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The Worth of Education.

THE presidential address delivered on Dec. 31 last by Sir Richard Gregory at the nineteenth annual Conference of Educational Associations was entitled "The Worth of Science". Proverbial philosophy warns us of the difficulty—even the impossibility—of getting a quart into a pint pot; otherwise the president might have been able to include a few remarks on the kindred subject, "The Worth of Education". This subject is controversial, especially if discussed in relation to the Education Bill now before Parliament for raising the age for compulsory education to fifteen; and Sir Richard Gregory may have preferred the primrose path of peace and order; or he may have foreseen, warned again by proverbial philosophy, that others, including the present writer, would rush in where angels fear to tread.

From this point of view the intervention of Sir Ernest Benn on the following day, addressing the Independent Schools' Association, was *ben trovato*. As a business man, he has for some time sounded a booming note like Big Ben into our economic darkness. May it continue until the dawn of a new economic day! Why, he asked, did it cost £4 a year before the War to give a child elementary education and £13 to-day? In his opinion, there was no public demand for the School Attendance Bill. It was a "Bill to educate the child to put the father out of work". The officials of the Board of Education, he supposed, exercised their wits by settling questions which arose among themselves. There may be some truth in this, for those who wish to study the question of "The Worth of Education" in the dry light of science must be impressed by the lack of evidence on the subject. The student of our elementary education in Victorian times reads and digests Matthew Arnold's "Reports on Elementary Schools, 1852–1882", written, as his editor says, in a simple and telling style with so much knowledge of our own and foreign systems; with so sweet a reasonableness, and with so high authority as an expert. But he will look in vain for corresponding official reports to-day.

We are all educationists nowadays. As Charles Hargrove says, teaching is the most difficult job in the world, but "every parent, teacher, elder brother or sister, trained or untrained, themselves ill-taught, impatient, dogmatic, stupid, ignorant, and unsympathetic—all must try, for good or ill". There is certainly a need for guidance and we

should be grateful if the officials of the Board would suspend for the time being their discussion of the questions which arise among themselves in order to give the public trustworthy information about the condition of the schools of England. For, failing such evidence, the public may draw conclusions, possibly wrong ones, from unofficial publications, such as Ethel Mannin's "Confessions and Impressions", a book written by an original author who in happier circumstances might have become President of the Board of Education.

Ethel Mannin and Sir Charles Trevelyan, the President of the Board of Education, have this in common—that neither profited much from school education; though we are not disposed to accept *au pied de la lettre* Sir Charles's denunciation of his old school, Harrow, with its distinguished roll of old boys. Ethel Mannin tells us that during the War she was a pupil at a public elementary school and was told to write an essay on patriotism, a suitable subject. Having heard her father quote Dr. Johnson's dictum, "Patriotism is the last refuge of the scoundrel", she naturally worked it into her essay. For this piece of flagrant subversiveness she "was called up before the head mistress, lectured on the wickedness and stupidity of my attitude, and caused to kneel for a whole morning in the school hall, a punishment popular in the school". Her spirit was not broken. She failed, however, to obtain a secondary school scholarship, collapsing miserably in the viva voce examination! The examiners thought her stupid, but as she observes: "I knew I was not stupid, but only that I had not their kind of non-stupidness". Wise child!

'Expert' is no doubt a much-abused word. Mr. Henry Ford tells us that so soon as a man calls himself an expert, he bundles him out of his works. Ethel Mannin would not claim the proud title of educational expert, but her evidence seems to be very much *ad rem*, pointing as it does to the need for improving our existing elementary education before extending its scope. The most remarkable thing about the discussion of the present Education Bill is that the opinions expressed on its fundamental principles have been, with few exceptions, unfavourable. The Bishop of Gloucester stresses this point in his letter to the *Times* of Jan. 10: "I do not suppose", he writes, "that any educational reform of the magnitude implied by the proposed Hadow schools has ever been introduced with less authority behind it. It has really nothing to support it except a Departmental Committee and a good Press"; and later, in the same letter: "It is obvious that the proposal to raise the age of compulsory attendance at schools meets with only a limited approval".

In a short article it is not possible to summarise the views which have been expressed on this question; but readers of NATURE will respect the opinion of Sir William Pope, as given in his Norman Lockyer lecture to the British Science Guild. "There is little to indicate", he said, "that a rationalisation of our educational methods is in progress. Those who have to deal much with the young, realise that many, from all classes of society, are so poorly endowed mentally that all but the rudiments of education are wasted on them. Others, again drawn from every stratum of society, are intellectually so gifted that their education may be profitably extended until well into the twenties." No one will suspect this distinguished chemist of a desire to create 'wage-slaves'.

Manual work is sometimes the best method of developing human personality. "I don't like work—no man does", says one of Conrad's characters, "but I like what is in work—the chance to find oneself—your own reality—for yourself, not for others—what no other man ever knew." Regimentation, however distasteful to the English people, is necessary to secure that all children learn to read and write and to do sums; though, as regards the last accomplishment, many of the wise and eminent pass through life by using their fingers, Nature's abacus. But the shades of the prison-house should begin to lighten before the growing boy as soon as he has acquired these rudiments of knowledge. Part-time education, Mr. Fisher's golden calf, before which the whole educational world prostrated itself a few years ago, is now cast down—unfortunately, we think, particularly as regards works' schools.

What is most to be regretted, however, is the lack of common sense shown in the discussion of these vital questions. Sir Ernest Benn (loc. cit.) said that in 1830 very little common sense in regard to education was to be found. We will show our possession of this rare commodity by bringing this article to a close before it becomes discursive—and how better than by reproducing Sir Richard Gregory's quotation in his address on "The Worth of Science" from Descartes, who said that he studied science "to learn how to distinguish truth from falsehood, in order to be clear about my actions and to walk surefootedly in this life". T. Ll. H.

Geometry of Four Dimensions.

Geometry of Four Dimensions. By Prof. A. R. Forsyth. Vol. 1. Pp. xxix + 468. Vol. 2. Pp. xi + 520. (Cambridge: At the University Press, 1930.) 75*s.* net.

THIS work, which is primarily a formal treatise on the differential geometry of curves, surfaces, and threefold regions in ordinary homaloidal space of four dimensions, follows fairly closely on the lines of the author's very well known treatise on differential geometry in a three-dimensional space. Prof. Forsyth naturally prefers, however, in a treatise of this kind, not to assume, on the part of the reader, any previous knowledge of the elementary metrical properties of lines, planes, and planar threefolds in four dimensions, and he devotes the first half of his first volume, therefore, to a very systematic investigation of such properties, partly as a foundation to the subsequent theory, and partly for their own sake. This section of his work includes, therefore, a consideration of such concepts as the four direction cosines of a line and the six orientation co-ordinates of a plane, leading up to a very complete set of formulæ for the inclination and other properties of lines, planes, and threefolds in four dimensions; and though some readers will probably claim that part of this work could have been simplified by making use of the projective aspect of metrical four-space, and in particular by introducing the concepts of solid at infinity and absolute quadric, yet no one will deny that the author's treatment is very clear and adequate as it stands. He concludes this more elementary work by a chapter on what he calls *globular* representation of directions, analogous to spherical representation in ordinary space, and uses this in the analysis of general finite or infinitesimal displacements of the orthogonal frame of reference.

The remainder of the first volume is taken up with the foundations of the differential theory of curves and surfaces in four dimensions, the analysis involved being very analogous to that in Prof. Forsyth's former treatise referred to already. He proceeds in particular to establish the properties of a curve at a point of itself, namely, the natural orthogonal frame of reference at the point, the curvature, torsion, and tilt of the curve, and the centres and radii of circular, spherical, and globular curvature. He investigates also the curves, analogous to the helix in ordinary space, which have constant curvature, torsion, and tilt, and also those for which the ratios only of these are constant. In Chapter ix. he considers the dual aspect of a curve as the edge of regression of a developable generated by the intersection of consecutive solids of a simply infinite family; and further on, he interprets the various developables associated with a curve; and finally, in Chapter xi. he finishes off his work on curves by outlining briefly the general theory of a curve in any number of dimensions.

The chapters on surfaces which occupy the remainder of vol. 1 provide a most fascinating investigation, presented with delightful clarity and skill of exposition. It appears that a surface in four dimensions is a much more interesting construct in some ways than one in three dimensions. It has, for example, at any point O of itself, a normal or orthogonal plane N instead of a unique normal line as in three dimensions, and it appears on one hand that the intersections with N of the normal planes at points consecutive to O lie on a conic in N called by Kommerell the *characteristic conic* of the point O, while on the other hand, the centres of circular curvature at O of geodesics through O lie on a lemniscate in N which is in fact the pedal of the conic in regard to O. Not only so, however, for it appears in addition that there are four principal radii of circular curvature of geodesics through O, and these turn out very nicely to be the four normals from O to the characteristic conic, while the feet of the normals, which incidentally are points of contact of the conic and the lemniscate, are the centres of curvature on the four radii in question. Prof. Forsyth has certainly succeeded in giving a fine account of this fascinating theory.

In the second volume the author begins by laying the foundations of the theory of curved three-dimensional regions in space of four dimensions. He defines such a region by giving expressions for the co-ordinates in terms of these parameters, and after obtaining the fundamental quadratic differential form for an arc element on the region, he places on record all the necessary relations between the various associated magnitudes, including expressions for the parameter derivatives of the coefficients of the fundamental quadratic form in terms of Christoffel index symbols, formulæ expressing those of these latter which belong to one kind in terms of those of the other kind, and formulæ for the fifty-four derivatives of Christoffel symbols of the second kind, obtaining finally the complete set of six Gauss and eight Codazzi relations between the coefficients of the fundamental and secondary quadratic differential forms. Proceeding then to extend to a region the various notions already familiar in regard to a surface, he gives one chapter on linear curvature and lines of

curvature on a region, another on properties of geodesics and geodesic polar co-ordinates, a third and most interesting chapter on geodesic surfaces and the two measures of superficial curvature, the Riemann and the additive, associated with any orientation of a tangent plane at a point of the region, together with an investigation of their principal values; and he adds a fourth chapter on properties of loci of centres of curvature.

In treating next of general properties of surfaces in a region as distinct from those of a surface in free homaloidal four-space, he is careful to point out the important properties of *immersion* possessed by the former relative to the regions in which they lie, as, for example, the measure of deviation of their geodesics from the geodesics of the region. He obtains, however, all their spatial properties and curvatures as well, relating these wherever possible to properties of the region.

After an illustrative chapter on ovoidal or quadric regions, the author gives next an introduction to the theory of minimal surfaces in four dimensions, first in regard to surfaces of minimal area existing in free space, and secondly in regard to surfaces whose area is minimal on a region contained in such a space. These latter are, of course, of great importance as being the most obvious generalisations of the all-important geodesic curves, and Prof. Forsyth obtains their characteristic property, namely, that their additive measure of regional geodesic curvature is zero. Nevertheless, one feels inclined to think that these surfaces might surely be made to play a more important part than they seem to at present. Prof. Forsyth, however, evidently finds a more stimulating topic in his succeeding work on minimal regions.

In Chapter xxiv. the author sketches the theory of the various curvatures, linear, superficial, regional, etc., of a manifold of n dimensions in space of $n+1$ dimensions, obtaining also their principal values at a point. He obtains finally, without reference to the absolute differential calculus, the principal values of all the curvatures at a point in terms only of those of the linear curvatures there. One curious fact which emerges here is that although for surfaces in ordinary space the coefficients of the secondary quadratic form are not usually expressible in terms of those of the fundamental quadratic form, yet for a manifold of n dimensions in $(n+1)$. space $(n \geqslant 3)$, the corresponding coefficients are in general so expressible—a most interesting result.

The rest of the work is taken up with a systematic investigation and geometrical interpretation of the concomitants of configurations in quadruple space. For this purpose, Prof. Forsyth uses by preference Lie's theory of continuous groups, which he believes to have certain definite advantages in this connexion over the method of the absolute differential calculus. He considers in successive chapters concomitants of curves, surfaces, and threefolds, and includes in the last chapter complete systems of concomitants of a region, of grades three and four, in terms of which all others of the same or lower grade can be expressed. J. G. S.

Concerning Ceramics.

(1) *An Encyclopædia of the Ceramic Industries: being a Guide to the Materials, Methods of Manufacture, Means of Recognition, and Testing the various Articles produced in the Clayworking and Allied Industries.* By Alfred B. Searle. In 3 volumes. Vol. 1. Pp. xxvii + 391. Vol. 2. Pp. 462. Vol. 3. Pp. 384. (London: Ernest Benn, Ltd., 1930.) 63*s.* net each volume.

(2) *Diatomaceous Earth.* By Robert Calvert. (American Chemical Society Monograph Series, No. 52.) Pp. 251. (New York: The Chemical Catalog Co., Inc., 1930.) 5 dollars.

(3) *Some Writers on Lime and Cement from Cato to Present Time.* By Charles Spackman. Pp. xvii + 287. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1929.) 15*s.* net.

(1) IN attempting to arrive at an estimate of the utility of this complex work—Searle's "Encyclopædia"—the reviewer first commenced to trace out the ramifications of various subjects, but the constant distractions provided by interesting notes on totally different matters made progress slow and uncertain. This method was then discontinued in favour of a system of 'dipping' on single topics, some of which were very familiar to the reader and some the reverse. Continuing this method for a few months rather drastically altered his first impressions. It is not difficult to find a variety of mistakes, and by these to frame a condemnation of the work. What is more difficult is to view the work fairly from the point of vantage of the normal user, that is, one frankly seeking information.

The book is full of pleasant surprises; on the other hand, much is omitted which one might fairly expect to find. The author largely forestalls criticism of his imperfections by suggesting that the work, to be done perfectly, could not be accomplished by any man, and that, with all its imperfections, it might still be very useful; and so it is.

Its primary appeal, properly enough, is to those who have, so far, not had much contact with the object of their inquiry. Nevertheless, there is an imposing array of articles of a very high standard. Examples are the articles on electrical insulators and porcelain, hardness (of ceramic materials), plasticity, roofing tiles, rope haulage, and semi-dry process. A very valuable feature of the book is the inclusion of fairly extensive references to the literature. In this respect, if no other, the research worker and technical man, engaged in the task of collecting information on a new venture, are sure to be well repaid by including this book as a means of ready access.

Although the work is, on the whole, well balanced, the reviewer feels that there is less vitality and intimate appreciation shown in the articles relating to pottery practice than in the other numerous, and chiefly 'heavy claywares', branches. Information relating to kilns and ovens for fine ceramic goods seems disproportionately small, though this can be compensated by use of the references. In this connexion, a misrepresentation of accepted theory is to be found in the article on continuous chamber kilns, where it is stated that "A further disadvantage is that hot air must pass downwards through the chambers to be heated; this is in the opposite direction to its natural flow, so that it is difficult to ensure the heat being uniformly distributed". The article on "Output of Kilns" might have been expected to give typical figures for different kilns and products, whereas the information afforded is limited to the acceleration of brick kilns and general remarks about chimneys, foundations, leakage, and wet fuel.

The article on drying, though founded on the excellent treatment by Bourry, has a rather antique aspect for a modern work and would have been improved by the infusion of ideas from, for example, the work of Fisher and of Sherwood. The author bravely copes with the causes of defects in drying, but seems to explain them in terms which leave the reader no wiser. He refers to the importance of a knowledge of the ratio of the rate of evaporation to the rate of diffusion of water in the body, and that this ratio must be found for different materials, and *shapes*, by trial, before such defects can be cured. Now, a ratio, being a number, needs an instrument, or instruments, for its measurement. One never hears of such being used in practice, and, in fact, such problems are solved, on the works, by hit-and-miss methods. Furthermore, it is certain that the diffusion of moisture in clay becomes more and more difficult as its shrinkage progresses, and a piece of clayware, particularly if thick, has a moisture gradient, with corresponding variations of resistance, from the inside out to the face. The state of affairs is such that the ratio must be different for every part of the article and every interval of time during the course of the drying.

In dealing with the high-temperature side of ceramics, a large number of phase diagrams is reproduced. Many of these are well placed, but some appear to be purely ornamental, as no reference is made to them, or explanation of the marked points, in the text. Future editions will, no doubt, amend this.

The article on barium carbonate should distinguish between the relative utility, as a cure for troubles due to soluble sulphates, of the precipitated substance and of ground witherite.

In dealing with daub for kiln wickets, etc., a better statement should have been given of the making of a suitable mixture, sufficiently adherent, and, above all, free from such shrinkage as gives rise to cracks on drying.

The question of filtration of ceramic body slips is one of very great importance, and whilst many aspects are well treated, it is regretted that due emphasis is not placed on the fact that clay filters itself, the filter-cloth being merely a support; and that, being to some extent colloidal, the pressure of filtration has much to do with the ultimate residue of water in the cake, apart from its effects on the speed of working.

The reviewer would like to put forward a plea for that important clay-working area, North Staffordshire, in the matter of the use of the term marl. It is the custom of that district to refer to the local fireclays as 'marl', without any suggestion that they are inferior in refractoriness due to the presence of lime, which they are not. The confusion which arises is one which could readily be cleared up in a work of this nature.

Among definitions which will prove misleading to the student, though clearly not intentional, are: "Kation—One of a pair of electrodes", and, under "Quartz", "angular rotation in degrees per min.". There is a number of other mistakes, doubtful statements, and cases of bad construction in this article. They appear sporadically in a work which is, on the whole, well edited. The article on plasticity, in spite of its general good quality, suffers in this way. The thickness of the water-layer on clay particles in a plastic mass is given as 1·00005 in., alumina- for alumino-, W. E. Emery for W. E. Emley, Emerly for Emery, and Jachum for Jochum.

The tables giving the composition of seger cones are in need of editorial attention.

The reader of this rather fearsome sample of objections and errors might be influenced to avoid the book. That would not be the reviewer's wish, considering the very wide scope of the work, its undoubted helpfulness for ready reference, and the considerable opportunities afforded by the literature references of eliminating errors by closer inquiry. Mr. Searle is certainly to be congratulated. He has greatly lessened the labour for those who may follow in his footsteps, and, in the meantime, provided a useful guide for busy men.

(2) Calvert's "Diatomaceous Earth" is a very worthy addition to the American Chemical Society's Monograph Series, which already includes books of the greatest interest to the ceramic technologist. Amongst these may be mentioned Sosman's "Properties of Silica", Svedberg's "Colloid Chemistry", and Vail's "Soluble Silicates in Industry". The use of diatomaceous earth, or kieselguhr, for high temperature insulation has very greatly increased in the last decade, and no better subject for a monograph, collecting existing information in a useful form, could have been chosen. The same remark applies, with equal if not greater force, with reference to its use as an aid to filtration, notably of sugar syrups, and as an addition to Portland cement. Whilst these are the chief uses of kieselguhr, it has many others depending on its fine-pore structure, polishing powers, and reactivity with lime and alkalis.

Calvert deals with the natural origins, properties, and uses of his material in a manner which leaves little to be desired. The illustrations and references are copious and well chosen; ready reference is facilitated by good indexes. The paper and binding are of good quality. Very few adverse criticisms seem possible: a few cases of faulty construction and printers' errors occur. For those who prefer to think of furnace temperatures in terms of Centigrade degrees, the almost invariable use of the Fahrenheit scale involves frequent mental arithmetic. The importance of the Danish deposits has not, perhaps, received its due, but as the development in this area has been chiefly recent in date, it will perhaps receive more attention in a future edition. The work undoubtedly deserves a special place on the bookshelves of every ceramic technologist.

(3) All those who have cause to search the literature for historical information on calcareous cements and lime will be grateful to Charles Spackman for collecting the results of his researches in this volume. The work commences with short definitions of a large variety of cements, and an index to the names of the authors whose works are dealt with chronologically in the main body of the book. The works abstracted or described range from Marcus Porcius Cato, 234–149 B.C., to the modern works of Knibbs and Eckel and the publications of the Building Research Board. The reviewer has noted a few minor errors, but, on the whole, the book has been well edited. It concludes with a suitable subject index. S. R. HIND.

A Late Greek Manuscript on Alchemy.

Union Académique Internationale. Catalogue des manuscrits alchimiques grecs. Publié sous la direction de J. Bidez, F. Cumont, A. Delatte, Sir Frederic Kenyon, O. Lagercrantz, J. Ruska et C. O. Zuretti. Tome 7: Anonymi de arte metallica seu de metallorum conversione in aurum et argentum. Edidit C. O. Zuretti. Pp. lx+466. (Bruxelles: Maurice Lamertin, 1930.)

THE earliest treatises on chemistry were composed in Hellenistic Egypt (Alexandria) during the first centuries of the Christian era. Their language was Greek (κοινή), and their continuations in the Byzantine period, for example, under Heraclius (A.D. 610–641), present no new features. After the Mohammedan conquest of Egypt in A.D. 640, the treatises passed into an Arabic dress, and from about A.D. 1100 they arrived, in a sadly corrupted form, in the west in the shape of Latin versions (or 'perversions') made in Spain. The original Alexandrian treatises have been published, with translations, by Berthelot and Ruelle ("Collection des alchimistes grecs", 3 vols., Paris, 1887–88), and, although from time to time threats of an 'improved' edition have been put forward rather fretfully by German scholars, this publication is likely to remain for some time to come the basis of our knowledge of the earliest chemistry. The principal manuscripts and their contents have been known for a long time; in the selection of texts for publication or republication the advice of a chemist would no doubt prove useful, since the interest and value of such texts vary considerably.

That the Latin versions were sometimes retranslated into modern Greek was well known: Berthelot ("La Chimie au moyen âge", vol. 1, p. 155; *ib.*, "Introduction à la chimie des anciens et du moyen âge", p. 207) had directed attention to a case in point, the work "Πέτρου τοῦ Θεοκτονίκου

πρὸς τὴν τέχνην τῆς ἀρχημίας", which is merely a translation of a Latin work attributed to Albertus Magnus. Some of the "Traités techniques" published by Berthelot ("Collection", 321 f.) also appear to be of this character.

