution indicated on a map. Two new species, *A. improcerus* from Manchuria and *A. ussuriensis* from the Ussuri-land, are described and figured.—**I. Efremov**: Finds of stegocephals in the north-east of European Russia. Four distinct places where fossil remains of stegocephals are found are described in detail.—**A. P. Filippov**: Deformation of elliptic plates with supported margins.—**T. Ščegoleva-Barovskaja**: The first representative of the family Mordellidæ (Coleoptera) from the Jurassic deposits in Turkestan. A new genus and species, *Præmordella martynovi*, representing a new subfamily Præmordellinæ is described.

ROME.

Royal National Academy of the Lincei, Feb. 3.—**G. D'Achiardi**: Mode of formation of mimetic groups of dachiardite. This mineral, found in the geodes of one of the pegmatitic veins traversing the granite of Monte Capanne, near S. Piero in Campo, Elba, was termed mimetic zeolite, from its composition and from its occurrence in apparently octagonal prisms formed by the union of eight crystalline individuals. The pseudo-prismatic groups have an upper funnel-shaped end, either closed or open at the centre. The origin of this structure is discussed.—**L. Petri**: Behaviour of the olive under the influence of uranium radiations and of ionisation of the air. The stimulating action of ionised air on the growth of the olive is neutralised by the radiations emitted by the green oxide of uranium, when these exceed in intensity a certain limiting value.—**G. Vitali**: Bianchi's identity for Riemann's symbols in generalised absolute calculus.—**A. Signorini**: Electrostatic interpretation of the Kutta-Joukowski theorem.—**L. Fantappié**: Functional operators and calculation of infinite matrices in the quantum theory (2). By means of the notion of a symmetrical or hemisymmetrical functional product and, in general, of the notions of the theory of analytical functionals, it is possible not only to replace all the symbolic formations (mostly divergent series) used in the calculus of matrices due to Heisenberg, Born, and Jordan, by so many integral formations of well-defined significance, but also to reduce the whole matrix calculus to the calculus of symmetrical composition of the functions of two variables co-ordinated to the matrices themselves.—**A. De Mira Fernandes**: Superficial transports.—**Silvia Martis in Biddau**: Investigation of a rational expression for the powers of a matrix of the third order.—**Ines Sacilotto**: Riemann symbols in generalised absolute differential calculus.—**B. Colombo**: Certain theorems regarding the generalised transformations of Darboux.—**A. Carrelli**: Broadening of bands by resonance (1). The causes for the broadening of spectral lines are numerous. When, for example, the concentration of sodium atoms is diminished, the effect of resonance becomes annulled, but the pressure or Stark effect begins to preponderate, this effect being proportional, not to the number of atoms of the same kind, but to the total number of atoms or ions of any kind present in the flame. Moreover, when the concentration is extremely small, the line, although having zero breadth from the Holtzmark effect or the effect of pressure, has a finite breadth by auto-extinction or by the Doppler effect, and hence there should be a zone of values for the concentration in which anomalies in behaviour foreseen by Holtzmark become apparent. Such a zone may be readily realised experimentally.—**M. Amadori**: Condensation products of glucose and *p*-anisidine. Like *p*-phenetidine, *p*-anisidine condenses with glucose, giving two products, one, melting at 86°, having a glucosidic constitution, and the other, melting at 140°, the constitution of a Schiff's base.—**G. Malquori**: Conductivity of mixed solutions of lead and ammonium nitrates. The formation of complex compounds, assumed to be a probable cause of the solubility relations of solutions containing lead and ammonium nitrates, is confirmed by a study of the electrical conductivities of such solutions.—**A. Tulli**: Chemical analysis of a mummy: contribution to the study of mummification. Examination of a mummy from the Vatican Museum which, although bearing an inscription indicating it to be that of a lady of noble birth, was that of a man, points to the use of natural balsams in the mummifying process.—**Maria Bergamaschi**: Absorption of carbon dioxide by means of roots, and its utilisation in chlorophyllic synthesis. The results of experiments on maize and other plants show that plants grown in an atmosphere absolutely devoid of carbon dioxide form starch in their leaves by utilising the carbon dioxide absorbed by their roots from the soil or from the nutrient solution surrounding the roots. Plants grown in this way from seeds contain a greater amount of carbon than the seeds themselves, and are, therefore, able to 'organicise' carbon dioxide absorbed through the roots. The objection that, in such cases, the organic substance is formed entirely at the expense of the carbon dioxide furnished by respiration is thus refuted. These results are of both physiological and practical importance, and indicate the value of supplying carbon dioxide to the roots as well as to the leaves.—**G. Quagliariello**: Investigations on the mechanism of lymph formation. The differences in chemical constitution and in chemico-physical properties between lymph and plasma may be explained to some extent by assuming that, between the two liquids separated by a membrane far more permeable to electrolytes than to colloids, there is a tendency to the establishment of a membrane equilibrium. It is not, however, contended that the relationship between blood and lymph is completely represented by a simple system of this kind, as it is recognised that lymph is formed, not only from the blood but also from the tissues, which may be able to withdraw from the lymph one element in preference to another.