The work edited by M. Zuretti, with great care and skill, which is now before us, appears to be a translation made about the fourteenth century in Italy from a Latin treatise or treatises, probably in turn translated from Arabic sources. The date and language of the treatise will be sufficiently obvious from the small chrestomathy which follows :

ἐλέξιρ
ἐν φουρνέλου ;
ἐν ὕδατι καυστικῷ ;
ἁλὸς νίτρου καὶ βοραχίου ;
ἐπὶ νάφθαν ;
βάλε εἰς οὐρινάλιον ;
ἁλὸς ἀμμωνιακοῦ ;
ἐν σιέλῳ (*axungia*) ;
ἅλας βίτρουμ.

μπότον μπαρβότον
τὸ ἀτιγκὰρ ἐν ἔλαιον ἱερουσολυμιτικόν ;
ἐν ὀθονίῳ πυκνῷ ;
ἐν φιάλῃ (for a flask) ;
ῥότουλον ἀρσενικόν ;
ὕδωρ ζωῆς (*aqua vitae*) ;
ἅλας ἀλκαλὶ . . . καλουμένης σόζα (*soda*) ;
ἅλας τῆς πέτρας (*sal petrae*) ;
ἅλατος τοῦ ταρτάρου.

The theory of the composition of metals from mercury and sulphur, which is attributed to Hermes Trismegistus, is given in the usual form : the four 'spirits' (that is, volatile bodies, a designation which appears in the Alexandrian treatises) are mercury, sulphur, arsenic, and sal ammoniac, although the latter is said to be really a salt, not a spirit. The word *xerion*, which usually means simply 'powder' (λείωσον εἰς ξηρίον), is, for some reason, not translated by the editor. An unusual feature is the classification of some metals as 'masculine' (for example, iron), which may have an astrological basis.

The only actual authority quoted in the text appears to be "Solomon the soldier" (κατὰ τὸν Σολομῶντα τὸν στρατιώτην), although Arnold of Villanova appears in the table of contents. Sublimation is ἀνάβασις: the Alexandrian term is ἄρσις. Some of the recipes have the ending characteristic of a Byzantine treatise : σὺν θεῷ (Stephanos in Ideler's "Physici et medici Graeci minores", vol. 2, pp. 199-253, each chapter, πρᾶξις, title, of which has it). There is an attempt at a lexicon of concealed names (p. 174), and no doubt many of the names of substances in the recipes are of this character, since the chemical operations as given are frequently impossible. A very curious name is ἅλας τὸ ἀλαμπρὸτ (*sal alembroth*, used, according to Kopp, "Geschichte", vol. 4, p. 195, for a mercury salt by Paracelsus "or perhaps earlier" : in our treatise it is a mixture of alkali salts). Mineral acids (ὕδωρ δὲ χαλκάνθου) appear, as well as rectified alcohol.

Several words are left untranslated by the editor : (1) κηρὸν νεοὺμ τίμιον (p. 216), given as *ceronneum pretiosum* (? "precious ointment", as μύρου βαρυτίμου in Matthew xxvi. 7) ; the translation on p. 217 seems defective in some respects ; *ceration* is an operation described in the early Alexandrian treatises and is derived from the old encaustic painting in four colours : black, white, yellow, red, in wax, these colours being mixed on the palette, κηροτακίς, over a small brazier (shown in Berthelot's, "Introduction", p. 146, but there erroneously called a "bain-marie") ; (2) τζηρίκι (probably related to ξηρίον) ; (3) σαρευπίνουμ (indexed as "? franco-gallice *sapin* ?", which is improbable : *serapinus* is gum arabic in Ruhland's "Lexicon", 1612, p. 432) ; (4) μαστίχιον, which dissolves iron and all bodies, and is μυστήριον θαυμαστόν ; perhaps an acid distilled in the alembic ("instrument de verre, en forme de μαστάριον," in Synesios ; Berthelot, "Introduction", p. 164) ; (5) ὀκόν (p. 320 ; perhaps ὠχρόν, as it is among yellow and red colours) ; (5) ἰνδανικόν (? *ondanique* = Chinese iron) ; etc.

The mention of a reverberatory furnace (φουρνέλλιον ῥεβερμπερατιόνις ; p. 262, etc.) seems an early reference : reverberatory fire (πῦρ ῥεβερμπερατιζιόνις ; p. 308) is also used. The use of the reverberatory furnace in England is said by Bishop Watson ("Chemical Essays", vol. 1, p. 33, vol. 3, p. 273, where it is called a *cupola*) to date only from the end of the seventeenth century.

The Latin translation appears to be technically fairly good (θεῖον translated as *aes* on p. 383 has escaped the list of corrigenda on p. 465) ; the requirements of chemists would better be met by French or English. The chemical interest of the treatise is small ; most of the recipes given seem to have been copied unintelligently by the compiler of the manuscript, which appears to contain material of very various dates. Some parts are derived from Alexandrian or early Byzantine material ; others have certainly come from Arabic versions, whilst others seem quite late and are probably derived from Italian recipe-books almost contemporary with the date of compilation of the MS. It is perhaps noteworthy that the treatment of pigments finds no place in the treatise, whilst it occupies most of the space in Italian recipe-books of the same or somewhat later period.

We have to thank M. Zuretti for the very successful result of his difficult task of editing this interesting work and for the excellent index which accompanies it.

J. R. PARTINGTON.

Our Bookshelf.

Allen's Commercial Organic Analysis. Vol. 8: *Glucosides, Non-Glucosidal Bitter Principles, Enzymes, Putrefaction Bases, Animal Bases, Animal Acids, the Cyanogen Compounds, the Proteins, the Digestion Products of Proteins.* By the Editor and the following Contributors: Julius Grant, G. Barger, K. G. Falk, Philip B. Hawk and O. Bergeim, G. H. Buchanan, S. B. Schryver and H. W. Buston. Editor: Dr. C. Ainsworth Mitchell. Fifth edition, revised and partly rewritten. Pp. x+761. (London: J. and A. Churchill, 1930.) 30*s*.

NEARLY twenty years have elapsed since the issue of the corresponding volume in the fourth edition of "Allen's Commercial Organic Analysis". Probably in no field of analytical work have more changes taken place during this period than in the subject matter under review, and particularly in the sections on nitrogenous constituents of animal and plant materials. The present volume is, therefore, practically a new book. The general subject is considered in a series of well-written monographs by specialists in their respective subjects, and the high standard of the previous volumes has been maintained.

As pointed out by the editor, there must of necessity be a certain amount of overlapping in an exhaustive work of this type written by a large number of experts. Thus, enzymes are considered in their relation to glucosides and elsewhere in the book from a different aspect, namely, in their connexion with the hydrolytic dissociation of proteins. On the whole, however, the book gains by such repetition, since the subject matter is considered by each specialist from a different aspect. Again, in a consideration of the subject matter of 'animal bases', certain related compounds have been discussed already in previous volumes (pyridine derivatives, mononamines, etc.), while some related compounds are reviewed in the section on 'putrefaction bases'. In this section, therefore, the author has been able to omit these from his review. Even with these omissions this section on 'animal bases' extends to more than 180 pages, and constitutes a very complete thesis in itself, on this difficult subject. The sections in the present volume on the analysis of proteins and on the digestive products of the proteins are the last contributions of the late Dr. S. B. Schryver to this branch of chemistry. It is of interest to note that it is intended to include a tenth volume in this series which will include recent advances and also a complete index to the whole series.

J. REILLY.

Gestalt Psychology. By Prof. Dr. Wolfgang Köhler. Pp. xi+312. (London: G. Bell and Sons, Ltd., 1930.) 15*s*. net.

THE author in his preface apologises for his difficulty in presenting *Gestalt* psychology in a foreign language; one may say at the outset that his English is much better than that of many writers to whom it is the mother-tongue. The author also points out that the subject matter as presented resembles a promising start rather than a complete achievement. It is a pity that this useful point of view is not maintained as the tone of the actual exposition, for that appears to be rather unnecessarily controversial and dogmatic.

To express the *Gestalt* theory in a few words is impossible. It arose primarily out of the experimental study of space perception, and the results of this study led to dissatisfaction with the prevailing theories and the formulation of what is known as the *Gestalt* theory. The word *Gestalt* has too much significance, unfortunately, in the German language, and its English equivalent too little. It is used to mean 'form' or 'shape', but also a state or process, or a segregated whole; and the theory is applied to most of the phenomena of sense perception, and then to processes of thought. The author discusses the properties of organised wholes, behaviour, association, reproduction, and insight, from this point of view. The varieties of directed attitude are held to be due, not to instincts or pre-existing drives, but to the actual situation. In experimentation the Gestaltists have done excellent work, and their challenge has been a useful stimulus, but a book of this size ought not to omit such contemporary work as that of Prof. Spearman.

The hypotheses put forward involve both physiology and physics, and the truth cannot be estimated yet. "All experienced order in space and time is a true representation of a corresponding order in the underlying dynamical context of physiological process." We do not know. Although there are constant references to the experimental data, yet few details are here given. Less repetition and fewer analogies from physics would have added considerably to the value of this nevertheless important communication.

The Aquatic (Naiad) Stage of the British Dragonflies (Paraneuroptera). By William John Lucas. (Ray Society Volume No. 117, for the Year 1930.) Pp. xii+132+35 plates. (London: Dulau and Co., Ltd., 1930.) 25*s*.

IN this work the author describes and figures the last immature instar in each of the forty-two species of dragonflies found in Great Britain. Since the whole of the early life of these insects is passed in water, and lasts on an average about two years, it is not surprising that the complete biology of very few of the species has been followed. There is consequently a large field open for the enthusiastic naturalist to explore as regards these insects. In the introduction to this volume the general structural details of the immature stages of dragonflies are explained, and with this information the reader is enabled to pass on to the diagnostic keys to the nymphs or naiads, as they are variously termed, arranged in families, genera, and species. The use of these keys will enable any given example to be traced down, and this preliminary determination can then be confirmed by reference to the detailed specific descriptions given in the general text.

At the end of the book there is a wealth of coloured and half-tone plates, which are reproduced in all cases from the author's personal drawings. In these plates the entire nymph, or naiad, is accurately figured, together with the mentum and palpi. In the suborder Zygoptera one of the caudal lamellæ is usually also represented. A monograph so complete as the present one is obviously the result of many years' patient search and observation. In some cases the living stages have been procured and the descriptions and illustrations made from these; in others, spirit material has been utilised; while for a considerable number, recourse had to be made to the exuviæ out of which the imagines had emerged. The author has appended to his descriptions notes relative to the habits, etc., of the different species. Although all the species are carnivorous, little seems to be known relative to their actual prey and whether they exercise much discrimination in this respect.

The present volume is well up to the standard of other volumes issued by the Ray Society, and both that body and the author are to be congratulated upon its production. A. D. I.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. 8, 1927–1928. Pp. xi + 196 + 23 plates. (London: The Newcomen Society, 1929.) 20*s*.

VOL. 8 of the *Transactions* of the Newcomen Society contains ten papers read during the winter 1927–28 and during the summer meeting of the latter year at Stourbridge; two notes and communications; a subject list of books and pamphlets relating to the history of technology, 1926–30; a list of members; the annual report, and 23 finely produced plates. As usual, the range of subjects is a wide one, the papers iucluding those of Mr. E. W. Anderson on the development of the organ; of Mr. T. Rowatt on railway brakes; of Mr. J. E. Hodgson on James Sadler of Oxford, and of Mr. J. W. Hall on the making and rolling of iron.

Two papers respectively by Engr.-Capt. E. C. Smith and Mr. L. F. Loree deal with the early history of steam navigation in England and America. In that by the former is an account of the machinery of the s.s. *Victory* in which Capt. John Ross set out in 1829 to discover the North-west Passage. From Ross's account of his long sojourn in the north, it was known that the machinery proved a failure, but hitherto nothing was known of its construction. Particulars and sketches of it were found a year or two ago in the note-books of Simon Goodrich which were preserved in the Science Museum, and some of his sketches have been reproduced in the *Transactions*.

The summer meeting gave an opportunity for several interesting communications on the early industries of the Stourbridge district. One of the 'notes' included in the volume is a long and valuable paper by Col. N. T. Belaiew on the Sumerian mina, its origin and probable value; while another by Dr. Carl Sahlin recalls the work of Thomas Lewis and Samuel Owen, two British pioneers of mechanical engineering in Sweden.

Myths and Legends of the Australian Aboriginals. By Dr. W. Ramsay Smith. Pp. 356 + 38 plates. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1930.) 21*s*. net.

DR. RAMSAY SMITH classifies the myths and legends of the Australian aborigines which he has collected in this volume into 'origins', that is, stories of the creation and beginnings of things; animal myths; religious, social, and personal myths; and has strung them together in the form of a connected narrative by notes on customs and beliefs cognate to each class. These notes give the uninstructed reader a general view of aboriginal culture as a background for the stories. Dr. Ramsay Smith is fully alive to the importance of aboriginal legendary lore in its bearing upon their institutions, and it is therefore surprising to find that, even though he disclaims any intention of giving a scientific exposition of Australian mythology, there is no indication of where and when the material was collected. Except in one or two cases, the name of the tribe in which the myth occurred is not mentioned. All that we are told is that the myths refer to "only a few localities in Australia and only a few tribes in them". As the stories, which are very much 'written up', bear very directly upon problems of aboriginal belief, this is a grave defect—all the more, perhaps, because the book is intended to be popular.

La Lorraine métallurgique. Par Axel Sömme. Pp. viii + 250 + 7 planches + 12 cartes. (Paris: Éditions Berger-Levrault, 1930.) 30 francs.

IN spite of their low iron content, the minette deposits of Lorraine are of great importance. Before the European War they were partly in Germany; now they lie in France except for a small area in Luxemburg, which will probably be exhausted in half a century. Prof. Sömme has made a close study of the geographical and economic conditions in these relatively new iron-ore districts with their rapidly growing towns. He has produced a monograph of considerable value, tracing the growth of the industry, its lessening dependence on Ruhr coke, its markets and lines of export, and the main labour problems which are entailed. He discusses even the effect of the industry on agriculture in Lorraine and Luxemburg. The book is well documented and has a number of sketch maps and illustrations.

Philosophy of a Biologist. By Sir Leonard Hill. Pp. viii + 88. (London: Edward Arnold and Co., 1930.) 3*s*. 6*d*. net.

THIS little book is a review of our present knowledge and views by a distinguished physiologist. It will be read with pleasure and interest by all scientific men, whether or not they agree with the author's endeavour to suggest that "modern science has brought us to the conception of a power eternal, infinite, unknowable . . . energizing all in the universe, the dead no less than the quick".

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.*]

Stellar Structure.

IT is only with some qualms that an outsider can enter into the discussion of questions of stellar structure, but I feel that Sir James Jeans is speaking more favourably of Prof. Milne's theory than he thinks when he says that it contains little that has not been anticipated either by Sir Arthur Eddington or by himself.[1] A theory that will combine the good points of Eddington's and Jeans's theories is precisely what observers of the progress of astrophysics have long wished to see. Jeans requires a liquid interior to explain binary fission; Eddington says that owing to ionisation the gas laws must hold through most of the interior. Eddington, assuming that the gas laws hold throughout the interior, infers the mass-luminosity relation, which is verified by observation except for the adjustment of a single constant. Neither theory appears to account for the facts explained by the other, and there must be something that both authors have overlooked. It seems to me that the chief recommendation of Prof. Milne's method of attack is that it foreshadows a means of finding out what this is.

As to Prof. Milne's results, the most striking seems to me to have escaped comment. In his forthcoming paper [2] he gives results for the companion of Sirius, containing an adjustable parameter β. If we take this equal to 0·28, we get:

	Theoretical.	Observed.
Mean density (gm./cm.^{3}) . .	6×10^4	6×10^4
Radius (cm.)	$3{\cdot}4 \times 10^9$	$1{\cdot}9 \times 10^9$
Effective temperature (degrees)	6000	8000–10000

An agreement in order of magnitude for matter so far removed from any state known in the laboratory must be impressive, particularly since, as Prof. Milne indicates, the theory is capable of further development.

The generation of stellar energy has long been an intractable problem. Eddington recognises the difficulty of accounting for it at the temperatures given by his theory. Jeans deals with it by introducing radioactive elements of higher atomic number than uranium. Whether this is an assumption or an inference, mere radioactivity, as usually understood, scarcely seems likely to give so great a secular diminution of mass as the stellar time-scale requires. Mutual annihilation of protons and electrons will do it, but this does not take place in ordinary radioactive processes. The great recommendation of Prof. Milne's theory is that it provides temperatures in the central regions of a star such that this mutual annihilation can be explained without going beyond current physical theories. On the other hand, the amount of generation given still needs quantitative test.

The defect of Milne's and Eddington's theories alike seems to be that they require too high a value of the stellar opacity, as was pointed out by several speakers in the recent discussion at the Royal Astronomical Society. Is it possible that this is because the chief mode of transfer of stellar energy is not by radiation but by vertical convection currents? All existing theories are against this suggestion, yet two circumstances point towards it. The granular appearance of the surface of the sun, as seen in a photograph taken in monochromatic light, strongly resembles that noticed by Bénard [3] and later workers [4] in the surface of a thin layer of liquid that has become unstable under a vertical temperature gradient just exceeding the adiabatic; also that shown in photographs of the upper surface of strato-cumulus clouds. Against this we have the fact that Prof. Milne seems to have shown [5] that the temperature gradient in the photosphere does not reach the adiabatic except possibly inside a sunspot. Secondly, if we *demand* a temperature of the order of 10^{10} degrees for the generation of subatomic energy, the whole of this generation must be in a small sphere about the centre of the star, and radiation may be unable to dispose of it at a gradient under the adiabatic.

Current theories, by assuming generation throughout the star, must give too low a gradient in the central regions. If this suggestion is correct, vertical currents must be generated, and these will redistribute the heat so as to keep the gradient near the adiabatic for a stream of matter carrying its radiation with it. This has been discussed by Prof. Milne, apparently with adverse results, but I am still inclined to think that his discussion may have constructive and not merely destructive value.

HAROLD JEFFREYS.

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[1] NATURE, Jan. 17, p. 89.
[2] *Mon. Not. Roy. Ast. Soc.*, Nov. 1930.
[3] *Ann. d. Chimie et d. Physique*, **23**, 62-144, 1900; also James Thomson, "Collected Papers", p. 136.
[4] Cf. A. R. Low, NATURE, **115**, 300; 1925.
[5] *Quart. Jour. Math.*, **1**, 1-20; 1930.

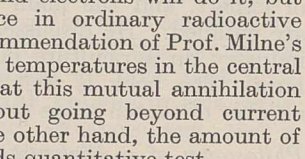
An X-Ray Study of Mannitol.

IN NATURE of Jan. 3, p. 11, Miss Thora C. Marwick gives the results of an X-ray examination of mannitol. I have recently completed an investigation of the structure of *d*-mannitol in the Chemistry Department of the University of Edinburgh, and have obtained the following results from the X-ray analysis:

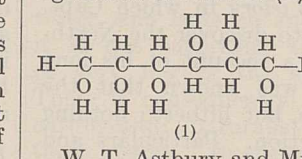
Space-group, Q^4; $a = 8{\cdot}66$ A.; $b = 16{\cdot}58$ A.; $c = 5{\cdot}50$ A.; calculated density, 1·522 gm. per c.c.; 4 molecules per cell.

Groth (*Chem. Kryst.*, vol. 3, p. 431) reports on two crystalline modifications of *d*-mannitol; the β-form which is always obtained by crystallisation from water is the form which was examined.

Irvine and Paterson (*Jour. Chem. Soc.*, **105**, p. 898; 1914) have shown that the terminal primary hydroxyl groups of the *d*-mannitol molecule do not appear to possess free rotation, but assume preferentially the fixed positions shown in formula (1). A second possible configuration is shown in formula (2), but a comparison of the reactive powers of the terminal hydroxyl groups made by Irvine and Steele (*Jour. Chem. Soc.*, **107**, p. 1221; 1915) proves that the configuration of formula (1) is correct.



(1)



(2)

W. T. Astbury and Miss K. Yardley (*Phil. Trans.*, A, vol. 224, p. 221; 1924) show that in a crystal belonging to the space-group Q^4, and having four molecules in the unit cell, the molecules must be asymmetric. Of the two possible configurations shown in formulæ (1) and (2), that of the latter possesses a diad axis of symmetry, while that of the former cannot possess any symmetry. The structure of the molecule of *d*-mannitol within the crystal is therefore represented by formula (1). This structure was also assigned to *d*-mannitol by Irvine and his collaborators examining the substance in solution.

An investigation of the crystal structure of *d*-

mannose is now nearing completion, and the results of the X-ray analysis of *d*-mannitol and *d*-mannose are to be incorporated in a paper which is in preparation.

GEORGE W. MCCREA.
University, Edinburgh, Jan. 12.

The Nature of Time.

EDDINGTON [1] has argued that the second law of thermodynamics definitely requires a one-way flow of time, although all other physical laws are equally valid for $+t$ and $-t$. Lewis [2] has taken the opposite stand, and concluded that entropy entails no temporal implications, hence time must be considered as twofold. Both agree that consideration of an individual particle yields no clue to the dilemma.

Pressing Eddington's 'time's arrow' argument, it appears theoretically possible to interconnect all elementary volumes of equal entropy in the universe by hyper-surfaces orthogonal to the time lines tangent to 'time's arrow'. Since entropy is a relativity invariant, this would determine a unique lattice for separating space and time, contrary to the principle of relativity.

It has occurred to us that since the only real argument in support of one-way time is derived from a consideration of statistical assemblages, it may be that time itself is discrete and should be statistically treated. To our knowledge this possibility has not previously been suggested, although Eve [3] has recently pointed out the intimate association of frequency (and therefore time) with mass and energy, both of which have been found to be discrete.

Pursuing the thought a little further, if the unit of time were intimately connected in some way with the electron or proton, some light might be shed on the mystery of quantum jumps. Since h/mc^2 has the dimensions of time, a possible value for a quantum of time would be $8{\cdot}12 \times 10^{-21}$ sec. obtained by substituting the mass of the electron for m in the above expression.

If time is found to be essentially discrete and statistical, then, since action and matter are already so accepted, the postulate of discrete or statistical space and electric or magnetic fields would also become highly probable.

F. O. WOLLASTON.
K. W. MILLER.

Commonwealth Edison Company,
Chicago, Illinois, Dec. 20.

[1] "Nature of the Physical World", Cambridge University Press, 1928.
[2] "Symmetry of Time in Physics" (*Science*, June 6, 1930, p. 569).
[3] "The Growing Importance of Frequency" (NATURE, Mar. 22, 1930, p. 454).

Equipotentiality of the Amphibian Eye Primordia.

THE experiments referred to below are concerned with the problem of the regulative power of embryonic *anlage*, the study of which has been taken to prove the equipotentiality of the eye primordia in amphibian embryos in the stages following the closure of the medullary folds. In *Pleurodeles waltli* it has been shown [1] that two optic vesicles may fuse together when that of the donor is transplanted in the close proximity of the optic vesicle of the host, keeping the same orientation of the normal position in the implanted eye. The degree of fusion depends upon the size of the removed portion of the vesicle in the host, and varies from that of double eyes partially fused to single eyes of larger size than the normal, which have developed by complete fusion of the two optic vesicles, which regulate its size afterwards, provided that the lens is not double.

By transplanting the optic vesicle of the donor dorsally and ventrally, cranially and caudally, or in the outer portion of the vesicle in the host, it has been possible to show the morphogenetic equipotentiality of the eye primordia. This is further shown by the fact that the anterior, posterior, ventral, dorsal, or medial halves of the vesicle may regulate and give rise to a normal but smaller eye. Such results have been extended by myself in further experiments on *Triton*, *Axolotl*, *Rana esculenta*, later by Detwiler [2] in *Rana fusca*. More recently, in some experiments on lens induction in *Rana catesbiana*, I repeated my own experiments on the fusion with the same results.

The chief results concerning the extent of fusion of two optic primordia in the experiments already described, together with the regenerative power of the optic vesicle or its compensatory regulation, have been dealt with. Our experiments have shown that the easiest way to get complete fusion is to remove a certain amount of the exterior part of the host vesicle, transplanting in its place the vesicle of the donor; with the same kind of operation, it has been possible to get the clearest cases of regulation in the medial half of the vesicle. In this way the potentiality of the optic vesicle's constituents has been analysed, controlling each half of the vesicle delimited by the transversal, frontal, and sagittal planes.

It has been found also, in my fusion experiments, that there exists a very close relation between the behaviour of the lens and the fused eye. Examples of such are cases in which the lens ectoderm was not transplanted with the optic vesicle and the double eye arose with a normal size lens; cases of transplantation of the optic vesicle with the overlying ectoderm which gave rise to double eyes with double lenses; or cases of a single lens produced by the fusion of two lens primordia. In the first case the regulatory reduction of the size in the double eyes seems to be accelerated, the same occurring in eyes with single fused lens; in the latter case the presence of two lenses causes less regulation of the form and size of the eye, and in some cases this regulation does not occur at all. A point of particular interest which has been investigated more carefully is the reaction of nerve centres to the double eye (resulting from complete fusion of two optic vesicles), in which case the number of nerve fibres growing in the thicker nerve has been increased by the implantation of an additional optic vesicle. There is always a very clear hyperplasia of the central nervous system, and the amount of the grey matter in the wall of the mid-brain on the side opposite to the double eye increases because of the greater number of the ingrowing nerve fibres.

A similar reaction has been shown for a single eye transplanted in the ear region by May and Detwiler [3] in *Amblystoma*, by May [4] in *Rana temporaria* and *Bufo vulgaris*, but in this new condition established by a double nerve which belongs to a larger sense organ, this reaction has a particular significance for its quantitative nature. These effects are closely similar to the hyperplasia found by Burr [5] in *Amblystoma* following the fusion of two nasal pits, and to the hyperplasia described by Twitty [6] when a large *Amblystoma tigrinum* eye is transplanted in its normal position in *A. punctatum* embryos.

In my experiments the size of the larger eye, sometimes double that of the normal and originating by complete fusion of the two eye primordia, the normal and the grafted one, and the consequent disturbance of the number of ganglionic cells in the double retina, causes also a real shifting of the grey matter cells in the brain toward the ingrowth of the supernumerary nerve fibres. My new experiments in *Axolotl* [7] have shown the possibility of such an increase of the amount of the grey matter as a result of the transplantation of a supernumerary single eye in a different region of the head; in other words, with abnormal connexions with the brain in the olfactory

optic and otic region. This change of the grey matter occurs also in the brain tissue belonging to the donor which has been involved in the transplantation either in the anterior, middle, or posterior brain. In any event, the shifting and increasing of cells in the grey matter are always quantitatively greater with a double fused nerve. Therefore the affinity between nerve centres and sense organs is shown by a reaction of growth (cell division) which occurs in the region corresponding to the supernumerary sense organ. The latter, for that reason, must have a very clear influence on the development of nervous centres.

These results are in harmony with the recent investigations of Harrison [8] concerning development and growth of heteroplastically transplanted eyes.

P. PASQUINI.

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[1] P. Pasquini, *Boll. Ist. Zool. Roma*, vol. 5; 1927.
[2] S. R. Detwiler, *Arch. für Entwicklungsmech.*, Bd. 116; 1929.
[3] R. M. May and S. R. Detwiler, *Jour. Exp. Zool.*, vol. 43; 1925.
[4] R. M. May, *Arch. de Biol.*, vol. 37; 1927.
[5] H. S. Burr, *Anat. Rec.*, vol. 25, 1923; *Proc. Soc. Exp. Biol. Med.*, **21**, 1924; *Jour. Exp. Zool.*, vol. 55, 1930.
[6] V. Twitty, *Proc. Soc. Exp. Biol. Med.*, **26**; 1929.
[7] P. Pasquini, *Rend. R. Acc. Naz. Lincei*, **10**, serie 6, 2 sem., 1929.
[8] R. G. Harrison, *Arch. für Entwicklungsmech.*, Bd. 120; 1929.

Periodic Fluctuations in a Vertical Temperature Gradient.

THE accompanying diagram (Fig. 1) suggests a striking example of wave motion in the vertical temperature gradient at St. Hubert Airport, near Montreal, during a large inversion of lapse rate in the early morning of Oct. 12, 1930. The upper curve shows the temperature at 100 feet above the ground minus that at 4 feet, in degrees Fahrenheit. The lower curves show the velocity and direction of the wind at 60 feet.

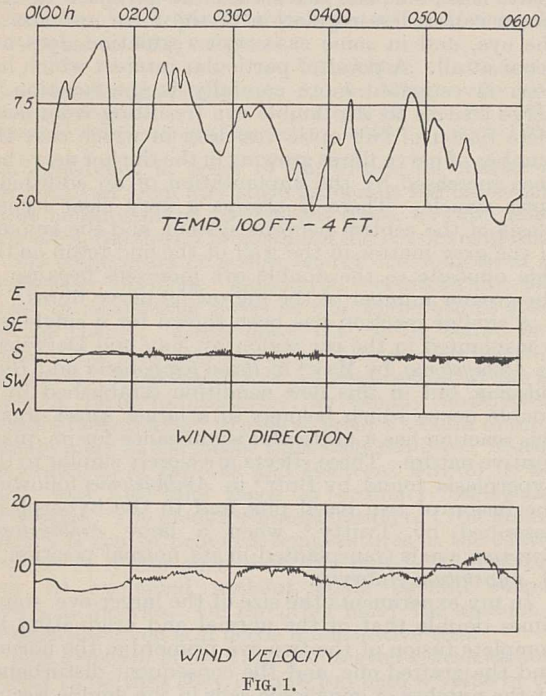

FIG. 1.

Five complete waves occur in the vertical gradient between 0105 hours and 0520 hours, with an average period of about 50 minutes. The gradient in question was measured by platinum resistance thermometers continuously ventilated by a fan.

The barometer was very steady, and the wind unusually so. At this time, the station was about 300 miles from the centre of a large, slow-moving anticyclone about 1500 miles in diameter. Very light winds had prevailed for three days, and unseasonably high daytime temperatures. There is no information about cloud at this station at night, but the skies were cloudless for two days before and the day after, which renders it likely that the night was clear. The country to the south of St. Hubert (from which direction the wind was blowing) is very flat for some miles.

During more or less stationary anticyclonic conditions, fluctuations of the same general magnitude often occur in the early hours of the morning; but in this example the periodicity is especially apparent.

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315 Bloor Street, West,
Toronto (5), Dec. 15.

The Value of M/m.

PROF. H. S. ALLEN has directed my attention to the short account in NATURE of Dec. 13, p. 942, of a recent paper by Sir Arthur Eddington, in which Sir Arthur suggests on theoretical grounds that $M/m = (136)^2/10 = 1849{\cdot}6$. Prof. Allen in 1915 suggested [1] that a relationship of this type might be true.

Assuming that $M_H/m = 1850{\cdot}6$, and taking the values of the Faraday constant and atomic weight of hydrogen as given by Birge,[2] I deduce

$$e/m = (1{\cdot}7719 \pm 0{\cdot}0001_3) \times 10^7.$$

Now this is not only higher than I estimate,[3]

$$\left.\begin{matrix} 1{\cdot}7688_2 \pm 0{\cdot}0006_3 \\ 1{\cdot}767_7 \pm 0{\cdot}001 \end{matrix}\right\} \times 10^7,$$

but also is higher than the values given by Birge,[4] higher than two recent determinations,[5] and higher than all the final values tabulated in the "Handbuch der Physik" (**22**, p. 81) and in J. J. and G. P. Thomson's "Conduction of Electricity through Gasses" (**1**, p. 264)—with the exception of the one higher determination of Classen. This seems to me sufficient evidence to show that M_P/m cannot be exactly 1849·6. There is, however, more evidence to this effect.

Using the estimate $e/m = (1{\cdot}7719 \pm 0{\cdot}0001_3) \times 10^7$, together with Rydberg's formula and Eddington's equation $hc/2\pi e^2 = 137$ (experimental evidence for which I explained in my December paper), I deduce:

$$e = (4{\cdot}771_6 \pm 0{\cdot}0004) \times 10^{-10}$$
$$h = (6{\cdot}537_3 \pm 0{\cdot}0009) \times 10^{-27}$$

(for the subsidiary data I have used Birge's values). These estimates of e and h may at first seem acceptable enough: but when they are compared with the determinations of h by five other methods as given by Birge,[6] using the graphical method given in my paper, it is found that all five deviate from the present estimates *in the same sense*. As there is only a probability of 1/16 of the five being all in error in the same sense, I can only conclude that this is more evidence against the equation $M/m = 1849{\cdot}6$.

W. N. BOND.

Department of Physics,
University of Reading,
Jan. 3.

[1] *Proc. Phys. Soc.*, **27**, p. 430.
[2] *Phys. Rev.*, Supplement, vol. 1, No. 1, pp. 1-73.
[3] *Phil. Mag.*, Dec. 1930.
[4] Loc. cit.
[5] *Phys. Rev.* 1930.
[6] Loc. cit. p. 57.

Giant Oysters.

DR. ORTON[1] has given the dimensions and weight of two exceptionally large specimens of *O. edulis*, which have led to interesting comparisons. The closely allied southern Australian species, *O. sinuata* (*angasi*), normally grows to a large size, specimens 1 lb. in weight being quite common. The largest specimen of this species which I have seen weighed when wet, but without meat, 2 lb. 3 oz.; the dry shells weigh 1 lb. 4½ oz. This oyster is 6¼ inches long, 7 inches broad, and 3 inches deep. It was gathered in George's Bay, Tasmania, and local residents informed me that they have seen considerably larger samples.

The largest oyster we have here in our collection is a specimen of *O. crista-galli* from the Great Barrier Reef, North Queensland (Fig. 1). It weighs (dry shells)

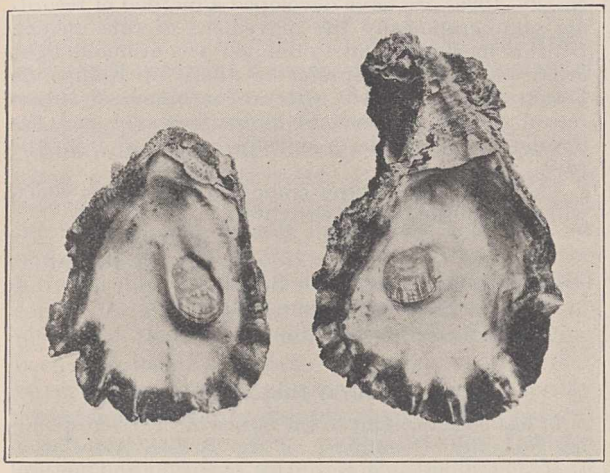


FIG. 1.—*Ostrea crista-galli* from the Great Barrier Reef, North Queensland.

4 lb. 2½ oz. When alive it probably weighed in the vicinity of 5 lb. Its dimensions are: length 9¾ inches, breadth 6⅛ inches, depth 4½ inches. This oyster had attained a great age, as indicated by the extraordinary development of the umbo of the right shell, which is 3½ inches long. Saville-Kent, in his "Great Barrier Reef of Australia", p. 244, states that oysters of this species "not unfrequently weigh as much as from 5 to 7 lb., and have a diameter of from eight to twelve inches".

It will be interesting to learn which species of the world-wide genus *Ostrea* attains the largest size.

T. C. ROUGHLEY.

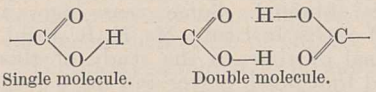
Technological Museum,
Sydney, N.S.W.

[1] NATURE, Aug. 30, 1930, p, 309.

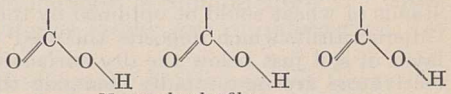
Adhesive Forces in Surface Films.

DR. N. K. ADAM'S contention (NATURE, Dec. 20, 1930), that the molecules of a fatty acid on the surface of water may be held together by the mutual attraction of the 'heads', even when the hydrocarbon chains are in such violent agitation as to have lost all adhesive force, may be thrown into a more precise form by making use of the conception of the co-ordination of hydrogen,[1] which has also been described more picturesquely as "Bigamous Hydrogen".[2] This conception serves to account for the formation of the acid fluoride ion $[FHF]^-$, but was first applied by Pfeiffer,[3] so long ago as 1913, in order to account for the lack of acidic properties in *o*-hydroxyanthraquinone.

The interaction between contiguous –OH and >C=O groups, which Pfeiffer postulated, has already been used to account for the peculiar properties of the two radicals when united to form a carboxyl-group,[4] and for the formation of double-molecules both in the vapour and in crystals of carboxylic acids. It is, therefore, an obvious step to make use of it also to account for the adhesion between contiguous molecules in a monomolecular film of a fatty acid on the surface of water. The three methods in which carboxyl-groups may be affected by this co-ordination may be indicated by the following formulæ, where the hydrogen is supposed to be under the influence of both of the oxygen atoms to which it is adjacent:



Single molecule. Double molecule.



Monomolecular film.

T. M. LOWRY.

Laboratory of Physical Chemistry,
University of Cambridge,
Dec. 24.

[1] Lowry and Burgess, *Trans. Chem. Soc.*, **123**, 1866; 1923.
[2] Armstrong, NATURE, April 17, 1926.
[3] *Ann.*, **398**, 152.
[4] G. N. Lewis, "Valence", pp. 154-155.

Spectrum of Doubly Ionised Iodine.

THIS spectrum has been under investigation for some time past in the visible and ultra-violet regions, and it has been found that a good many of the strong lines owe their origin to the terms of $2O_2P_1$, $2O_2P_2$, and $2O_2P_3$ electronic configurations. All the quartet terms for these have been recognised, the lines originating from them having been obtained by a consideration of the spectra of doubly ionised indium, tin, and antimony which have been elucidated by various investigators. In spite of the difficulties of correctly estimating the intensities of lines for highly ionised elements, the multiplets in the present case follow the usual intensity rules fairly well. The $2O_2(P_1 \leftarrow\!- P_2)$ and $2O_2(P_2 \leftarrow\!- P_3)$ lines are grouped about the region λλ 3900 A. and 3100 A. respectively. The following table gives the separations which occur between the components of a few of the principal multiple terms. For the purpose of comparison, the corresponding separations in the analogous spectra of doubly ionised fluorine, chlorine, and bromine (already determined by previous investigators) have also been included in the table.

Elements.	F^{++}.	Cl^{++}.	Br^{++}.	I^{++}.
Atomic No.	9	17	35	53
P in X_1 level $P_1 - P_2$	211	358	518	576
P in X_1 level $P_2 - P_3$	319	520	838	1090
D in X_2 level $D_1 - D_2$	115	260	332	320
D in X_2 level $D_2 - D_3$	190	430	576	625
D in X_2 level $D_3 - D_4$	259	600	748	830

Full details will be published elsewhere.

J. B. SETH.

Physics Laboratory,
Government College, Lahore,
Dec. 29.

Agricultural Field Experiments.

IN the correspondence on this subject in NATURE of Nov. 29 last, p. 843, "The Writer of the Article" suggests that depth of sowing in wheat plays an important part in accurate field experiments. Many years' experience on the black cotton soils of Central India and on the alluvium of the Indo-Gangetic plain fully confirms this view. Until quite recently, the practice among the cultivators round Indore was to sow wheat by means of a bamboo tube fixed behind the country plough. The consequence was that many of the seeds germinated but the seedlings never reached the surface. In dry years particularly, when many of the seeds were covered by large clods, a very uneven stand was obtained. Some years ago, a member of the staff of this Institute, Mr. K. R. Joshi, devoted a good deal of time to the study of this question, and found that much better and more even stands of wheat could be obtained by the two-coulter Gujerati drill, which deposits the seed in the moist layer of soil just below the dry surface mulch. The cultivators are now rapidly changing their practice, and the drilling of wheat is now to be seen in many of the villages on the Malwa plateau. I have myself, on the alluvial soils of the plains, often observed the deleterious effect of sowing wheat too far below the surface.

In both plant-breeding work on wheat and in variety trials, too much attention cannot be paid to correct farming procedure. It is obvious in such questions that nothing can be gained by the application of formulæ and figures to the results obtained by poor agriculture.

ALBERT HOWARD.

Institute of Plant Industry,
Indore, Central India,
Dec. 26.

Wisdom in Words.

THE time may come,

> When the Gates cease to ruggle,
> When the Danes hald in juggle
> And the Brides can write no more,

that Lamarckian moonshine will no longer be adumbrated in terms of Hibernian green and questions as to the meaning of life will be discussed in language that has plain meaning. Awaiting that far-off day, we may ask: "What is the difference between a philosopher and a scientific man—can either, if there be two of them, be 'as such'?" Mr. Bartrum would treat them as beings apart. The one term is Greek, the other Latin of sorts. The one is a man who has and uses knowledge, maybe makes it. The other is a lover of knowledge, of wisdom, but it is impossible to love without having and using and even seeking for an increase in return. Seeing that it is the business of the scientific man *to know*, truth is his clear concern in his every search. Faraday, *the scientific man* 'par excellence' in history, ever the seeker after truth and wisdom, definitely elected to call himself a *philosopher*; he also sought to use a clear language. Surely, our present need is to get rid of the 'flossofer' *as such*—the mere man of words, who but thinks he knows.

Is there more behind all this pother about evolution and vitalism—not to mention entelechy—than mere word-slinging? Have we not had more than enough of it to satisfy our present state of ignorance of intimate organic structure? That we can see the chromosome is wonder enough. Let us leave it at that, until we can put some real chemistry into its purse; all talk of 'autocatalysis' is just meaningless, pretentious phrasing. INQUIRER.

Determination of the Velocities of Projectiles by Light Interception.

THE principle of the method for the determination of the velocity of projectiles described by Taylor and Wark in the issue of NATURE for Dec. 27, p. 994, has been used previously, notably by Kampé de Fériet, who published a full description, illustrated with some excellent photographs, in 1925 (*Mem. de l'Art. franc.*, vol. 4, p. 289). Using what was essentially a single but comparatively wide band of light, a continuous record was obtained of the flight of the projectile for a distance of 25 metres.

Consideration of the flight of solid projectiles has been helpful to us in our investigation of the solid particles sent out at high speed by coal-mining explosives. For this purpose, using our 'wave-speed camera' (Safety in Mines Research Board, *Paper* No. 29, 1926), we have developed a method of recording photographically the movement of rifle bullets. By this means we have obtained a continuous light interception record similar to those of Kampé de Fériet, but combined with a continuous *Schlieren* record of the atmospheric pressure waves and the powder gases, visible or invisible, sent out from the rifle.

The results have been embodied in a paper which will be published at an early date.

W. PAYMAN,
D. W. WOODHEAD.

Safety in Mines Research Board,
Research Station, Harpur Hill,
Buxton, Derbyshire, Jan. 3.

School Natural History Societies.

IT has been brought to the notice of the Corresponding Societies' Committee of the British Association that a number of noteworthy scientific and natural history societies exist in connexion with public schools, of which the Committee would welcome brief particulars of their origin and development, together with an epitome of practical work attempted in their respective districts, especially where the observations have been published.

It would be a valued assistance to my Committee if any readers of NATURE could conveniently furnish me with the names of societies of this kind known to them which, in their opinion, might be invited to contribute some particulars as to work accomplished to a report which it is proposed to prepare for the centenary meeting of the Association in September next. CLARENCE TIERNEY.

British Association,
Burlington House, London, W.1,
Jan. 16.

Synthesis of Munjisthin.

A MISTAKE in nomenclature has, through our inadvertence, crept into our communication on the "Synthesis of Munjisthin", published in NATURE of Nov. 15, 1930, page 761, which we hasten to rectify.

In line 6, par. 2, instead of "2 - chloro - 3 methyl - 4 methoxy", read "1 - chloro - 2 methyl - 3 methoxy"; and in lines 8-9 of the same par., instead of "2 - chloro - 3 methyl - 4 hydroxy", read "1 - chloro - 2 - methyl - 3 oxy".