Official Publications Received.

BRITISH.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1168 (Ae. 332): Experiments on a Model of the Airship R. 101. By Dr. R. Jones and A. H. Bell. (T. 2304.) Pp. 27+7 plates. (London: H.M. Stationery Office.) 1s. 3d. net.

Cambridge Natural History Society. Fauna List No. 2: The Spiders of Cambridgeshire (including Harvest Spiders and Pseudoscorpions). By W. S. Bristowe. Pp. 25. (Cambridge.)

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 4, No. 2, April. Pp. 103-208. (Cambridge: At the University Press.) 12s. 6d. net.

Hull Museum Publications. No. 155: Record of Additions. Edited by T. Sheppard. Pp. 24+8 plates. No. 156: Oil Seed Crushing. By T. Sheppard. (Commercial Museum Handbooks, No. 3.) Pp. 10+4 plates. No. 157: Record of Additions. Edited by T. Sheppard. Pp. 50. (Hull.)

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1928, presented to the Annual Meeting, February 11th, 1929. Pp. 41+13. (York.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 41: Studies concerning the so-called Bitter Pit of Apples in Australia, with special reference to the variety "Cleopatra". By W. M. Carne, H. A. Pittman and H. G. Elliot. Pp. 101. (Melbourne: H. J. Green.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1196: Report on Progress during 1927-28 in calculation of Flow of Compressible Fluid, and Suggestions for Further Work. By Prof. G. I. Taylor. (T. 2654.) Pp. 18+3 plates. (London: H.M. Stationery Office.) 1s. net.

Memoirs of the Asiatic Society of Bengal. Vol. 9, No. 5: Geographic and Oceanographic Research in Indian Waters. Part 5: Temperature and Salinity of the Surface-Waters of the Bay of Bengal and Andaman Sea, with references to the Laccadive Sea. By Lieut.-Col. R. B. Seymour Sewell. Pp. 205-355. (Calcutta.) 5.10 rupees.

Publications of the South African Institute for Medical Research. No. 23: A Mosquito Survey of certain Parts of South Africa, with special reference to the Carriers of Malaria and their Control (Part 2). By Dr. Alexander Ingram and Botha de Meillon. Pp. 83-170+10 plates. (Johannesburg.)

The Quarterly Journal of the Geological Society. Vol. 85, Part 1, No. 337, April 19th. Pp. xlviii+108+10 plates. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

FOREIGN.

Scientific Papers of the Institute of Physical and Chemical Research. No. 182: Researches on the Piston Ring. By Keikiti Ebihara. Pp. 107-185. 1.20 yen. No. 183: The X-Ray Diffraction Haloes in the Aqueous Solutions of Electrolytes. By Hikoichi Shiba and Tokunosuke Watanabe. Pp. 187-192. 20 sen. No. 184: A Study of the Helium Band Spectrum. By Sunao Imanishi. Pp. 193-209. 25 sen. No. 185: Non-Consumption of Vitamin B by growing Chicken Sarcoma. By Waro Nakahara and Eiichi Somekawa. Pp. 211-220. 25 sen. (Tōkyō: Iwanami Shoten.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 81. Studies in Malayan Blattidae (Orthoptera). By Morgan Hebard. Pp. 109+6 plates. (Philadelphia.)

Bulletin of the American Museum of Natural History. Vol. 58, Art. 6: The Parasitic Worms collected by The American Museum of Natural History Expedition to the Belgian Congo, 1909–1914. By Horace W. Stunkard. Pp. 233-289. (New York City.)

The Danish *Dana* Expeditions, 1920–1922, in the North Atlantic and the Gulf of Panama. Oceanographical Reports edited by the *Dana* Committee. No. 3: Contribution to the Hydrography of the North Atlantic, the *Dana* Expedition 1921-22. By J. P. Jacobsen. Pp. 98. (Copenhagen: Gyldendalske Boghandel; London: Wheldon and Wesley, Ltd.) 12s.

Smithsonian Institution: United States National Museum. Bulletin 100: Contributions to the Biology of the Philippine Archipelago and adjacent Regions. The Fishes of the Series Capriformes, Ephippiformes, and Squamipennes, collected by the United States Bureau of Fisheries Steamer *Albatross*, chiefly in Philippine Seas and adjacent Waters. By Henry W. Fowler and Barton A. Bean. Pp. xi+352. (Washington, D.C.: Government Printing Office.) 60 cents.

CATALOGUES.

Nickel Cast Iron. Series B, No. 5: Nickel Cast Iron. By Prof. D. Hanson. Pp. 12. (London: The Bureau of Information on Nickel, Ltd.)

Chemical Apparatus: Laboratory Apparatus, Machinery and Equipment for all branches of Educational Research and Industrial Chemistry, Chemicals and Reagents, Scientific and Technical Books. (Catalogue No. 12A.) Pp. xvi+990. Microid Pyrometers. (Catalogue No. 20T.) Pp. 44. (London and Glasgow: Griffin and Tatlock, Ltd.)

Diary of Societies.