The mistake, which we very much regret, is due to our overlooking the fact that the position (2^1) in the formula of benzoyl benzoic acid becomes the position (1) in the formula of the anthraquinone.

P. C. MITTER.
HAROGOPAL BISWAS.

22 Garpar Road, Calcutta, Dec. 8.

Present Status of Theory and Experiment as to Atomic Disintegration and Atomic Synthesis.*

By Prof. ROBERT A. MILLIKAN, California Institute of Technology, Pasadena, California.

MY task is to attempt to trace the history of the development of scientific evidence bearing on the question of the origin and destiny of the physical elements. I shall list ten discoveries or developments, all made within the past hundred years, which touch in one way or another upon this problem and constitute indications or sign-posts on the road toward an answer.

Prior to the middle of the nineteenth century, little experimental evidence of any sort had appeared, so that the problem was wholly in the hands of the philosopher and the theologian. Then came, first, the discovery of the equivalence of heat and work, and the consequent formulation of the principle of the conservation of energy, probably the most far-reaching physical principle ever developed.

Following this, and directly dependent upon it, came, second, the discovery, or formulation, of the second law of thermodynamics, which was first interpreted, and is still interpreted by some, as necessitating the ultimate 'heat-death' of the universe and the final extinction of activity of all sorts; for all hot bodies are observed to be radiating away their heat, and this heat after having been so radiated away into space apparently cannot be reclaimed by man. This is classically and simply stated in the humpty-dumpty rhyme. As a natural if not necessary corollary to this was put forward by some, in entire accord with the demands of medieval theology, a *Deus ex machina* initially to wind up or start off this running-down universe.

Then came, third, the discovery, through studies both in geology and biology, of the facts of evolution—facts which showed that, so far as the biological field is concerned, the process of creation, or upbringing from lower to higher forms, has been continuously going on for millions upon millions of years and is presumably going on now. This tended to direct attention away from the *Deus ex machina*, to identify the Creator with his universe, to strengthen the theological doctrine of immanence, which represents substantially the philosophic position of Leonardo da Vinci, Galileo, Newton, Francis Bacon, and most of the great minds of history down to Einstein.

Neither evolution nor evolutionists have in general been atheistic—Darwin least of all—but their influence has undoubtedly been to raise doubts about the legitimacy of the dogma of the *Deus ex machina* and of the correlative one of the heat-death. This last dogma rests squarely on the assumption that we, infinitesimal mites on a speck of a world, know all about how the universe behaves in all its parts, or more specifically, that the radiation laws which seem to us to hold here cannot possibly have any exceptions anywhere, even though that is precisely the sort of sweeping generalisation that has led us physicists into error half a dozen times during the past thirty years, and also though we know quite well that conditions prevail outside our planet which we cannot here duplicate or even approach. Therefore the heat-death dogma has always been treated with reserve by the most thoughtful of scientific workers. No more crisp or more cogent statement of what seems to me to be the correct position of science in this regard has come to my attention than is found in the following recent utterance of Gilbert N. Lewis, namely, "Thermodynamics gives no support to the assumption that the universe is running down". "*Gain of entropy always means loss of information and nothing more.*"

The fourth discovery bearing on our theme was the discovery that the dogma of the immutable elements was definitely wrong. By the year 1900 the element radium had been isolated and the mean lifetime of its atoms found to be about two thousand years. This meant definitely that the radium atoms that are here now have been formed within about that time; and a year or two later the element helium was definitely observed to be growing out of radium here and now. This raised insistently the question as to whether the creation, or at least the formation, of all the elements out of something else may not be a continuous process—stupendous change in viewpoint the discovery of radioactivity brought about, and a wholesome lesson of modesty it taught to the physicist. But a couple of years later, uranium and thorium, the heaviest known elements, were definitely caught in the act of begetting radium, and all the allied chain of disintegration products. Since, however, the lifetime of the parent atom, uranium, has now been found to be a billion years or so, we have apparently ceased to inquire whence it comes. We are disposed to assume, however, that it is not now being formed on earth. Indeed, we have good reason to believe that the whole radioactive process is confined to a very few, very heavy elements which are now giving up the energy which was once stored up in them—we know not how—so that radioactivity, though it seemed at first to be pointing away from the heat-death, has not at all, in the end, done so. Indeed, it seems to be merely one mechanism by which stored-up energy is being frittered away into apparently unreclaimable radiant heat—another case of humpty-dumpty.

The fifth significant discovery was the enormous lifetime of the earth—partly through radioactivity itself, which assigns at least a billion and a half years—and the still greater lifetime of the sun and stars—thousands of times longer than the periods through which they could possibly exist as suns if they were simply hot bodies cooling off. This meant that new and heretofore unknown sources of heat energy had to be found to keep the stars pouring out such enormous quantities of radiation for such ages upon ages.

* Retiring presidential address to the American Association for the Advancement of Science, delivered at Cleveland on Dec. 29.

The sixth discovery, and in many ways the most important of all, was the development of evidence for the interconvertibility of mass and energy. This came about in three ways. In 1901 Kaufman showed experimentally that the mass of an electron could be increased by increasing sufficiently its velocity: that is, energy could be definitely converted into mass. About the same time the pressure of radiation was experimentally established by Nichols and Hull at Dartmouth College, New Hampshire, and Lebedew at Moscow. This meant that radiation possesses the only distinguishing property of mass, the property by which we define it, namely, inertia. The fundamental distinction between radiation and matter thus disappeared. These were direct, experimental discoveries. Next, in 1905, Einstein developed the interconvertibility of mass and energy as a necessary consequence of the special theory of relativity. If, then, the mass of the sun could in any way be converted into radiant heat, there would be an abundant source of energy to keep the sun going so long as necessary, and all our difficulties about the lifetimes of the sun and stars would have disappeared. But what could be the mechanism of this transformation?

Then came the seventh discovery, which constituted a very clear finger-post, pointing to the possibility of the existence of an integrating or building-up process among the physical elements, as well as in biological forms, in the discovery that the elements are all definitely built up out of hydrogen; for they—the ninety-two different atoms—were all found, beginning about 1913 by the new method of so-called positive ray analysis, to be exact multiples of the weight of hydrogen within very small limits of uncertainty. This fact alone raises very insistently the query as to whether they are not being built up somewhere out of hydrogen now. They certainly were once so put together, and some of them, the radioactive ones, are now actually caught in the act of splitting up. Is it not highly probable, so would say any observer, that the inverse process is going on somewhere, especially since the process would involve no violation either of the energy principle or of the second law of thermodynamics; for hydrogen, the element out of which they all must be built, has not a weight exactly one in terms of the other ninety-two, but about 1 per cent more than one, so that since mass or weight had been found in the sixth discovery to be expressible in terms of energy, the union of any number of hydrogen atoms into any heavier element, meant that 1 per cent of the total available potential energy had disappeared and was therefore available for appearance as heat.

When, about 1914–15, this fact was fitted by MacMillan, Harkins, and others into the demand made above in the fifth discovery for a new source of energy to keep the sun pouring out heat so copiously for such great lengths of time, it seemed to the whole world of physics that the building up of the heavier elements out of hydrogen under the conditions existing within the sun and stars had been practically definitely proved to be taking place. This would not provide an escape from the heat-death, but it would enormously postpone it, that is, until all the hydrogen in the universe had been converted into the heavier elements.

By this process, however, the suns could stoke at most but 1 per cent of their total mass, assuming they were wholly hydrogen to begin with, into their furnaces, and 99 per cent of the mass of the universe would remain as cold, dead ash when the fires were all gone out and the heat-death had come. But about 1917 the astronomer began to chafe under the time-limitation thus imposed upon him, and this introduced the eighth consideration bearing upon our theme. He could get a hundred times more time—from now on, much more than that, because only a small fraction of the matter in the universe is presumably now hydrogen—by assuming that, in the interior of heavy atoms, occasionally a negative electron gets tired of life at the pace it has to be lived in the electron world, and decides to end it all and commit suicide; but, being paired by Nature in electron-fate with a positive, he has to arrange a suicide pact with his mate, and so the two jump into each other's arms in the nucleus, and the two complementary electron lives are snuffed out at once; but not without the letting loose of a terrific death-yell, for the total mass of the two must be transformed into a powerful ether pulse which, by being absorbed in the surrounding matter, is supposed to keep up the mad, hot pace in the interiors of the suns. This discovery, or suggestion, to account for the huge estimated stellar lifetimes, of the complete annihilation of positive and negative electrons within the nucleus, makes it unnecessary to assume, at least for stellar lifetime purposes, the building up of the heavier elements out of hydrogen. Indeed, it seems rather unlikely that both kinds of processes, atom-building and atom-annihilating, are going on together in the same spot under the same conditions; so we must turn to further experimental facts to get more light.

The ninth sign-post came into sight in 1927, when Aston made a most precise series of measurements on the relative masses of the atoms, which made it possible to subject to a new test the Einstein formula for the relation between mass and energy, namely, $E=Mc^2$. This Aston curve is one of the most illuminating finger-pointings we now have. It shows that:

1. Einstein's equation actually stands the quantitative test for radioactive or disintegrating processes right well, and therefore receives new experimental credentials.

2. The radioactive or disintegrating process with the emission of an alpha ray must be confined to a very few heavy elements, since these are the only ones so situated on the curve that mass can disappear, and hence heat energy appear, through such disintegration.

3. All the most common elements, except hydrogen, are already in their most stable condition, that is, their condition of minimum mass, so that if we disintegrate them we shall have to do work upon them, rather than get energy out of them.

4. Therefore, man's only possible source of

energy other than the sun is the upbuilding of the common elements out of hydrogen or helium, or else the entire annihilation of positive and negative electrons; and there is no likelihood that either of these processes is a possibility on earth.

5. If the foregoing upbuilding process is going on anywhere, the least penetrating and the most abundant radiation produced by it, that corresponding to the formation of helium out of hydrogen, ought to be about ten times as energetic as the hardest gamma rays, that is, it ought to correspond to about twenty-six million electron-volts in place of two and a half million.

6. Other radiations corresponding to the only other abundant elements, namely, oxygen (oxygen, nitrogen, carbon), silicon (magnesium, aluminium, silicon), and iron (iron group), should be found about four times, seven times, and fourteen times as energetic as the ' helium rays '.

7. The radiation corresponding to the smallest annihilation process that can take place—the suicide of a positive and negative electron—is three hundred and fifty times as energetic as the hardest gamma ray, or thirty-five times as energetic as the ' helium ray '.

This brings us to the tenth discovery, that of the cosmic rays. These reveal: *

1. A radiation, the chief component of which, according to our direct comparison, is five times as penetrating as the hardest gamma ray, which, with the best theoretical formula we have relating energy and penetrating power (Klein-Nishina), means a ray ten times as energetic as the hardest gamma ray, *precisely according to prediction.*

2. Special bands of cosmic radiation that are roughly where they should be to be due to the formation of the foregoing abundant elements out of hydrogen, though (for reasons to be given presently) no precise quantitative check is to expected except in the case of helium.

3. No radiation of significant amount anywhere near where it is to be expected from the annihilation hypothesis, thus indicating that at least 95 per cent of the observed cosmic rays are due to some other less energetic processes.

4. A radiation that is completely independent of the sun, the great hot mass just off our bows, and not appreciably dependent on the Milky Way or the nearest spiral nebula, Andromeda, one that comes in to us practically uniformly from all portions of the celestial dome, and is so invariable with both time and latitude at a given elevation that the observed small fluctuations at a given station reflect with much fidelity merely the changes in the thickness of the absorbing air blanket through which the rays have had to pass to get to the observer.

This last property is the most amazing and the most significant property exhibited by the cosmic rays, and before drawing the final conclusions its significance will be discussed. For it means that at the time these rays enter the earth's atmosphere, they are practically pure ether waves or photons. If they were high-speed electrons or even had been appreciably transformed by Compton encounters in passing through matter into such high-speed electrons or beta rays, these electrons would of necessity spiral about the lines of force of the earth's magnetic field and thus enter the earth more abundantly near the earth's magnetic poles than in lower latitudes. This is precisely what the experiments made during the last summer at Churchill, Manitoba (lat. 59° N.), within 730 miles of the north magnetic pole, showed to be *not true*, the mean intensity of the rays there being not measurably different from that at Pasadena in lat. 34° N.

Nor is the conclusion that the cosmic rays enter the earth's atmosphere as a practically pure photon beam dependent upon these measurements of last summer alone. It follows also from the high altitude sounding-balloon experiments of Millikan and Bowen in April 1922, taken in connexion with the lower balloon flights of Hess and Kolhörster in 1911–14. For in going to an altitude of 15·5 km. we got but one-fourth the total discharge of our electroscope which we computed we should have obtained from the extrapolation of our predecessors' curves. This shows that somewhere in the atmosphere below a height of 15·5 km. the intensity of the ionisation within a closed vessel exposed to the rays goes through a maximum, and then decreases, quite rapidly, too, in going to greater heights. We have just taken very accurate observations up to the elevation of the top of Pike's Peak (4·3 km.), and found that within this range the rate of increase with altitude is quite as large as that found in the Hess and Kolhörster balloon flights, so that there can be no uncertainty at all about the existence of this maximum. Such a maximum, however, means that the rays, before entering the atmosphere, have not passed through enough matter to begin to get into equilibrium with their secondaries—beta rays and photons of reduced frequency—in other words, *that they have not come through an appreciable amount of matter in getting from their place of origin to the earth.*

This checks with the lack of effect of the earth's magnetic field on the intensity of the rays; and the two phenomena, of quite unrelated kinds and brought to light years apart, when taken together, prove most conclusively, I think, that the cosmic rays cannot originate even in the outer atmospheres of the stars, though these are full of hydrogen and helium in a high temperature state, but that they must originate rather in those portions of the universe from which they can come to the earth without traversing matter in quantity that is appreciable even as compared with the thickness of the earth's atmosphere—in other words, that *they must originate in the intensely cold regions in the depths of interstellar space.*

Further, the more penetrating the beta rays produced by Compton encounters, the greater the thickness of matter that must be traversed before the beam of pure photons which enters the atmosphere gets into equilibrium with its secondaries; and until such equilibrium is reached, the apparent

* See articles by Millikan and by Millikan and Cameron, *Phys. Rev.*, Dec. 1, 1930, and in press.

absorption coefficient must be less than the coefficient computed with the aid of the Klein-Nishina formula from the energy released in the process from which the radiation arises. Now the Bothe-Kolhörster experiments of about a year ago show that when the energies of the incident photons are sufficiently high, the beta rays released by Compton encounters do indeed become abnormally penetrating: so that it is to be expected that, for the cosmic rays produced by the formation of the heavier of the common elements like silicon and iron out of hydrogen, the observed absorption coefficients will be somewhat smaller than those computed from the energy available for their formation. This is precisely the behaviour which our cosmic ray depth-ionisation curve actually reveals. At the highest altitudes at which we have recently observed (14,000 ft.), the helium rays have reached equilibrium with their secondaries, and the observed and computed coefficients agree as they should. For the oxygen rays the observed coefficent is a little lower than the computed value —about 17 per cent lower; for the silicon rays still lower—about 30 per cent; and for the iron rays considerably lower still—about 60 per cent: all in beautiful qualitative agreement with the theoretical demands as outlined.

The foregoing results seem to point with much definiteness to the following conclusions:

1. The cosmic rays have their origin not in the stars but rather in interstellar space.

2. They are due to the building up in the depths of space of the commoner heavy elements out of hydrogen, which the spectroscopy of the heavens shows to be widely distributed through space. That helium and the common elements oxygen, nitrogen, carbon, and even sulphur, are also found between the stars is proved by Bowen's beautiful recent discovery that the 'nebulium lines' arise from these very elements.

3. These atom-building processes cannot take place under the conditions of temperature and pressure existing in the sun and stars, the heats of these bodies having to be maintained presumably by the atom-annihilating process postulated by Jeans and Eddington as taking place there.

4. All this says nothing at all about the second law of thermodynamics or the *Wärme-Tod*, but it does contain a bare suggestion that if atom formation out of hydrogen is taking place all through space, as it seems to be doing, it may be that the hydrogen is somehow being replenished there, too, from the only form of energy that we know to be all the time leaking out from the stars to interstellar space, namely, radiant energy. This has been speculatively suggested many times before, in order to allow the Creator to be continually on his job. Here is, perhaps, a little bit of *experimental* finger-pointing in that direction. But it is not at all proved or even perhaps necessarily suggested. If Sir James Jeans prefers to hold one view and I another on this question, no one can say us nay. The one thing of which we may all be quite sure is that neither of us *knows* anything about it. But for the continuous building up of the common elements out of hydrogen in the depths of interstellar space the cosmic rays furnish excellent experimental evidence. I am not unaware of the difficulties of finding an altogether satisfactory kinetic picture of how these events take place, but acceptable and demonstrable facts do not, in this twentieth century, seem to be disposed to wait on suitable mechanical pictures. Indeed, has not modern physics thrown the purely mechanistic view of the universe root and branch out of its house?

Geodesy in India.

IN the British Empire at the present time, geodetic operations are mainly confined to Canada, India, and South Africa. The Dominion and the Union are working principally for the more pressing needs of development; in India, on the other hand, apart from the necessity for revision, more attention is being paid to the interpretation of results. The Great Trigonometrical Survey of India itself being long complete, triangulation is now being carried on in the outer zones—in Burma and on the Siamese frontier at the date of the last Geodetic Report.[1]

The main triangulation in 1928–29 was executed with Wild theodolites, which gave very good results when the instruments were working. Their axes, however, stiffened in the field, causing serious loss of time. Surveyors cannot adjust the instruments in the field, and even the mathematical instrument workshop in Calcutta found adjustment difficult, though mere oiling is simple if the method is known. It was intended to keep the older and heavier 12-inch theodolites at hand during the ensuing season, in case of further failures.

Precise levelling is perhaps the most economically important section of the revisionary geodetic work: of the new net of 16,000 miles proposed, nearly one-half was completed in 1929. Levelling on hilly circuits appears to show that the shorter sights thereon contribute to accuracy as against longer sights in flat country; experience in precise levelling has given revised results on hilly circuits in Ceylon which are practically as good as on the plains. Indian investigations show that error due to differential refraction on steep slopes is negligible, and the greater part of the errors of closure is believed to be due to changing length of the staves. The results of levelling must lie within limits of accidental and systematic error which are strictly defined; one notices that 55 per cent of one line was relevelled. On the several lines—not yet, of course, referred strictly to M.S.L.—the relative discrepancies between the new and the old measures do not ordinarily exceed 6 inches; but there are interesting exceptions. Thus there is evidence of a sinkage around Ambala of about an inch per decade, attributed to removal of water from wells. On the line between Sukkur and Hyderabad the results of much levelling have given

measures so discordant that it has been decided to abandon the line. India has hitherto used wooden staves, and it is not stated if these have been rendered non-hygroscopic; change in length, which appears to have a diurnal range, being attributed to temperature. In any event, staves with invar strips were to be substituted.

Heights are subject to orthometric and dynamic corrections, the former to take account of the non-parallelism of the equipotential surfaces at different altitudes, the latter to refer all heights to a standard equipotential surface of sea-level at a mean latitude, in India 24° north. The corrections are easily computed by formulæ, in which case they depend on theoretical, not observed, values of gravity. The Director of the Geodetic Branch, Dr. De Graaf Hunter, discusses the question of a rigorous investigation, and finds that the effect at Mussoorie, 7000 feet, is 0·7 ft.; he concludes that the severe labour involved in applying a rigorous correction is not justifiable in hilly country and is unnecessary in flat country, even though in strictness values derived by formula give heights in an unknown unit above an unknown datum.

India controls tide-gauges at forty eastern ports and issues predictions. An outstanding discrepancy in 1928 was 4·6 feet at Basrah on a certain date—not surprising at the mouth of great rivers and at the head of a great gulf. By arrangement with the Admiralty, the tide-tables will be extended to sixty-eight ports in the Indian Ocean, and they will be issued in cheaper form—sufficient evidence of the success of the Survey in deriving harmonic constants in a region where monsoons and unique tides must sometimes give rise to peculiar conditions.

It has been decided to re-map at least a portion of the Dependency on areas of conical orthomorphic projection; in such an immense area the change-over will be gradual. The areas proposed are 8° in latitude by 16° in longitude. In this matter South Africa and India represent extreme views, the former adopting a width of 2° as against 8° in India. At the bounding parallels the scale error is about 1/400, which will be reduced one-half by a scale factor. The magnitude of the scale error and, perhaps more particularly, the rapid change of scale at the bounding parallels will doubtless evoke criticism.

The Survey has constructed a mural base for standards of length. Such bases already exist at Sèvres and Teddington; yet the writer doubts if this is the best form of construction, even though the thermal expansion of the wall becomes fairly well known after some years.

In the course of the longitude campaign the variation of latitude was studied; the results appear to show a well-marked correlation with the moon's age, as already described in NATURE.[2] The mean longitude of Dehra Dûn as derived from the Bordeaux and Rugby signals in 1928–29 is 5 h. 12 m. 11·79 s., precisely the same as in the longitude campaign of 1926. A Shortt clock was installed this year to supplement the Riefler.

The most interesting portions of the Report deal with gravity and the geoid in India; it would be impossible to deal adequately in a short review with the wealth of material here provided. The Director reaffirms his conclusion that conditions of approximately perfect Hayford isostasy are not met with in peninsular India; but the interested reader must be referred to the Report itself for a description of the numerous investigations. Work with the Cambridge pendulum apparatus is being vigorously pursued, old values being revised and new stations added, with the object of having one station in every seventy-mile square.

The Survey of India has made remarkable contributions to geodesy in the past. It is doubtful if any single volume has approached in interest and instruction that of the year under review.

G. T. McC.

[1] Geodetic Report, Vol. 5, of the Survey of India. From Oct. 1, 1928, to Sept. 30, 1929. Published by order of Brigadier R. H. Thomas, Surveyor-General. 8vo., pp. 150+29 charts. (Dehra Dûn: Geodetic Branch Office, 1930.) 5*s.* 3*d.*

[2] Bomford, G., NATURE, June 8, 1929, vol. 123, p. 873.

Obituary.

THE death on Dec. 28 of Prof. Eugen Goldstein, head of the Astro-Physical Section of the Potsdam Observatory, removes an observer whose work on the phenomena which accompany the passage of electricity through rarefied gases is well known. He was born at Gleiwitz on Sept. 5, 1850, was educated at the Ratibor Gymnasium and the Universities of Breslau and Berlin. At Berlin he worked under Helmholtz at the electric discharge in vacuum tubes, and in 1876 his first paper on the subject appeared in the *Berliner Berichte*, and was followed for fifty years by a long series dealing with cathode and anode rays and the influence of magnetic fields and of the dimensions of the discharge tube on the character of the discharge. He maintained throughout that the luminous discs of the positive column were repetitions with decreased intensity of the cathode glow. His recent work was mainly on the complex discharge near the anode, but he is probably best known for his discovery of the anode or canal rays. He was awarded the Hughes Medal by the Royal Society in 1908.

WE regret to announce the following deaths:

Mr. R. G. Lunnon, lecturer in physics at Armstrong College, Newcastle.

Dr. A. P. Maudslay, president in 1911–12 of the Royal Anthropological Institute, who was well known for his investigations of Mayan and Aztec sites in Mexico and Central America, on Jan. 22, aged eighty-one years.

Mr. H. W. Monckton, sometime treasurer and several times vice-president of the Geological Society, and vice-president and treasurer of the Linnean Society up to the time of his death, on Jan. 14, aged seventy-four years.

Prof. C. Y. Wang, professor of pathology in the University of Hong-Kong, author of numerous papers on tuberculosis and other bacterial diseases, on Dec. 16, aged forty-two years.

News and Views.

AT a recent meeting of the Council of the University of Bristol, an announcement was received with much gratification of two munificent offers for the endowment of research in physics, one from the Rockefeller Foundation and one from Mr. W. Melville Wills. Impressed by the possibilities of the Henry Herbert Wills Physical Laboratory as a centre of research, the Rockefeller Foundation offered the sum of £50,000 to the University of Bristol for the endowment of research in experimental and theoretical physics, on condition that a further contribution of £25,000 for the same purpose was secured from other sources. Mr. Melville Wills, already a benefactor to the University, has most generously offered to give the required sum of £25,000 in memory of his late brother, the founder of the laboratory. Thanks to this further act of beneficence by a member of the Wills family, the University has been able to accept the Rockefeller Foundation's offer. The laboratory was founded by a gift of £200,000 from the late Mr. Henry Herbert Wills, and was opened in 1927 under the direction of Prof. A. M. Tyndall. A broad view of the term 'laboratory' was taken, and a professorship in theoretical physics was created so that the closest co-operation between theory and experiment might be effected in the laboratory. With the concurrence of the Rockefeller Foundation, the gift of Mr. Melville Wills will be utilised for the endowment of the chair at present held by Prof. J. E. Lennard-Jones in theoretical physics. One portion of the Rockefeller gift will be devoted to researches in the field of molecular structure and the borderland of physics and chemistry, to which the laboratory has already contributed on both the theoretical and the experimental sides. After providing for certain other immediate needs, the remainder of the gift will form a reserve to meet the growing requirements of the laboratory as a centre of research.

ON Feb. 5 occurs the centenary of the death of Commander Henry Foster, who in 1827 was awarded the Copley Medal of the Royal Society for his magnetic observations made in the Arctic regions. Born in August 1796, Foster was the eldest son of a clergyman of Woodplumpton, near Preston, Lancs, and joined the Navy as a volunteer in 1812. He served in various parts, and after the Napoleonic wars became known as a surveyor. He accompanied Basil Hall to South America in 1820, served under Parry in the *Hecla* in 1824 and in 1827, and it was for his work in the *Hecla* that he was awarded the Copley Medal. Promoted to commander, he was appointed to the command of the *Chanticleer*, commissioned by the Admiralty, at the request of the Royal Society, for determining the ellipticity of the earth. Foster sailed in April 1828, visiting South America and the Cape and then Panama, where he unfortunately met his death by accidental drowning in the River Chagres. His body was recovered and a monument was erected over his grave. There is also a tablet to his memory in Woodplumpton Church. Foster's pendulum experiments, carried out at fourteen different stations between 10° 38′ north latitude and 62° 56′ south latitude, were made with the most scrupulous regard to accuracy, and they were the most extensive series of experiments made up to that time. After his death his papers were placed in the hands of Baily, who gave an account of his work in the seventh volume of the *Memoirs* of the Royal Astronomical Society.

"BIOLOGY and Statecraft" formed the subject of a national lecture broadcast by Sir Walter Morley Fletcher on Jan. 23. Sir Walter briefly epitomised the historical developments in biology, and emphasised the sudden speeding up of this development within the memory of living man. Reasons were given for this sudden increase in speed of development, the chief two being the invention of the microscope and the use of experiment. The latter, we think, forms the most important explanation of all. Microscopy has just followed a serene type of development since its inception in the seventeenth century. On the other hand, experimental biology, such as physiology, and the chemical aspects of mycology, entomology, and so on, are of much more recent development. It was entomology, a comparatively recent science, that received Sir Walter's attention, based on his statement that insects are still our most destructive enemies and rivals. Such insects will have to fight hard with pathological bacteria in order to retain this distinction. As Sir Walter pointed out, the study of entomology should receive more recognition by the State. There are only 275 official entomologists in the British Empire, and we spend only a quarter of the amount that the United States of America spend on this science. It is difficult to ascribe this dearth of entomologists to any one factor. We must not blame completely, as Sir Walter suggests, the lacking in scientific knowledge by our statesmen and those in administrative authority, for they are now offering great facilities for the training of entomologists; but, we believe, the root of the trouble is that such opportunities for training, offered by the State, have not yet been appreciated by men students. Nevertheless, as we have often remarked, science must not become the tool of the State, but must always remain the concern of the State; and then, as Sir Walter said of biology, we shall be able to bring into our methods of statecraft the guidance of biological truth.

THE Representation of the People Bill, which has recently been issued, includes a clause providing for the total abolition of university constituencies. These constituencies were originated at the beginning of the seventeenth century by James I. with the object of enabling universities to send grave and learned representatives to parliament. As, however, men of scholarship are not now segregated and confined solely to universities, these constituencies were threatened with extinction just before the War; though, since then, as stated in a leading article in NATURE of Nov. 4, 1922, they have become enhanced in prestige and extended application. It is on this

latter observation that the case for the retention of university constituencies should be based. At the same time, some type of legislative reform is clearly necessary, if only to take account of modern developments of universities. In view of this progress, the present method of university representation is distinctly old-fashioned and undesirable. Plural representation of the older universities seems unnecessary, and a fuller representation of the newer universities is worthy of consideration. The list of voters in 1929, which appears in the memorandum upon university representation submitted to the electors of the older universities, the substance of which appears on p. 183, supports this view. However this may be, the proposal to abolish university constituencies altogether must raise strong protests from members of all parties.

THE university of to-day is not merely a collection of books as Carlyle suggested, neither is it just a place of advanced lectures followed by examinations and ultimately a degree. At one time, it was; but now it is the head of, the power behind, the whole of our great system of education, without putting itself as the 'be-all and end-all' of everyone who is being educated. In more ways than one it influences all primary and secondary education, and has thus become a great, comprehensive entity. Although we have a Board of Education with its specially appointed advisory councils and committees, representatives of universities—that is, representatives of our complete educational system, from five to twenty-five—are clearly desirable in Parliament, to safeguard and advertise the aims and projects of one of the most essential features of our modern constitution. It is therefore a little surprising that a measure to abolish direct academic representation should be brought forward at the present time, and especially by a government which has shown genuine concern for the development of educational work of all types.

ALTHOUGH we have as yet in the British Isles no professedly and distinctively Children's Museum on the lines of the many now existing in the United States, still the movement here is progressing. Indeed, under the curatorship of Miss Beatrice Hindshaw, the Horsfall Art Museum in Ancoats, Manchester, is already in practice, if not in theory, a museum for the boys and girls of that otherwise poor district. In the Liverpool Museum, Dr. Allan has been furnishing a Children's Corner; and the boys, if not the girls also, of London are eagerly awaiting the treat promised them by Sir Henry Lyons at the Science Museum. These are notable instances of what is being done, but the museum founded for children alone is yet unborn. It is, however, in embryo. A meeting held in London a few months ago decided "to found a Children's Museum in London, to be a national and international centre, to educate and inspire the children of all races, and to stimulate child-lovers of the British Empire and the World".

To judge from the printed statement, the promoters of the Children's Museum base their museum idea on the child's world as it appears to the child, or as it might more happily appear, rather than on the world of the adult, to which the museum should gently introduce the child. Stress seems to be laid on such objects as toys, pictures, and models, and on such methods as marionettes, a children's orchestra, theatre, dance hall, and fairy-tale rooms. More serious subjects are not definitely excluded, but science and natural history might well bulk more largely in the programme. These schemes, however, have a habit of growing according to circumstances rather than plan. The important thing is to make a start in a house (or room) with some energetic curators (or even one only), and the gifts for which the distinguished supporters appeal will then flow in. The honorary temporary secretary is Mrs. Chas. E. Dawson, 8 Queen's Gardens, Lancaster Gate, London, W.2.

AT a meeting of the Ross Institute Industrial Anti-Malarial Advisory Committee in December last, reports were received on anti-malarial work carried out in various tropical countries. Dr. G. C. Ramsay stated that in tea gardens in Assam he had been able to exclude hookworm disease and kala-azar as chief sources of sickness among the coolies. The principal cause of sickness, inefficiency, and death was malaria, and the contrast between the malarial and the non-malarial gardens was extraordinary. Mosquito control consisted, in the first place, in studying those species in a district which carried malaria, and their habits, and then taking measures directed especially against those species. In his own district, Dr. Ramsay found twenty species of anopheline mosquitoes present, but an intensive study proved that practically only one (*A. minimus*) carried infection. The value and application of larvicides, oiling, and Paris green as anti-mosquito agents were described, and examples given of immediate improvement following their use. Biological methods were also employed, such as encouraging the growth of certain swamp plants and destroying others. Sir Malcolm Watson, principal of the Malaria Department, Ross Institute, confirmed Dr. Ramsay's results. He stressed the value of quinine in the treatment of malaria, provided it was used in sufficient doses over a sufficient period. Plasmoquine might be a valuable adjunct to quinine, for it was claimed that this drug killed the sexual forms of the malaria parasite, which are those that infect the mosquito. He pointed out that investigation is required to explain why some anopheline mosquitoes carry malaria and others do not, and why a particular species may carry malaria in one country and not in another.

MR. NICOLAUS, of the Selection Trust, speaking of the Rhodesian Copper Mines, stated that since the Ross Institute expedition to Northern Rhodesia the incidence of malaria at one mine had dropped from 27 per cent of population per month to only 8 cases per month in a population of between 8000 and 9000. At another mine, with a population of between 10,000 and 11,000, since mosquito control had been inaugurated, the malaria incidence last October was nine new cases only. The Tata Iron and Steel Company have also adopted a scheme of mosquito control,

drawn up by Sir Malcolm Watson, and report that the Noamundi Mine is now entirely free from both larval and adult anophelines, and that no new cases of malaria have occurred for some time. The Burma Shell Group is to join with the Ross Institute in an investigation of the oils available in India for oiling mosquito-breeding waters, so that the oil most suitable for any place in cold or in hot weather may be selected. The Ross Institute Industrial Anti-Malarial Advisory Committee was formed in 1928 to keep industry in touch with science, to make the tropics healthy, and expand the markets of the world. It consists of representative members of industry and members of the Ross Institute. The Ross Institute and Hospital for Tropical Diseases, Putney Heath, London, S.W.15, is entirely supported by voluntary contributions.

THE annual general meeting of the Royal Meteorological Society was held on Jan. 21, when Mr. R. G. K. Lempfert was re-elected president. The Buchan Prize, which is awarded biennially for the most important original papers contributed to the Society during the previous five years, was presented to Dr. C. E. P. Brooks. Mr. R. G. K. Lempfert delivered an address on the work of the Meteorological Office at the Royal Airship Works, Cardington, of which Mr. M. A. Giblett, who lost his life in the disaster to the *R101*, was in charge. The weather charts constructed from all available material for the study of the conditions over the area between Great Britain and India were described. The greater part of the address was, however, devoted to describing the experimental investigation of atmospheric turbulence which is still in progress. Four anemometer stations have been set up at Cardington, separated from one another by distances of about 700 feet. Each station is equipped for recording the direction and velocity of the wind on a very open time scale, so that the variations of wind from second to second can be examined. Comparison of these detailed records from the four stations will furnish important information regarding the extent and intensity of the eddies which are always present in the wind. The importance of the eddying character of the air movement which we call wind is being more and more recognised in the science of meteorology. The stresses and strains to which structures are exposed during gales are due to the eddies. Fog formation equally depends on eddy motion, though on a different scale; so does the distribution of atmospheric pollution. Closely associated with the details of wind structure is the distribution of temperature in the vertical, and the arrangements made at Cardington, and also at Ismailia, for keeping this important meteorological factor under constant observation up to a level of 200 feet were described.

AN important feature of the work of the enlarged Rubber Service Laboratory of Imperial Chemical Industries, Ltd., opened at Blackley on Jan. 22, is that devoted to rubber service for users of Vulcafor products, and is intended to assist rubber manufacturers in the solution of problems which arise in connexion with the use of accelerators, anti-agers, pigments, and other products; but research work represents one of its chief activities. Such research work includes studies on the new rubber substitutes, etc., prepared by the treatment, polymerisation, and so forth, of vegetable oils and other organic compounds, with the object of developing new products for use in the rubber industry; also investigations aiming at the discovery of vulcanisation accelerators, anti-agers or anti-oxidants, anti-scorching compounds, etc., of improved properties, intended to increase the life of rubber articles. During the last few years, for example, the mileage life of a motor tyre has been increased from the order of 5000 to nearly 20,000. Other research is concerned with the properties of various rubber compounds and the development of improved methods of physical and chemical testing. The laboratory is a normal development of the British dyestuffs industry, with the other research laboratories of which it is in close collaboration. The enlarged laboratory is the most completely equipped of its type outside the United States of America.

IN one of his series of popular meteorological articles entitled "Why the Weather", issued by Science Service, Washington, D.C., Prof. C. F. Talman directs attention to important advances in travelling comfort introduced in recent years in the United States. On certain steamers that navigate tropical waters, and later on certain railway lines crossing very hot desert regions, arrangements for controlling the temperature and humidity of the air in saloons and restaurants have been successfully introduced. Experiments on these lines must lead to increased knowledge of the effect of various atmospheric conditions on human comfort, and it is to be hoped that they will result eventually in the carrying out of an important climatological inquiry. A vast amount of information has been accumulated about the temperature, humidity, wind, etc., in different parts of the world, but anyone confronted with statistics of this kind is apt to be misled as to the extent to which any very abnormal temperatures are likely to give rise to discomfort, through inability to make a proper allowance for the other factors. What is required is some system of reducing ordinary air temperatures to what might be called 'virtual temperatures', so that the regions of greatest physiological heat and cold could be shown on climatological maps. It is recognised that the 'wet bulb' thermometer is superior to the ordinary 'dry bulb' in this respect, but something more representative of human sensations than even the wet bulb is required. There is, for example, the difference of sensation between cloudy and clear weather, due to radiation effects, that should be taken into account. Meteorological statistics would clearly be rendered of very much greater practical value if work on these lines could be successfully carried out on a world-wide scale.

SIR WILLIAM BRAGG'S Friday evening discourse on Jan. 23, at the Royal Institution, on "The Scattering of Light", was the first to be given in the reconstructed theatre of the Royal Institution. The subject of Sir William Bragg's discourse had a historical connexion with the Institution. In its earliest form it asked

for explanations of the blue of the sky and sea Prof. Tyndall and the late Lord Rayleigh were among the earliest and most important contributors to the solution of the problem. Rayleigh put the theory on a sound basis, and explained exactly why the blue is scattered more than the red, so that it was turned aside while the red passed on. The same explanation was applicable to the colours of the rising and setting sun. Rayleigh showed also that there was no need to postulate the presence of water vapour: the molecules of the air itself were sufficient to explain the amount of the scattering. In recent years the interest of the subject has been greatly increased by the discoveries of Sir C. V. Raman, of Calcutta. He has shown that there is a form of scattering hitherto not observed. Some of the original light is scattered with change of colour, and this change is capable of the most precise measurement. Many workers in various parts of the world have extended Raman's discovery and a new and most fascinating field of research has been opened up. The change mentioned depends on the nature of the scattering atoms and molecules, the properties of which are thereby made capable of closer observation. Moreover, the explanations of the new effects are more easily expressed in terms of the quantum or corpuscular theory of light, and in this way the highly attractive mystery of the nature of light is still further enhanced.

THE Annual Report of the Director of the U.S. Bureau of Standards (Dr. G. K. Burgess) to the Secretary of Commerce for the year ending June 30, 1930, is a pamphlet of 53 pages which gives a short account of each section of the work of the Bureau. The staff numbers 1161, the average salary is £490, and the total expenses for the year £588,000, an increase of £37,000 on last year. The largest item, £54,000, is for tests of building materials; the next, £44,000, for standardisation of the products of industry, and this work seems so much appreciated by the manufacturers that between 80 and 90 per cent of them are carrying out the recommendations of the Bureau in respect of between seventy and eighty commodities. Industrial research has cost the Bureau £41,000, but forty-one associations and manufacturers co-operate with the Bureau and maintain ninety-six research associates, eleven of whom work at the Bureau on radio and electrical problems, eight on cements, eight on petroleum and its products, seven on fuel, and seven on steam and high temperatures. The fee value of the tests carried out at the Bureau was £137,000. The present buildings are greatly overcrowded and a five-year building plan has been submitted to Congress.

SOME interesting particulars of the activities of the Bureau of American Ethnology are given in the recently issued forty-fifth Annual Report, which covers the period 1927–28. Miss Densmore has made additional studies of the music of the American Indian, both in the field and in the laboratory. Her remarkable collection of phonograph records now amounts to 1695. Study of the Columbia Basin and Lower Snake River in Oregon by Mr. N. W. Kreiger has revealed a uniform culture, with some remarkably clearly defined localised specialisations in tools and art designs. It is expected that further investigation will show the relation between the culture of this area and the pre-agricultural south-west. In two areas in particular the work of the staff of the Bureau requires mention. In the south-western States the investigation of the Basket-maker and Pueblo cultures is producing some of the most notable results in American archæology. In Alaska, Mr. Henry B. Collings, jun., and Mr. T. Dale Stewart, conducting investigations at Nunivak Island and along the adjacent coast, have found what is held to be the most primitive of all the Alaskan Eskimo. Among the "Accompanying Papers" two important contributions, dealing respectively with the Salishan tribes of the Western Plateaux and the Thompson Indians, are edited by Prof. Boas from the papers of Mr. James Teit, whose intimate knowledge of the Thompson Indians was based on a residence among them of many years. It is interesting to note that Dr. La Flèsche's record of an Osage war ritual was written down at the request of the Indians themselves to ensure correct rendering of the ritual at the next performance. The request is significant as indicating a desire to keep up old customs, which is losing ground in a struggle against the weakening of tribal memory.

THE Department of Zoology of the British Museum (Natural History) has recently received, as a donation from His Royal Highness the Duke of Gloucester, the skin and skull of a Menelik's bushbuck (*Tragelaphus scriptus meneliki*), and from Mr. A. S. Vernay, a large collection of antelopes and other big game from Bechuanaland. Recent donations from the Trustees of the Rowland Ward Bequest include a ratel, or 'honey badger' (*Mellivora ratel*), from Kenya Colony. The ratel is found over a great part of Africa south of the desert region and in many parts of India. The forelimbs carry very large and powerful claws, which are used by the animal for burrowing. Although a comparatively common animal, it is, owing to its nocturnal habits, but rarely met with, living amongst rocks or the roots of trees. Ratels are practically omnivorous, feeding on honey, a variety of fruits, snakes, and sometimes raiding poultry farms. They can attack bees' nests with impunity, as the great thickness of the skin prevents any serious harm being done by the bees' stings. The Museum has also received a collection of more than 7000 specimens of land shells from Lord Howe Island and Norfolk Island; the land snails of these isolated islands are of importance for the study of geographical distribution, The Department of Botany has purchased the *Transactions* (in manuscript) of the Society of Amateur Botanists, in two volumes, 1863–64, from the library of Sir George Watt. The Society was formed among the old students of M. C. Cooke's evening classes in botany, for artisans, held at Trinity Schools, Lambeth, where Cooke was headmaster. Many others joined who afterwards became eminent botanists, including J. Britten, W. Thiselton Dyer, Berthold Seeman, Worthington G. Smith, and Henry Trimen. The meetings were held first at the

Metropolitan Club, Edgware Road, and then over Robert Hardwicke's shop in Piccadilly. Hardwicke's *Science Gossip* was one result; another was the formation of the Quekett Microscopical Club, which replaced the Society in 1865.

SIR WILLIAM BRAGG, Fullerian professor of chemistry in the Royal Institution, has been elected an honorary member of the Institution of Electrical Engineers.

IT is announced in *Science* that Dr. David White, senior geologist of the U.S. Geological Survey and home secretary of the National Academy of Sciences, was awarded the Penrose Medal at the Toronto meeting of the Society of Economic Geologists.

THE one thousand dollar award of the American Association for the Advancement of Science for an outstanding paper presented at the recent Cleveland meeting was given to Drs. M. A. Tuve, L. R. Hafstad, and O. Dahl, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Their paper entitled "Experiments with High Voltage Tubes" was presented to the American Physical Society.

THE Society for Cultural Relations with Soviet Russia is considering the possibility of organising a tour of scientific institutes in Soviet Russia during July and August 1931. It is proposed to arrange for parties of British scientific workers engaged in physical, biological, and medical research to visit and meet Russian workers engaged in similar researches. V.O.K.S., the central institution in Moscow for organising cultural relations with foreign countries, is prepared to do everything possible to help the tour, and Intourist, the Soviet organisation for tourist parties, will consider giving specially reduced travelling charges. Scientific workers desirous of joining such a tour are invited to write to the Secretary, Society for Cultural Relations with Russia, 1 Montague Street, London, W.C.1.