FRIDAY, MAY 17.

ROYAL SANITARY INSTITUTE (at Town Hall, Devizes), at 5.30.—R. T. Rhodes and others: Discussion on The Milk and Dairies Order, 1926.—L. B. Densham and others: Discussion on Meat Inspection.

ROYAL PHOTOGRAPHIC SOCIETY (Pictorial Group, Practical Meeting), at 7.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section) (Annual General Meeting), at 8.—Dr. H. R. Spencer: A Straight Rod Pelvimeter.—G. I. Strachan: Some Contraindications to Radiotherapy in Carcinoma of the Uterus.—V. Bonney: Results of the Surgical Treatment of Carcinoma of the Uterus.

SATURDAY, MAY 18.

ROYAL SANITARY INSTITUTE (at Town Hall, Devizes), at 10 A.M.—H. R. Hooper and others: Discussion on Some Aspects of Local Government on Air, Water, and Sewerage.—A. W. Jakeway and others: Discussion on The Devizes Sewage Works and Small Type Refuse Destructor.

MONDAY, MAY 20.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—Dr. H. Jeffreys: On the Transport of Sediments by Streams.—Dr. B. F. J. Schonland: A New Electroscope.—J. Hargreaves: (*a*) The Dispersion Electrons in the One-Electron Problem; (*b*) Some Calculations Relevant to the Quantum Defect in the Extended Ritz Formula.—S. E. A. Landale: An Analysis of Triode Valve Rectification.—*Papers to be communicated by title only*:—J. A. Chalmers: An Approximate Method of Determining the High-Velocity Limits of Continuous β-ray Spectra.—L. Roth: Jacobian Surfaces of Quadrics in Four Dimensions.—L. Rosenhead: Systems of Double Rows of Line Vortices in a Channel of Finite Breadth where the Axis of the Row is Parallel to the Axis of the Channel.—J. R. Wilton: On Ramanujan's Arithmetical Function $\Sigma_{r,s}(n)$.—P. L. Srivastava: On the Phragmén-Lindelöf Principle.—Dr. A. C. Dixon: The Second Mean Value Theorem in the Integral Calculus.—R. A. Frazer: A Proof of Miquel's Theorem by Involutions in the Argand Diagram.

WEDNESDAY, MAY 22.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—Annual General Meeting.

EUGENICS SOCIETY (at Linnean Society), at 8.—Dr. R. A. Fisher, Prof. T. E. Gregory, and others: Discussion on Are Family Allowances Eugenic in Effect?

INSTITUTION OF WATER ENGINEERS (at Birmingham).

THURSDAY, MAY 23.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Prof. R. Robinson: The Chemistry of the Indole Group.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Prof. W. W. C. Topley: The Natural Acquirement of Immunity.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—F. A. Foord: Lubrication of Aircraft Engines.

FARADAY SOCIETY (Annual General Meeting) (at Chemical Society), at 7.45.—At 8.—J. C. Hudson: Third (Experimental) Report to the Atmospheric Corrosion Research Committee of the British Non-Ferrous Metals Research Association.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Annual General Meeting.

INSTITUTION OF WATER ENGINEERS (at Birmingham).

FRIDAY, MAY 24.

LINNEAN SOCIETY OF LONDON (Anniversary Meeting), at 5.—Presidential Address and Presentation of Linnean Gold Medal to Prof. H. de Vries.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Annual General Meeting), at 5.—Dr. F. J. Poynton: Some Phases in English Pediatrics as viewed by a General Physician.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. Ezer Griffiths: A Hygrometer for Use in Timber Seasoning Kilns.—Dr. J. H. Vincent: Experiments on Magneto-strictive Oscillations at Radio-Frequencies.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—F. J. Rennell Rodd: The Tuareg Tribes of Central Sahara.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland and Glasgow Sections) (jointly with Society of Chemical Industry—Edinburgh and East of Scotland and Glasgow Sections) (at Glasgow).—Prof. G. G. Henderson: Recent Research in the Terpene Series.

INSTITUTION OF WATER ENGINEERS (at Birmingham).

SATURDAY, MAY 25.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry—Edinburgh and East of Scotland and Glasgow Sections) (at Glasgow).

CONFERENCE.

MAY 18 TO 21.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (at Liverpool).

PUBLIC LECTURES.

TUESDAY, MAY 21.

UNIVERSITY COLLEGE, at 5.30.—Dr. R. Flower: Life, History and Folklore of a Kerry Island. (Succeeding Lectures on May 28, June 4 and 11.)

THURSDAY, MAY 23.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries at Beth-Peleth, Palestine. (Lecture to be repeated on May 31, at 5.30, and on June 1, at 3.)

UNIVERSITY OF BIRMINGHAM, at 4.—Dr. H. C. Cameron: Some Types of Septic Infection in the Newly-born (Ingleby Lectures). (Succeeding Lecture on May 30.)

FRIDAY, MAY 24.

BIRKBECK COLLEGE, at 5.30.—Prof. S. de Geer: Sweden and the North of Europe. (Succeeding Lectures on May 28 and 30.)