WHEN the late Sir Patrick Manson was addressing the Section of Tropical Diseases at the annual meeting of the British Medical Association in 1898, he said that there was not one of his hearers who did not bewail the crass ignorance in which he had lightly undertaken the care of men's lives in dangerous climates, nor one who could not pillory himself with the recollection of lives that perished owing entirely to the lack on his part of an elementary knowledge of tropical medicine. Manson's address came under the notice of Joseph Chamberlain, who took action which resulted in the establishment of the London School of Tropical Medicine. From that School, which Manson himself directed, and its successor, the London School of Hygiene and Tropical Medicine, some 4000 medical officers have gone to the far corners of the earth, trained in special post-graduate courses in tropical medicine. At the School on Feb. 3, 1931, Dr. Philip Manson-Bahr will deliver a public lecture on "The Dawn of Tropical Medicine, being an account of the Life and Work of Sir Patrick Manson". The chair will be taken by Sir Harry Goschen, Bart., and admission is free, without ticket.

THE Ministry of Agriculture and Fisheries has recently issued two advisory leaflets, one on "Swine Erysipelas" (No. 17), another on "Blackhead of Turkeys" (No. 20). Information is given on the symptoms, recognition, treatment, and modes of prevention of these diseases.

The annual "Guide to the Spas and Marine Health Resorts of Great Britain and Ireland and New Zealand", by Dr. R. Fortescue Fox, has recently been issued (London: J. and A. Churchill, 1*s.* net). Information is given on the climates of coastal resorts and inland spas, with indications regarding the ailments for which they are best suited.

THE "South African Journal of Science", vol. 27, which is the report of the South African Association for the Advancement of Science, has just been published by the Association at Johannesburg, price 30*s.* net. The volume contains a statement of the constitution of the Association, the presidential addresses, and a complete collection of the papers read and published. An account of the meeting, including brief notes on some of the papers, appeared in NATURE of Nov. 29, p. 862.

A SECOND edition of the economic pamphlet No. 112, entitled "The Cockroach, its Life-history and how to deal with it", by Mr. F. Laing, has recently been issued by the British Museum (Natural History). It provides a general account of the commoner species of these insects that frequent buildings, etc., and discusses means of their eradication. This pamphlet will be found useful by anyone troubled with these pests, and is obtainable at the Museum in Cromwell Road, or through a bookseller, price 6*d.* (postage 1*d.*).

THE Departmental Committee on Maternal Mortality and Morbidity in an interim report which was published last July found that not less than one-half of maternal deaths in childbirth are preventable under suitable conditions. The Ministry of Health has now issued a memorandum (*Memo.* 156/M.C.W.) with explanatory Circular (1167) to local authorities, directing their attention to this report, and urging them to exercise their full powers for the care of maternity. Authorities are reminded that an additional amount of £5,000,000 for the development of the maternity and child welfare services was included in the general Exchequer contribution under the Local Government Act, 1929.

DR. EDWARD R. WEIDLEIN, Director of the Mellon Institute of Industrial Research, announces that the Institute has lately begun a broad investigation into possible industrial uses for raw and refined sugar. The research will be carried on by a multiple industrial fellowship sustained by the Sugar Institute, Inc., of New York, an organisation that represents the cane sugar refiners of the United States. The investigation will be supervised by Dr. George D. Beal, assistant director of Mellon Institute, and by Dr. Gerald J. Cox, Senior Industrial Fellow. Four chemists have begun the initial scientific research of the industrial fellowship, and additions will be made to this staff, as needed, from time to time.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant lecturer in phonetics at the Glasgow Training Centre of the National Committee for the Training of Teachers—The Director of Studies, Training Centre, Jordanhill, Glasgow (Feb. 2). A graduate in engineering for physics, mechanics, mathematics and machine drawing at the Southall Technical Institute—The Principal, Southall Technical College, Southall, Middlesex (Feb. 2). A junior demonstrator in physiology at the University of Durham College of Medicine—The Registrar, College of Medicine, Newcastle-upon-Tyne (Feb. 2). A laboratory assistant in the Bacteriological and Pathological Laboratory, Birkenhead—The Town Clerk, Town Hall, Birkenhead (Feb. 6). A principal of the High Wycombe Technical Institute—The Secretary for Education, Education Department, County Offices, Aylesbury (Feb. 7). A head of the engineering department of the Leicester College of Technology—The Registrar, College of Technology, Leicester (Feb. 21). An assistant in the London Museum—The Keeper, London Museum, St. James's, S.W.1 (Mar. 14). An entomologist under the Indian Research Fund Association, able to undertake independent inquiries on malaria in the field or laboratory—The Secretary, Indian Research Fund Association, Simla, India (Mar. 31). A woman lecturer in geography at the Warrington Training College, Liverpool—The Principal, Warrington Training College, Wavertree, Liverpool. A full-time teacher of draughtsmanship (engineering), under the London County Council—The Education Officer (S.S.5), the County Hall, Westminster Bridge, S.E.1.

Our Astronomical Column.

Light-Variation of Eros.—*Beob. Zirk.*, No. 3, contains some observations of maxima and minima of Eros, made at Hamburg-Grossborstel by M. Beyer. The principal period is still $5^h\ 16^m\ 14^s$, but the light-range is notably smaller than it was at the beginning of December. Similar changes of light-range have been observed at other apparitions ; they favour the theory that the planet is double, and that mutual occultations occur when the earth is near the plane of rotation, but not otherwise. Duplicity ought to be detected by the great American telescopes at this near approach, if it exists. Prof. Yamamoto notes in *U.A.I. Circ.*, No. 309, that even if the variation arises from regions of very different albedo on the planet's surface, it may cause the centre of light to be shifted some 0·1″ from the centre of figure, which would be an appreciable amount in researches of such delicacy as are now being carried out. There was a request to observers with large instruments to try to observe the shape of the planet, but no reports have yet been received on the subject.

Locating the Sun's Corona.—In *Comptes Rendus* for Nov. 10, M. Lyot, of the Meudon Observatory, describes work conducted by him during July and August last, at the observatory of the Pic du Midi, for detecting the sun's corona without the unique conditions afforded by a total solar eclipse. M. Lyot states that from his observing station the purity of the atmosphere was such that, by the interposition, in the optical train, of a metal disc slightly larger than the image of the sun formed by a 4-cm. objective, the prominences at the sun's limbs were clearly visible without recourse to a spectroscope. Working under these conditions with a very sensitive polariscope, he explored the sky immediately surrounding the sun's disc. It was found that the proportion of polarised light (the plane of which appeared to be radial) was insensible at about 6′ from the sun's limbs but increased inwards. M. Lyot proved to his satisfaction that the origin of the polarisation was neither atmospheric nor instrumental, and he concludes that he has observed the polarisation of the sun's inner corona. Figures for July 29 and 31 derived from the observations made at various position angles at a constant distance of 80″ from the sun's limbs show two minima that correspond to the position of the sun's axis on those days. A further substantiation was made by observing the strength and length of two bright lines of the spectrum that were visible with a direct vision spectroscope. These lines were evidently the coronal lines λ5303 and λ6374, and their variation at different position angles around the disc corresponded generally with the degree of polarisation observed. These results are of great interest, for they indicate a means of studying frequently certain attributes of the sun's corona that have hitherto been available to observation during the brief and infrequent occasions of a solar eclipse.

Rotation of the Galaxy.—Sir Arthur Eddington chose this topic as the subject for the Halley Lecture on May 30, which has been published at Oxford by the Clarendon Press. After a brief historical sketch, he gives a proof of the formula published by Dr. Oort a few years ago, which states that the radial velocities of the stars contain a term varying as twice the sine of their galactic longitude, this being measured from the centre of galactic rotation. He notes that the same formula was published by Gylden in 1871, but did not then attract much attention.

The formula gives two alternative positions for the galactic centre, diametrically opposite to each other. The one in Sagittarius is now selected, on other grounds, but Gylden chose the one in Gemini. Prof. Turner had also been led to the position in Gemini by consideration of the two stellar drifts ; but that method likewise gave two opposite positions as possible. Dr. Plaskett, in the George Darwin Lecture of the Royal Astronomical Society delivered last May, showed that the radial velocities of the stars of types *O* and *B* supported Oort's position of the centre, and further indicated that the interstellar gas shares the rotation of the stars. Sir Arthur Eddington notes that, owing to the viscosity of this gas, it does not appear that its rotation could be maintained indefinitely ; this tends to support the shorter time-scale that limits the duration of the stellar system to a few thousands of millions of years, whereas the long scale gives millions of millions.

Galactic rotation gives an explanation of the fact that the quick-moving stars are all moving towards one hemisphere ; these are really the laggards, and the sun is moving from them, not they from the sun. Stars with high speed in the rotational direction would escape from the galaxy, the attraction of which could not control them. They have already been eliminated. Sir Arthur Eddington notes that the aspect of the spiral nebulæ is far from suggesting stability. As our galaxy is believed to resemble them, this consideration also favours the shorter time-scale. The rapid recession of the spirals, if taken as real, is shown to provide an argument tending in the same direction.

Research Items.

The Klamath.—In 1925 and 1926 Mr. Leslie Spier visited the Klamath of southern Oregon to study their religion and social organisation, now a thing of the past, but of which the memory still exists among some of the elder people who still occupy their old home. The results of the investigation are published as vol. 30 of the *University of California Publications in American Archæology and Ethnology*. The Klamath are the northern of two major dialectic groups of the Lutuami linguistic stock, of which the southern is the Modoc. The Klamath have the richer and more specialised culture. They were first visited by whites in 1825 and 1826, at a time when the Snake Indian raids were at their height. These raids probably account for the fact that country between the Klamath and the Dalles on Columbia river was unoccupied. It is probable that in historic times their highest number was about 1200. Owing to lack of adequate information relating to the tribes of the region, it is difficult to place the Klamath in relation to surrounding cultures. Their food habits and material culture generally follow the plateau peoples. Although their river—the Williamson river—was a minor stream, they are as much a river people as the Thompson, Lilloet, and Sushwap. Their staple food was fish, supplemented by roots and seeds. Deer and other game, though abundant, was not hunted. Their mode of living was arbitrary and not decided by geographical conditions. Klamath and Modoc represent the southern boundary of the plateau culture, but they have a strong leaning toward north-eastern California. The basis of their religious experience is that of the northern interior, the Columbia basin, and the north-west coast. Specifically the resemblance appears in the circumscription of spirit-possession to the mid-winter month. Details of shamanism, on the other hand, link with north-eastern California. Social organisation is simple and like that of the basin and plateau in every particular.

Tuberculosis in Man and Lower Animals.—The material for an important memoir under this title by Dr. H. H. Scott (*Medical Research Council, Spec. Rep. Series*, No. 149: H.M. Stationery Office, 4*s*. net) is derived from post-mortem examinations made by Dr. Scott of 300 cases of fatal tuberculosis occurring among Chinese of the labouring class in Hong Kong, and from similar examinations of a series of wild animals dying of tuberculosis while in captivity in the Zoological Gardens, London. He also reports upon some cases of mycosis in animals, the lesions of which are not unlike those of tuberculosis. Interesting details are given of the kind of lesions and their distribution and histology in the various animals. Thus in the dog, whitish circumscribed tumours with viscid or mucopurulent centres occur in the lungs, liver, and kidneys, which in their naked-eye appearances simulate cancerous growths. Microscopically, the tubercle of the dog differs from that found in man and most other mammals by the absence of giant-cells. In the parrot, which is susceptible to both the human and the avian types of the bacillus, pulmonary tuberculosis is rare and cutaneous infection is common, taking the form of lupoid or warty affections of the head. Tuberculosis is of exceptional occurrence in cold-blooded animals and the bacilli are of several types. Lesions may be present in the lungs, liver, and intestine, and occasionally as a cutaneous infection. Mycoses are commoner in birds than in mammals and double infection with tuberculosis is not infrequent. Dr. Scott doubts the occurrence of tuberculosis among animals in the wild state.

Musk-Ox in Sub-Arctic Canada.—In continuing the account of his expedition to sub-arctic Canada, to which we have already referred, Capt. J. C. Critchell-Bullock discusses the habits of the musk-ox (*Canadian Field-Naturalist*, Nov. 1930, p. 187). He does not agree with the notion that the musk-ox is a migratory animal. It is gregarious, and the band may indeed make periodical journeys, but these are usually due to lack of food in the northern haunts, where grass and willows do not grow so profusely as towards the southern limit of their range. Apart from such movements, they prefer to associate themselves with a chosen locality, where they remain indefinitely. Nor does the author agree with the report of the Royal Commission of 1922 upon the musk-ox, as regards feeding habits. Instead of showing preference for grass as compared with willows, moss, and lichens, as the report suggests, the musk-oxen of the Thelon district were only once seen to eat grass where young shoots of willow bushes were available. The species has been practically exterminated about the head-waters of the Coppermine and Black's Rivers, and the evidence suggests that the policy of conservation is not resulting in the increased numbers hoped for. In the musk-ox country there were fewer signs of wolves than anywhere else, but it is possible that the grizzly bear may do some damage, though the likelihood is that the inland Eskimo has more to do with the reduction of a species which may still be said to be in no little danger of extermination. A good omen, however, was the observation of Capt. Critchell-Bullock that calves composed almost one-third of the three bands he saw.

Hydatid Disease.—This disease is a condition caused by the developmental stage of a tape-worm which has its natural habitat in the intestine of the dog and occasionally in other carnivora. The cystic or developmental stage is particularly met with in the sheep and in man; it is usually those who come in contact with sheep who develop the disease. The disease is apparently rare in China, and Dr. H. H. Loucks, Department of Surgery, Peiping Union Medical College, in a paper entitled "Hydatid Cyst", reprinted from the *National Medical Journal of China*, vol. 16, pp. 402-496, 1930, has been able to collect only twenty cases recorded in the literature, but during the last ten years he has been able to add twelve more undoubted cases, and five others in which a diagnosis rested upon clinical evidence only. Full details of the cases, with a review of the literature on Chinese cases and a bibliography, are given.

Holacanthus bispinosus in the Philippines. — Mr. Heraclio R. Montalban, of the Division of Fisheries, Bureau of Science, Manila, records this handsome fish for the first time from the Philippines ("A Chaetodont new to the Philippines", *Philippine Journal of Science*, vol. 41, No. 3, March 1930) and redescribes it with a good coloured figure. The description is taken from two specimens, 78·5 mm. and 81 mm. in length, from Lumbian Islands, Sulu Archipelago. Previous records are from Zanzibar, Amboina, New Hebrides, Tahiti, Samoa, and the Hawaiian Islands. The fish bears some resemblance to *Holacanthus multispinis* Playfair, but is distinguished at once from the latter by the absence of a shoulder blotch.

Fauna of Lancashire and Cheshire.—An interleaved check list of the fauna of Lancashire and Cheshire ("A Check List of the Fauna of Lancashire and Cheshire", pt. 1. Arbroath: T. Buncle and Co.

5s. net) has been edited with great care by the secretary of the Fauna Committee of these two counties, Mr. A. K. Lawson, and has a preface from the pen of Prof. W. M. Tattersall, of University College, Cardiff. Twenty-two orders, ranging from Mammalia to Oligochæta, are included, and the number of insects, spiders, birds, fishes, mites, mammals, worms, and other creatures amounts to upwards of four thousand. Mr. Coward is responsible for the Mammalia (50 species), Aves (288), Reptilia and Amphibia (both 6 species), and non-marine Pisces (32). Of ants Mr. Donisthorpe records 27 forms; there are 1920 Coleoptera, 414 Hemiptera in two almost equal divisions, and 157 Tenthredinidæ classified by Mr. Britten. Mr. Lucas deals with the Mecoptera (3), Neuroptera (28), Paraneuroptera (23), and Orthoptera (34). There are 22 species of Siphonaptera, and no fewer than 467 Arachnida. The latter, together with the Opiliones (15 species) and Pseudoscopiones (14), are treated by Mr. Falconer, who, together with the Rev. J. E. Hull, is responsible for the Acari (345 species). Prof. Tattersall and Mr. Britten record a hundred and one Crustacea, Dr. Wilfrid Jackson 143 Mollusca, and the Rev. Hilderic Friend 42 Oligochæta, or land and freshwater worms, with nine different parasites found in the same. Few counties can show so large a record, which is a testimony to the industry of the members of the county natural history societies and the recorders.

Use of Compost for Turf.—The use of compost in horticulture is nothing novel, but it has been little employed for the improvement of turf. A series of articles in the *Journal of the Board of Greenkeeping Research*, vol. 1, No. 3, shows how it may be applied to golf greenkeeping. The preparation and usage of compost is dealt with by R. B. Dawson. The term is applied to a mixture of soil and organic material piled up in alternate layers and allowed to rot. Heavy clay or pure sand should be avoided and horse stable manure is the most favoured type of organic matter, but peat moss, leaves, grass cuttings, spent hops, and seaweed are also mentioned as satisfactory. The stack must be protected from rain, both to facilitate subsequent sieving and also to prevent putrefaction and loss of valuable fertilising materials. A compost heap is best started in the spring and should be allowed to stand undisturbed for one or preferably two years before use, February and March being the best season for treating the turf. The American system is to apply one ton (1 cub. yd.) of screened compost per month per 5000 sq. ft., usually accompanied with 10-25 lb. sulphate of ammonia. However, considerable benefit is obtained with smaller quantities, and an application of one ton in the spring followed by monthly dressings of 5-10 cwt., to which sulphate of ammonia and sulphate of iron have been added for weed destruction, is suggested. The chief objections against the use of compost are based on the possible introduction of weeds. This difficulty can be entirely overcome by sterilising the compost before use, and practical details of the plant in use at the Malone Golf Club, Belfast, are described by J. Henderson. Baking appears to be the best method of procedure, and the cost of 1s. 6d. per ton is not considered prohibitive. The advantages from the use of compost are various. It tends to level the turf and encourages bottom growth of grass; it acts as a valuable carrier for the distribution of fertilisers, itself supplying humus and small amounts of plant food, and also exerts a protective action under conditions of drought or frost.

Huygens and other Lens Makers of the Seventeenth Century.—The addresses delivered by Dr. P. Zeeman, Prof. Picard, and others in the hall of the Academy of Sciences at Leyden in celebration of the tercentenary of the birth of Christian Huygens on April 14, 1629, have been issued in pamphlet form by Paris of Amsterdam, along with Dr. C. A. Crommelin's guide to the exhibit of Hugeniana in the Observatory, illustrations of apparatus, three portraits of Huygens, and a view of his home during a considerable part of his life in Holland. In a further pamphlet by the same publisher, Dr. Crommelin gives an account of the lens makers of the seventeenth century, with portraits and figures of their grinding apparatus. Although Descartes invented a grinding machine, he does not appear to have made lenses. Huygens and his brother Constantin began to grind lenses in 1655, and illustrations of their machines are given, as well as those of Hooke, Hevelius, Maignan, and several taken from Zahn's "Oculus artificialis" of 1685. Gutschoven, Calthof, Mocchi, Reeves, Campani, Divini, Hartsoeker, Spinoza, Leeuwenhoeck, and Le Bas are all mentioned as lens makers, but no details of their methods are given. Dr. Crommelin's pamphlet forms a valuable addition to the papers of von Rohr and Baxendall which have appeared recently in the *Transactions* of the Optical Society.]

Interaction of α-Particles and Helium Nuclei.—It has recently been shown by Dr. J. Chadwick that the collisions between α-particles of medium speed and helium nuclei do not follow the law of the original theory of scattering, but that they behave instead in a modified way because of interference between the material waves of the two similar particles. Dr. Chadwick's results were taken to as small velocities of the particles as were conveniently studied by the scintillation method. P. M. S. Blackett and F. C. Champion, in an investigation with a Wilson cloud apparatus, described in the January number of the *Proceedings of the Royal Society*, have now carried these further, and again obtained good agreement between their measurements of forks on α-particle trails at the end of the range in helium and the predictions of the wave-mechanics. The statistical element in this work is more important than in Dr. Chadwick's, in spite of the fact that trails of about 50,000 α-particles from polonium were examined, but the agreement remains, on the whole, very satisfactory. A new result of importance which has been obtained incidentally in connexion with the present work is the relation between the speed of very slow α-particles and the residual range in air under standard conditions.

Isotopes of Zinc, Tin, Chromium, and Molybdenum.—A description of the isotopes of these four elements, which have been successfully studied by the introduction of volatile methyl compounds and carbonyls into the apparatus, is given by Dr. F. W. Aston in the January number of the *Proceedings of the Royal Society*. In the case of zinc and tin, the order of intensity of the isotopes has been revised, and with the other metals new isotopes have been discovered. In all cases, very good agreement is found between the chemical atomic weight, as deduced from the masses and relative abundance of the various isotopes, and that obtained by the more usual direct chemical methods. The actual numbers for these constants from mass spectrograph data are: $Zn = 65{\cdot}38_0 \pm 0{\cdot}02$, $Sn = 118{\cdot}72 \pm 0{\cdot}03$, $Cr = 52{\cdot}001 \pm 0{\cdot}006$, and $Mo = 95{\cdot}97 \pm 0{\cdot}06$. Dr. Aston has not been able to obtain new results for cadmium and germanium. Cadmium methyl, although chemically similar to zinc methyl, behaved in a totally different way in the discharge, cadmium depositing on the walls and disturbing seriously the normal beam of

rays. Germanium was studied by germanium ethyl, by use of which it had already been shown that there are eight isotopes to this element, but no satisfactory quantitative results were obtained. Dr. Aston proposes to study germanium later with the methyl compound, but it appears that with cadmium it will be necessary to return to the more difficult technique of 'anode rays', by which its isotopes were first discovered.

Beam 'Arrays' in Short-Wave Transmissions.—During the last three years the technique of short-wave transmission of electric waves through space has been rapidly developing. It is interesting to remember that so far back as 1899, S. G. Brown took out a patent for an aerial which utilised the principles of interference now commonly adopted. The first successful high-speed radio telegraph service was inaugurated at Bodmin, Cornwall, in 1927 by Franklin and Marconi. They developed a method of short-wave generation, which enabled engineers to design transmitters able to supply a large output at a steady frequency. The transmitters used in short-wave transmission are 'arrays' of wires scientifically spaced and carrying currents in the correct phases so as to increase greatly the resultant field strength in a definite direction. In a paper read to the Institution of Electrical Engineers on Dec. 3, T. Walmsley described many of the beam 'arrays' which are used in different countries, and in particular his own 'T.W.' aerial array which is used at the Post Office radio station at Rugby. He pointed out that the question of suitable transmission lines to the 'array' is of great importance. The Marconi beam stations, the French and the German stations, all use concentric tube transmission lines. Mr. Walmsley, however, pointed out that the losses in open circuit lines are much less than most engineers think, and so they can in many cases be usefully employed. Provided that the currents in the lines are well balanced, the radiation losses are small. There are losses in open circuit lines due to the 'high frequency' resistance, the proximity of the wires, the dielectric losses in the insulators, and the reflections from points on the circuit where the electrical constants change. He suggested methods for reducing these losses.

Problems in Lighting Systems.—Dr. W. T. Walsh, of the National Physical Laboratory, has contributed an interesting paper on photometric research to *World Power* for January. In considering the merits of any lighting system it is necessary to take 'glare' into account. It is found that the sensitivity of the eye is diminished four-fold if a light source of sixty candles is placed 10 feet from the observer, when the line joining the source to the eye makes an angle of 3° with the line of sight. The rate at which the eye loses sensitivity when a light suddenly appears and the rate at which it recovers when the glare is removed are being investigated. There is at Teddington a model street, 500 feet long and 35 feet broad, which is well adapted for tests of street lighting fittings. In particular, the reflection from the road surface when the light is incident very obliquely and the angle of view is nearly horizontal has to be studied. Every material used as a road surface, no matter how rough it may seem, shows a large amount of specular reflection under these conditions. When the road is slightly worn the degree of polish is very marked. Another problem that has been successfully solved is the most economical size of 'light well' to use for large blocks of buildings. It is now possible from the curves and formulæ that have been published, to compute with sufficient accuracy the amount of light which will reach any point of a room facing a light well of given dimensions. A problem of practical importance is to design a picture gallery so as to avoid the annoying reflections on the glass with which the pictures are covered. The only satisfactory solution appears to be to arrange the windows so that as little light as possible falls on the spectators, while the full amount reaches the picture wall.

Chlorine Monoxide.—Goodeve, in the December issue of the *Journal of the Chemical Society*, describes experiments on the vapour pressure of chlorine monoxide, Cl_2O, which indicate that the boiling-point at 760 mm. pressure is 2·0° and not 3·8° as found by Goldschmidt. The freezing-point is abnormally low, being −116°. The value −20° reported in tables (without indication of the origin) is, therefore, much too high. The vapour pressure curve of chlorine monoxide lies above that of chlorine dioxide found by Partington and King, and considerably below that of chlorine. The value of the Trouton coefficient indicates that the liquid is probably not associated.

Heats of Dilution.—Some accurate experiments on the heats of dilution of potassium chloride in sugar and urea solutions at 25°, with concentrations below 0·1 molar, are described by Lange and Robinson in the November number of the *Journal of the American Chemical Society*. The object of adding the non-electrolytes was to vary the dielectric constant of water and its rate of change with temperature, the values for pure water being used in the case of solutions in which these substances were absent. A linear relation at low concentrations with $\sqrt{c}$ was found, but the curves for sugar and urea were different. Although agreement with theory was not obtained, it was concluded that the existing data on dielectric constants made exact comparison impossible.

Nitrogen Tri-iodide.—The composition of nitrogen iodide appears to vary according to the method of preparation, the ordinary substance being regarded as $NI_3 . NH_3$ or NH_2I. In the December issue of the *Journal of the Chemical Society*, Cremer and Duncan describe some experiments on the action of dry ammonia on iodine bromide or, more conveniently, a polyhalide such as $KIBr_2$, which dissociates into potassium bromide and iodine bromide. In these reactions NI_3 is formed. The more stable dibromo-iodides, such as those of tetramethylammonium and trimethylsulphonium, do not react in this way, but form additive compounds with ammonia. The iodide of nitrogen was obtained by washing with water the product of the action of ammonia gas on the polyhalide, and was a black explosive powder.

Complex Salts of Bivalent Silver.—Although silver is normally univalent, its analogies with copper suggest that it should also function as a bivalent metal. The earliest observations on bivalent silver salts were made by Barbieri in 1912. He obtained a compound of argentic persulphate with pyridine, [Ag 4 py] S_2O_8, and in 1927 obtained the corresponding nitrate. In the December number of the *Journal of the Chemical Society*, G. T. Morgan and F. H. Burstall describe some further co-ordination compounds of bivalent silver in which both two and three diamine complexes (occupying two co-ordination positions) are present, indicating that the co-ordination numbers 4 (as in Barbieri's compounds) and 6 are possible for bivalent silver. The addendum employed was $\alpha\alpha^1$-dipyridyl, and the following compounds were obtained: [Ag_2 5 dipy]S_2O_8; [Ag_2 5 dipy]$(S_2O_8)_2$; [Ag 3 dipy]$(NO_3)_2$; [Ag 3 dipy]$(ClO_3)_2$; [Ag 3 dipy]$(ClO_4)_2$; [Ag 2 dipy]$(HSO_4)_2$.

Prize Awards of the Paris Academy of Sciences.

AT the annual public meeting of the Paris Academy of Sciences the prizes and grants for 1930 were awarded as follows :

Mathematics.—The Poncelet prize to Arnaud Denjoy, for the whole of his mathematical work ; the Francœur prize to Eugène Fabry, for his work on the singularities of analytical functions.

Mechanics.—The Montyon prize to Paul Le Rolland, for his work on the measurement of hardness by means of the pendulum ; the Henri de Parville prize to Émile Duchêne, for his work in ballistics.

Astronomy.—The Lalande prize to Nicolas Stoyko, for his theoretical and practical work on the calculation of planetary orbits ; the Valz prize to Gilbert Rougier, for his work on photoelectric cells ; the Janssen medal to Bernard Lyot, for his experimental work on the polarisation of light from the planets ; the Pierre Guzman prize to Alexandre Véronnet, for his works on cosmogony ; the La Caille prize to Mme. Edmée Chandon, for her work on the tides of the Red Sea.

Geography.—The Delalande-Guérineau prize to Félix Ollivier, for his book " La topographie sans topographes " ; the Gay prize to André Guillaumin, for his work on the flora of the islands of the Pacific ; the Tchihatchef foundation to Jean Bathellier, for his contribution to the systematic and biological study of the Termites of Indo-China ; the Binoux prize to Georges Poivilliers, for his work on the application of photography to topography.

Navigation.—The Prix de la Marine to Robert Bureau and Philippe Wehrlé, for their meteorological work in connexion with aerial navigation ; the Plumey prize to Paul Régnauld, for his work on the strength of materials used in the construction of steamships and boilers.

Physics.—The La Caze prize to Henri Abraham, for the whole of his scientific work ; the Hébert prize to Richard Langlois, for his memoir on asynchronous machines with rotating fields ; the Hughes prize to Alexandre Dauvillier, for his work on the X-rays ; the Clément Félix foundation to Jean Lecomte, for his work on the infra-red.

Chemistry.—The Montyon prize (unhealthy trades) to Roger Douris, for his work on poisonous gases ; the Jecker prize to Joseph Bougault, for the whole of his work in organic chemistry ; the La Caze prize to Georges Denigès, for the whole of his work in analytical chemistry ; the Cahours foundation to Lucien Andrieux, for his researches on the electrolysis of metallic oxides in solution in fused boric acid, borates, or fluorides ; the Houzeau prize to Paul Mondain-Monval, for his work in physical chemistry.

Mineralogy and Geology.—The Cuvier prize to Maurice Gignoux, for the whole of his geological work ; the Joseph Labbé prize to Jean Jung, for his geological work applied to prospecting for petroleum deposits.

Physics of the Earth.—The Victor Raulin prize to Albert Baldit, for his work on the influence of the relief and nature of the soil on the meteorological elements.

Botany.—The Desmazières prize to Frédéric Bataille, for his researches in mycology ; the Montagne prize to Pierre Allorge, for his work on the Muscineæ and fresh-water Algæ ; the de Poincy prize to Mlle. Aimée Camus, for the whole of her botanical work.

Anatomy and Zoology.—The Da Gama Machado prize to Marcel Avel, for his experimental researches on the somatic sexual characters of *Lumbricus* ; the Savigny foundation to Louis Parrot, for his studies in the biting Arthropods, particularly in North Africa ; Jean Thore prize to Henri Bertrand, for his researches on the larval evolution and metamorphoses of the Coleoptera.

Medicine and Surgery.—Montyon prizes (2500 francs) to Marcel Aynaud, Henri Lagrange, and Lucien Viborel ; honourable mentions (1500 francs) to Paul Blum and Ernest Schaaf, to Nöel Fiessinger, Henri René Olivier and Maurice Herbain, and to Henri Fischer ; citations to Charles Mayer and to Gustave Rappin ; the Barbier prize to Léopold Lévi, for his researches on the endocrine glands ; the Breant prize between Julien Dumas (2500 francs), for his work on the bacillus of dysentery, and Stefan Nicolau, Ian Alfred Galloway, and Mme. Octavie Dimancesco-Nicolau ; the Godard prize between Jules Janet, for his memoir on the diagnosis and treatment of blennorrhagia in man and in woman, and Pierre Gley, for his work relating to the yellow body and ovulation ; the Mège prize to Henri Vignes, for his book on gynæcological physiology and medicine of women ; the Dusgate prize to Henry de Varigny, for his work on death, true and false ; the Bellion prize to Jean Bordas, for his work on the hygienic and economical treatment of manure ; the Baron Larrey prize to Joseph Maisonnet, Daniel Petit Dutaillis, and Théophile Alajouanine, for their memoir on the remote after-effects of trepanning ; the Alfred Dutens prize between Henri Bordier, for his memoir on diathermy and diatherapy, and Georges Bourguignon, for his work relating to chronaxy.

Physiology.—The Montyon prize to Charles Porcher, for his book on milk from the colloidal point of view ; the L. La Caze prize to Maurice Doyon, for the whole of his work in physiology ; the Pourat prize to Henri Delaunay, for his researches on the nitrogenous excretion of the Invertebrates ; the Martin-Damourette prize to Jean Régnier, for his researches on the influence of hydrogen ions on physiological phenomena and on anæsthetics ; the Philipeaux prize to Jacques Millot, for his work on the physiology of the Araneideæ.

Statistics.—The Montyon prize to René Roy, for the whole of his work on the application of mathematics to statistics and economics.

History and Philosophy of Science.—The Binoux prize (in equal parts) between Pierre Brunet and Niels Nielsen.

Works of Science.—The Henri de Parville prize to Raoul Combes, for his work on the life of the plant cell ; the Jeanbernat-Doria prize to Henri Volkringer, for his book, " The Stages of Physics ".

Medals.—Berthelot medals were awarded to Roger Douris, Joseph Bougault, Georges Denigès, and Paul Mondain-Monval.

General Prizes.—The prize founded by the State to Georges Valiron, for his work on analytical functions ; the Bordin prize to Louis Dangeard, for his contributions to our knowledge of the sea floor ; the Lallemand prize to Michel Raoul May, for his work on the nervous system and the grafting of sense organs ; the Vaillant prize to Robert Perret, for his topographical and geological map of the mountains between the valleys of Chamonix and Sixt ; the Le Conte prize to Elie Cartan, for the whole of his mathematical work ; the Houllevigue prize to Georges Giraud, for the whole of his work on partial differential equations ; the Saintour prize to Elie Ivanow, for his researches on the artificial impregnation of mammals ; the Jules Mahyer prize to Constantin Dawydoff, for the whole of his researches in zoology and especially on the embryo-

geny of the Vertebrates; the Henry Wilde prize between Maurice Leriche (2000 francs), for his palæontological researches, and Ferruccio Zambonini, for his work in mineralogy; the Caméré prize to David Wolkowitsch, for his memoir on the applications of geometry to the stability of constructions; the Gustave Roux prize to Marc André; the Thorlet prize to Adolphe Richard; the Albert I. of Monaco prize to Lucien Cuénot, for his biological work.

Special Foundations.—The Lannelongue foundation to Mmes. Cusco and Rück; the Hélène Helbronner-Fould prize to the late Mme. Yves Delage.

Prizes of the Grandes Écoles.—The Laplace prize to Henri Feltz; the L. E. Rivot prize between Henri Feltz, Pierre Julien Couture, Émile Bideau, and Camille Henri Foin.

Foundations for Scientific Research.—The Gegner foundation to Désiré Bois, for his book on the history, utilisation, and culture of plants used for food; the Jérome Ponti foundation to Robert Forrer, for his work on magnetism; the Hirn foundation to Maurice Kraïtchik, for his studies in the theory of numbers; the Henri Becquerel foundation to Jean Thibaud, for his work on X-rays of long wave-length and the joining up the ultra-violet and X-ray spectra; the Victor Noury foundation between Augustin Boutaric (3000 francs), for his work on colloids; Henri Baulig (3000 francs), for his book on the central plateau of France and its Mediterranean border, morphological study; the late Franz de Zeltner (2000 francs), for his work in western Africa; Pierre Lamare (2000 francs), for his geological researches in the Yemen; and Raymond Hovasse, for his biological and zoological work; the Charles Bouchard foundation to Léon Binet, for his experimental researches on apparatus for perfusion and artificial respiration; the Henry Le Chatelier foundation to Marcel Ballay, for his researches on the beryllium alloys; the Pierre Lafitte foundation to Raymond Jouaust, for the whole of his work on radio-electricity; the Roy-Vaucouloux foundation to Joseph Magrou, for his work on the production of tubercles and galls in plants.

THE LOUTREUIL FOUNDATION.

The Academy has considered twenty-nine applications for grants from this fund, and has made the following twenty-two awards, amounting in all to 121,000 francs:

1. *Researches on Definite Problems.*—10,000 francs to Louis Dunoyer, for the extension of his researches on photoelectric cells; 5000 francs to Raymond Ricard, for his researches on the spark spectra of metals; 5000 francs to Jacques Duclaux, for his work on the measurement of the transparency of the atmosphere; 4000 francs to Maurice Fontaine, for his researches on the physiology of marine organisms; 3000 francs to François Maignon, for the continuation of the study of the influence of the seasons and of the genital glands on respiratory combustion; 3000 francs to Gabriel Petit, for his researches on the grafting of endocrine glands; 3000 francs to Jean Verge, for his researches on d'Herelle's bacteriophage and its applications in veterinary medicine; 4000 francs to the viticulture laboratory of the National Hygronomic Institute (Director, Pierre Viola), for various researches in plant pathology now in progress.

2. *Voyages and Exploration.*—5000 francs to Charles Alluard, as a contribution towards an expedition to the southern Sahara; 3000 francs to Norbert Casteret, for his spelæological explorations in the Pyrenees; 4000 francs to Auguste Méquignon, for the continuation of his entomological researches in the Azores archipelago.

3. *Purchase of Material.*—3000 francs to Emilio Damour, for the completion of the installation of the glass laboratory at the Conservatoire national des arts et métiers; 3000 to Jean Georges Lafon, to complete the installation of electro-cardiography at the physiological laboratory of the National Veterinary School of Toulouse; 1000 francs to the Arcachon Scientific Society, as an aid to building.

4. *Libraries.*—15,000 francs to the National Museum of Natural History, for producing a catalogue of the books contained in the laboratory libraries; 12,000 francs to the Lyons National Veterinary School, and 4000 francs to the Toulouse National Veterinary School, for increasing their libraries.

5. *Publications.*—5000 francs for the Fauna of the French Colonies; 5000 francs to the French Federation of Societies for Natural Science; 15,000 francs for the continuation of the catalogue of the scientific periodicals in the libraries of Paris; 5000 francs to Emmanuel de Margerie, for the preparation of a geological map of Africa; 4000 francs to the Science Museum of Lyons, for assisting the publication of a memoir by L. Germain on the Helicides of the French fauna.

Fruit Cultivation in Great Britain.

AMONG the recent bulletins issued by the Ministry of Agriculture, those entitled "Fruit Production—Tree Fruits, No. 2", and "Fruit Production—Soft Fruits and Nuts, No. 4", are particularly welcome, as in the present economic condition of the commercial fruit-growing industry all available information as to the results of recent research should be studied by growers, and, where possible, applied to the elucidation of the many problems connected with this highly specialised calling. In these publications the amateur and the professional grower have access to much valuable advice, written in language at once clear and concise and not overburdened by technical terms.

The factors dealt with in the opening chapter on the planning and planting of an orchard merit close attention, as miscalculations on these matters are of frequent occurrence and in after years are extremely difficult to rectify.

The question of shelter is dealt with briefly, but it is difficult to over-emphasise its importance in the economy of a commercial plantation, as losses from high winds occur annually, and are occasionally of a very serious character. Three conifers are recommended as wind-breaks, but they are comparatively expensive. An excellent shelter belt may be formed by planting a mixture of common larch and spruce fir, which in a young state may be purchased at a cheap rate.

Information as to progress made in classification and suitability of vegetatively propagated stocks for various purposes is extremely helpful, as many amateurs fail to realise the influence of 'pedigree' stocks on the future behaviour of their trees. It is suggested that vegetatively propagated stocks, such as East Malling Types X., XII., XIII., XV., and XVI., may replace seedling stocks, but the existence of numerous orchards containing very large but possibly unremunerative apple trees testifies to the vigour of the stocks employed by earlier planters, and further information is desirable as to the ability of these standardised stocks to withstand the deleterious effects of grass.

The bulletin rightly stresses the importance of a rigid selection of plum stocks, and condemns the

practice of utilising suckers, carelessly taken from plum orchards for propagation purposes, owing to the risk of working stocks infected with 'silver leaf'.

The thorny subject of pruning is dealt with in a masterly manner, and the section devoted to this important operation will appeal to the many amateur fruit-growers who, owing to well-meant but occasionally contradictory suggestions of numerous advisers, are hopelessly at sea on this matter. The general principles are clearly indicated; it is pointed out that no hard and fast rule can be applied to all species and varieties, but that the system of pruning should be modified in accordance with their special characteristics.

It is doubtful if the extended commercial cultivation of pears in Great Britain is worthy of consideration, as imported produce of high quality is now available for the greater part of the year. Much useful information respecting up-to-date storage methods is contained in a chapter devoted to this subject, but further research is needed.

Renovation of old orchards and the control of pests and diseases of fruit trees are ably dealt with, and the bulletin should be in the hands of all who wish to see an improvement in the general standard of fruit culture, and are interested in the future of an important home industry.

Bulletin No. 4 deals with 'soft fruits', which now form an important section of the British fruit industry, and its contents comprise the more important results attained by research workers, and also details of sound cultural methods.

The descriptive lists of standard commercial varieties should be of great assistance to intending planters, and information respecting varieties suitable for canning will enable growers to cater specially for this purpose. Black currants and gooseberries in recent years have failed to give remunerative returns, and the area devoted to these crops will probably decrease. Figs and melons are among the fruits included in the bulletin, but their commercial cultivation is likely to remain in the hands of a comparatively few growers. Cob nuts and filberts realise high prices and there appears to be ample scope for their extended cultivation; the nut is not fastidious as to soil, but possibly the prevailing system of land tenure is responsible for the small area devoted to this and other 'permanent' crops.

Rainfall of the United States.

SUPPLEMENT Number 34 of the *Monthly Weather Review* of the United States Department of Agriculture is a summary giving the main results of fifty years of organised rainfall measurement, in the form of daily, fortnightly, monthly, and annual normals of precipitation for the regular first order stations of the U.S. Weather Bureau.

The need for a revision of the normals for the United States available before this publication appeared arises from the fact that the last revision was made so long ago as 1907, since when many new stations have been started. The new normals all refer to the period January 1878 to December 1927 inclusive. Where a complete record has not been available, the usual procedure has been adopted, namely, an adjacent station has been selected for which the full fifty years' record is available, and its measurements have been compared with those at the station with the incomplete record throughout the period of overlap of the two records. In this way the relative degree of wetness has been obtained, and thence a correction which, when applied to the normal computed from the period of overlap, gives a close approximation to the required normal.

A publication of this kind, consisting of little more than a vast array of figures in tabular form, is clearly not to be regarded as reading matter in the ordinary sense even for the expert meteorologist. It would, however, have been more nearly so had there been a key map showing the positions of all the places for which normals are given, preferably with shaded or coloured altitude zones, and any other features that might assist in explaining the great diversity in the amount and seasonal distribution of the precipitation, which a careful inspection of the tables reveals. For the work has under review the rainfall of a country in which virtually rainless areas exist side by side with areas of great altitude and wetness, where lofty mountain peaks force the moist westerlies from the Pacific to rise and undergo such dynamical cooling that a large proportion of their moisture is condensed to rain or snow. A rapid survey of the normal annual falls did not reveal any total that is not surpassed in the Lake District of England, but showed many smaller than can be found anywhere in the dry eastern lowlands of England and Scotland. Yuma, Arizona, has the interesting annual normal of 3·47 inches, based on a full fifty years' record.

In addition to its value in general climatology, this work is obviously of the first importance to American water engineers and to many of the industries of the States, particularly farming. E. V. N.

Parliamentary Representation of the Universities of Great Britain.

IN view of the clause relating to the abolition of university constituencies which appears in the Representation of the People Bill, the text of which has recently been issued, a joint memorandum has been submitted to the electors of the Universities of Oxford and Cambridge by their present parliamentary representatives. The memorandum gives a brief history of university representation in Great Britain. In 1603 James I. by a charter issued on the advice of his Attorney-General, Sir Edward Coke, granted to the Universities of Oxford and Cambridge the right, which they have ever since enjoyed, of each returning two burgesses to Parliament. A similar right of representation in the Irish Parliament was accorded to Trinity College, Dublin, ten years later. By the time of the outbreak of the War there were nine university members in the House of Commons, returned by the following constituencies:

	Voters.
Oxford (2)	6,895
Cambridge (2)	7,145
Dublin (2)	5,020
London (1)	6,070
Edinburgh and St. Andrews (1)	11,319
Glasgow and Aberdeen (1)	11,714
	48,163

A large measure of parliamentary reform and a great extension of the franchise were undertaken by the Coalition Government in 1918. Three new university constituencies, the Combined English Universities,

the University of Wales, and Queen's University, Belfast, were created, and the Scottish universities were awarded an additional member. At the same time, reforms were effected in the qualification for the university vote which immensely increased the number of voters in the existing university constituencies, particularly in Oxford and Cambridge. It was also enacted that whenever a university constituency returned two or more members, the elections should be conducted according to that variety of proportional representation known as the single transferable vote.

As a result of these reforms, the university constituencies, at the date of the general election in 1929, were as follows :

	Voters.
Oxford (2)	15,770
Cambridge (2)	23,978
London (1)	15,558
Scottish Universities (3)	43,192
Combined English Universities (2)	13,775
University of Wales (1)	3,623
Queen's University, Belfast (1)	3,324
	119,220

In place, therefore, of five constituencies (if Trinity College, Dublin, be omitted) with 43,143 voters returning seven members, there are seven constituencies with 119,220 voters returning twelve members. Nor is the process of expansion nearly completed, especially at Oxford and Cambridge. Although these two constituencies have more than doubled in numbers since the franchise was altered in 1918, they will undoubtedly double themselves again in the next twenty years, as the existing regulations, which provide for the automatic registration of all British subjects who take degrees, gradually equate the number of voters with the number of living graduates of the university. It may, therefore, be predicted that if the representation of the universities in Parliament is left undisturbed for a generation, the twelve members will be representing a body of between 200,000 and 250,000 graduates.

When account is taken of the very large numbers of men and women students, from all grades of society, including those who began their education in our primary schools, who now make their way to Oxford and Cambridge, and of the still larger numbers who proceed to the Scottish and the modern English universities; of the pronounced success which has attended the efforts of the universities to provide a training suitable to students entering on professional, commercial, or industrial careers; and of the fact that the general widening of the educational ladder has not yet had time to bear its full fruit, it is claimed that graduates of the universities of Great Britain, as a whole, represent to-day, even more fully than they did half a century ago, that section of the community which exercises the greatest influence on the formation of public opinion.

Of 1263 men students matriculated at Oxford during the academical year 1928–29, less than half came from the English public schools. Of the remainder, 179 were students from overseas, and 445 were from secondary schools which do not rank as public schools. Of these 445, no fewer than 223 had started their education in public elementary schools, which means that at any time there are about 750 elementary schoolboys in residence at Oxford, and the proportion to the whole would be at least as large amongst the women students. The evidence also shows that more than 45 per cent of Oxford undergraduates are in receipt of financial assistance without which their parents would be unable to give them a university education. The figures for Cambridge are similar, and at some of the modern English universities more than two-thirds of the students began their education in the elementary schools.

Further justification for the existence of a small number of university representatives in the House of Commons is found in the special knowledge they may be expected to have of the needs of higher education and educational policy generally. The independence from government control enjoyed by the universities of the British Empire can only be maintained by very cordial co-operation between the governing bodies of the universities and the Government of the day, and in the delicate negotiations which such co-operation constantly involves, the university members play a part which is essential, although it naturally does not bulk in the public eye.

The university constituencies, by reason of their peculiar constitution, provide for the enfranchisement of a large number of men and women who would otherwise be without a vote. Since the university voter is placed on the register for life, and can vote through the post, he carries his qualification with him wherever he goes ; he can exercise it although, owing to a change of residence, he may be without an ordinary vote, or unable to travel to a constituency to exercise it : if he goes abroad, he can appoint a proxy, and, with the recent extension of air mails, he can now exercise the franchise himself from a great many distant parts of the world. A careful analysis of 900 consecutive voters on the Oxford Register showed that no fewer than 75 had addresses overseas, many of them serving their country in distant parts of the Empire, which means that at Oxford alone the abolition of the University seat would disfranchise nearly 1500 overseas voters. In the Scottish universities the proportion of overseas voters is probably higher.

University and Educational Intelligence.

CAMBRIDGE.—Applications are invited for a research studentship at Emmanuel College, the maximum annual value of which will be £150 and the period of holding two years or a possible third. Preference will be given to candidates who have completed one but not more than two years of research work. Applications must be received by the Master of Emmanuel College by, at latest, June 30.

THE Air Ministry announces that five hundred aircraft apprentices, between the ages of fifteen and seventeen years, are required by the Royal Air Force for entry into the Schools of Technical Training at Halton, Bucks, and at Cranwell, near Sleaford, Lincs. They will be enlisted as the result of an Open Competition and of a Limited Competition, to be held in the near future by the Civil Service Commissioners and the Air Ministry respectively. Boys in possession of an approved first school certificate may be admitted without other educational examinations. The scheme offers a good opportunity to well-educated boys of obtaining a three-years' apprentice course of a high standard. The principal trades open to them are metal rigger, a new trade brought into existence by the introduction of the metal aeroplane, which involves training in both fitting and sheet metal work; fitter (aero engine); fitter (armourer); wireless operator-mechanic; and electrician. Full information regarding the examinations can be obtained upon application to the Secretary, Air Ministry (Aircraft Apprentices' Dept.), Gwydyr House, Whitehall, London, S.W.1.

Birthdays and Research Centres.

Feb. 3, 1872.—Prof. F. J. COLE, F.R.S., professor of zoology, University of Reading.

My chief studies at present are concerned with the history of zoological discovery.

Feb. 4, 1875.—Dr. LUDWIG PRANDTL, For.Mem.R.S., director of the Kaiser Wilhelm Institute for Research on Fluid Flow at Göttingen.

In the Wilbur Wright Lecture before the Royal Aeronautical Society in May 1927, I pointed out that after the very satisfactory explanation of the lift on aerofoils and of all similar related problems, it is necessary to investigate the problem of resistance more closely, and that turbulence is an important factor in connexion with this latter question. Turbulence is that internal unrest in fluid motion which produces a continual mingling of fluid particles from the neighbourhood of the wall with those somewhat farther away, and as a result, frictional forces are increased, but the stream-line pattern approximates more closely to the form calculated for ideal fluids.

During the last few years, the investigations in my Göttingen Laboratory have gone into the properties of turbulent flow in great detail, and have, in fact, produced several important explanations. But much remains to be done, and much more work is necessary before the experimental results can be explained with the desired clarity.

Feb. 5, 1866.—Sir ARTHUR KEITH, F.R.S., Hunterian professor and Conservator of the Museum of the Royal College of Surgeons.

I am continuing my lifelong search for evidence bearing on the origin of man and of anthropoid apes. Especially am I concerned with factors which regulate or influence development and growth.

Feb. 6, 1852.—Dr. CONWY LLOYD MORGAN, F.R.S., emeritus professor of psychology in the University of Bristol.

One who enters on his eightieth year is not likely to be able to furnish an interim report of any new investigation now in progress. More probably he asks himself: What should I do were I near the start of my life-work instead of fast approaching its close?

Realising that comparative psychology is still in its infancy, I should concentrate attention for another lifetime on the earlier stages in the evolutionary genesis of mind in its natural process of concrescence. I should still urge that, since maturity is, in each individual, a novelty emergent on infancy, it does not accord with sound method in science to account for infantile (and even embryonic) occurrences in terms of mature processes if, on the available evidence, such processes are not as yet emergent in that instance of concrescent advance which is under scientific consideration.

Feb. 6, 1871.—Lieut.-Col. J. STEPHENSON, F.R.S., Indian Medical Service (retd.), formerly lecturer in zoology in the University of Edinburgh.

The main objects of my anatomical and systematic work on the Oligochæta are: (1) the tracing out of the course of evolution within the group—certain families, for example, the Megascolecidæ, allow lines of descent to be traced within them with more and more certainty as our knowledge of the anatomy and distribution of their members increases; (2) to contribute to the science of palæogeography by means of an increasingly accurate knowledge of the earthworm faunas of the several regions of the globe. Since earthworms for the most part spread only by their own slow progression in the ground, to a life in which they are absolutely confined, a knowledge of the distribution of the various genera affords valuable material for determining the configuration of the land in former epochs.

Societies and Academies.

LONDON.

Royal Society, Jan. 22.—**P. M. S. Blackett and F. C. Champion**: The scattering of slow α-particles in helium. Mott has calculated the scattering of α-particles by helium atoms on the assumption that the particles interact according to the inverse square law, that they have no nuclear spin, and that they obey the Einstein-Bose statistics. It is found that the scattering should vary periodically with changing angle and velocity; in fact, an interference pattern should be obtained the scale of which depends on the velocity. This theory has been tested by photographing the collisions between slow α-particles and helium atoms in a Wilson chamber. The results are in complete agreement with Mott's theory.—**W. A. Bone, R. P. Fraser, and F. Lake**: Explosions of mixtures of acetylene and electrolytic gas. The disturbing influence of successive additions of acetylene upon the uniformity of the initial flame movement in an explosion of electrolytic gas attains a maximum when 20 per cent of acetylene is present in the medium, thereafter declining, and eventually disappearing when 30 per cent of acetylene is present. There is a primary selective partial combustion of acetylene, $C_2H_2 + O_2 = 2CO + H_2$, in the flame front, followed, behind the flame front, by either (i), when sufficient oxygen is present, a highly luminous combustion of the nascent carbon monoxide, or (ii) otherwise, by a thermal decomposition of any unburnt acetylene. The explosion of a $C_2H_2 + O_2 + 2H_2$ mixture is differently affected by an equal dilution with argon or nitrogen.—**W. A. Bone and R. P. Fraser**: Flame speeds in the inflammation and detonation of CO-O_2 mixtures. In the initial phase of 'inflammation', and in the final stage of 'detonation', the maximum flame speed for moist mixtures at atmospheric pressure is obtained with a *circa* $3CO + O_2$, instead of a theoretical $2CO + O_2$, mixture. Dilution of the medium with either argon, helium, or nitrogen does not materially alter the proportions of carbonic oxide and oxygen in the maximum-speed mixture. Hence the point of maximum flame speed is principally determined by the concentration of carbon monoxide, and the combustion of moist carbonic oxide is conditioned by a prior 'excitation' of its molecules, which are then rendered combustible.—**C. V. Jackson**: Interferometric measurements in the arc spectrum of iron. Ten lines in the spectrum of the iron arc in air, between $\lambda 4000$ and $\lambda 4400$, have been measured by interferometric comparison with the red line of cadmium or with the secondary standards of neon. Sixty-eight lines in the spectrum of the iron arc in air between $\lambda 2300$ and $\lambda 3100$ have also been measured interferometrically. The results are in good accord with the wave-lengths recommended by the International Astronomical Union in 1928.

EDINBURGH.

Royal Society, Jan. 12.—**J. W. Gregory**: The Dalradian rocks of Scotland and the structure of the Southern Highlands. The Dalradian rocks can be traced across the Southern Highlands of Scotland from Argyll to the Moray Firth and the coast south of Aberdeen. The author in 1910 rejected the

generally accepted conclusion that the oldest Dalradian rocks outcrop along the southern border of the Highlands, and that there is an ascending series to the Moine gneiss to the north. He regards the slates and grits to the south as a younger but still pre-Palæozoic series (the Lennoxian), and as composed of Dalradian debris; the Dalradian band as consisting of five series, with the youngest to the north; and the Dalradian beds as having been deposited on the southern flank of a land composed of the Moine. The evidence for these conclusions is submitted in detail. The author regards the beds as in their original order, except where locally inverted as in Ben Lui and near Callander. He correlates the north-eastern Dalradian and Lennoxian rocks south of the Moray Firth with those of Perthshire and south-west Scotland, from which they are separated by the granites of the Cairngorms and western Aberdeenshire.—**J. Weir**: The British and Belgian Carboniferous Bellerophontidæ. Eighty-two forms are discussed under nine genera. The Bellerophontid faunas of various horizons and facies are tabulated and discussed, and attention is directed to assemblages of stratigraphical value in the Scottish Carboniferous succession and equivalent rocks in the north of England, with special reference to stages in the evolution of *Euphemus urei*, *Bucaniopsis decussatus*, and *Tropidocyclus oldhami*.—**Elsie J. Cadman**: Life history of *Didymium nigripes*. *Didymium nigripes* is a species belonging to the slime-fungi or Mycetozoa found growing on germinating beet-'seeds', and it also grows frequently on dead leaves of many kinds. The spores germinate readily, each spore giving rise to two swarm-cells, because germination is preceded by a division within the spore-coat. At the division four chromosomes are present, and there are distinct centrosomes. After several divisions the swarm-cells withdraw their flagella and become transformed into myxamœbæ. The myxamœba possesses no flagellum and no bleparoplast and cannot become a swarm-cell again. They fuse in pairs to form zygotes. A plasmodium which may be slightly bigger than those in its neighbourhood, either because it possesses a great number of nuclei or has engulfed a larger number of myxamœbæ, can exert some form of attraction on the smaller plasmodia around it, and they coalesce with it in large numbers. A large plasmodium, therefore, rapidly increases in size, and continues to do so by coalescing with the smaller plasmodia in its neighbourhood. Chromosome numbers were fully investigated.—**R. Crookall**: The genus *Lyginorachis* Kidston. This genus was instituted by the late R. Kidston, of Stirling, to include petrified leaf-stalks with a structure similar to that of the well-known Coal Measure plant *Lyginopteris oldhamia*. Though Kidston recognised and named two species of *Lyginorachis*, he described neither. In his admirable "Studies in Fossil Botany", Dr. D. H. Scott described, but did not figure, *L. papilio* from the Cementstone Group (Calciferous Sandstone Series) of Norham Bridge, Tweedside. The second species was appropriately named by Kidston *Lyginorachis taitiana*. It was referred to, but not described, by Dr. Scott. Fortunately, Kidston had prepared excellent photomicrographs of both forms, and these are used to illustrate the paper.—**J. Geronimus**: Some problems involving the persymmetric determinants.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—**F. Enriques**: Algebraic surfaces.—**G. Barba**: Generalised parallelism.—**F. Odone**: Rotation and divergence of a vector; gradients of a homograph in general curvilinear coordinates.—**Maria Pastori**: Further on the partial derivation of tensors.—**P. Cattaneo**: A class of cyclic varieties.—**M. G. Bouligand**: General expression for the solidarity between the problem of the minimum of an integral and the corresponding Hamilton-Jacobi equation.—**G. Andreoli**: Pseudo-limits of functions, pseudo-continuity, etc.—**M. Manarini**: Lines of curvature and geodetics of a surface.—**S. Finikoff**: The "suites" of M. Fubini.—**G. Bozza**: Action of certain apparatus for blowing gases.—**G. A. Barbieri**: Complex thiocyanates of quadrivalent molybdenum. Various difficulties are encountered in the preparation of these compounds, but a number of them have now been obtained by carefully oxidising the corresponding tervalent molybdenum derivatives by means of potassium ferricyanide.—**Giambattista Dal Piaz**: New genera and new species of artiodactyls in the Venetian oligocene. Investigation of the numerous fossil artiodactyls of the Basle Museum indicates that the genus *Anthracochœrus* occupies a completely isolated systematic position and shows a tendency to diverge from the complex type of *Anthracotheridæ* and to approach in some respects that of certain primitive *Sindæ*. It is concluded that the Monteviale artiodactyl is not related to any of the numerous phylogenetic lines of the *Anthracotheridæ*, but represents a type of which neither the eocene ancestors nor any oligocene successors are known.—**G. Brunelli**: Monotonous rotifer planktons in an elevated Apennine lake. The plankton of Lake Scanno consists mainly of *Cyclops strenuus* Fischer and of large masses of the rotifer *Asplanchna priodonta* Gosse.—**Teodoro Perri**: Behaviour of the optical vesicle of *Triton* grafted into embryos of *Rana esculenta* (Destruction and power of recovery).—**Giulio Cotronei** and **Aldo Spirito**: Zoological constitution and grafts. New experiments between Anura and Urodela (4).—**G. Mezzadroli** and **E. Vareton**: Action exerted by radium on the germination of seeds. Experiments in which barley, wheat, peas, and beans were subjected to the influence of the γ-rays of radium show that the effect of a short exposure on the germination of the seeds is beneficial and that of a long one injurious. When 3·9 mgm. of radium was used, benefit became appreciably apparent after 5 minutes and reached a maximum after 30 minutes. With one-half of this amount of radium, the exposure must be quintupled. The best result obtained consisted of increases of 30 per cent in the number of seeds germinated, 80 per cent in the total height, and 80 per cent in the weight of the plants. The stimulating effect is still active two months after the irradiation.

SYDNEY.

Royal Society of New South Wales, Oct. 1.—H. G. Roggatt: Thrust faults and compression joints in the Muree beds, near Grasstree, New South Wales. The beds in which the faults and joints occur, consist of sandstone and conglomerate—competent rocks—overlain and underlain by shale and mudstone—incompetent rocks—constituting an ideal series for the development of compression phenomena. Stress in a sandstone member is expressed by sharply defined faults which pass upward into conglomerate as monoclinal or slightly overturned folds. These thrust faults are inclined to the horizontal at an angle of about 30°. Joints are developed in two sets, one parallel to the faults and one inclined thereto at 120°. The fractures appear to obey Mohr's theory of rupture and furnish striking practical confirmation of Hartmann's law. Since the direction of thrust is known, the orientation of the strain ellipsoid is known, showing that the axis of maximum compression lies in the *acute* angle between the shear planes. Experimental determination of the angle of friction of the sandstone confirms

the view that the principal factor tending to reduce the fracture angle to less than 45° is the internal friction of the rock itself.—**A. J. Matheson**: The geology of the Wellington district, N.S.W., with special reference to the origin of the Upper Devonian Series. The oldest rocks are of Silurian age, comprising shales and limestones in which are interbedded a great volcanic series. The limestone occurs on two horizons and both are coralline; the upper limestone is the more highly fossiliferous and is the youngest of the Silurian rocks. It passes by a gradation through an arenaceous type into a calcareous sandstone and, finally, into sandstone itself; the sandstone series, in its upper part, contains *Lepidodendron Australe* and *Spirifer disjunctus*, and is, therefore, of Upper Devonian age. Sandstones are characteristically red in colour, and it is suggested that they were deposited under arid conditions. They are intruded by the Wuuluman granite.—**G. F. K. Naylor**: The history of the development of the present drainage system in the Marulan district. Theories involving river capture were advanced by Andrews in 1904 and by Woolnough and Taylor in 1906. Andrews suggested that the old Shoalhaven was beheaded by a tributary of the Hawkesbury, while the other writers postulated an old Wollondilly beheaded by a newly formed coastal stream. The theory now being put forward suggests that the present Shoalhaven-Kangaroo system originally flowed in a westerly direction away from the coast, in a manner analogous to the present Upper Nepean system. Capture and reversal by a coastal stream which developed as a result of the post-Tertiary uplift is regarded as having brought about the present river distribution.—**A. R. Penfold** and **F. R. Morrison**: Notes on the essential oils from some cultivated Eucalypts (2). The species consisted of *E. Australiana*, *E. Macarthuri*, *E. citroidora*, *E. Smithii*, *E. dives*, and *E. dives* variety 'A' and variety 'B'. Leaves from the trees of an avenue of *E. bicostata*, near Sydney, show considerable variation in size and shape although grown from the seed of one tree collected at Jenolan, New South Wales. The yield of oil varied from 1·23 to 2·4 per cent and the cineol content from 38 to 65 per cent. The species is really a form of *E. globulus* confined to the mainland of Australia and should have been named *Eucalyptus globulus* variety *bicostata*. The chemical constituents of the oil are similar to those of *E. globulus*, namely, isovaleric aldehyde, *d*-α-pinene, cineol, eudesmol, etc.

Official Publications Received.

BRITISH.

British Chemicals and their Manufacturers: the Official Directory of the Association of British Chemical Manufacturers (Incorporated). Pp. 405. (London.) Free.

The British Chemical Plant Manufacturers' Association. Official Directory of Members, 1931, with a Classified List of their Manufactures and Services. Pp. 151. (London.) Free.

County Borough of Southport: Meteorological Department. The Fernley Observatory, Southport: Report, and Results of Observations for the Year 1929. By Joseph Baxendell. Pp. 28. (Southport.)

The National Capital. The Presidential Address of Sir Josiah Charles Stamp delivered to the Royal Statistical Society, November 18, 1930. Pp. 24. (London: Royal Statistical Society.) 1*s.* 6*d.*

The Observer's Handbook for 1931. Published by the Royal Astronomical Society of Canada. Twenty-third Year of Publication. Pp. 77. (Toronto.)

Food Fakes: Ancient and Modern. By E. Gabriel Jones. Pp. 24. (London: Institute of Chemistry.)

Catalogue of the Twenty-first Annual Exhibition of Electrical, Optical and other Physical Apparatus, January 6, 7 and 8, 1931. Pp. 160+xl. (London: The Physical Society and the Optical Society.) 6*d.*

The Proceedings of the Royal Society. Series A, Vol. 130, No. A813, January 1. Pp. 239-431. (London: Harrison and Sons, Ltd.) 10*s.*

Department of Scientific and Industrial Research: Water Pollution Research. Summary of Current Literature. Vol. 4, Part 1, January 1931. Abstracts Nos. 1-138. Pp. 135. (London: H.M. Stationery Office.) 1*s.* 3*d.* net.

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1929. Pp. 44. (Entebbe: Government Printer.) 3*s.*

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 46: Black Disease (infectious Necrotic Hepatitis) of Sheep in Australia: a Toxæmia induced by a Specific Bacterium (B. œdematiens) in Hepatic Lesions resulting from the Migration of young Liver Flukes (F. hepatica). By Dr. A. W. Turner. Pp. 141. (Melbourne: H. J. Green.)

The Indian Forest Records. Entomology Series, Vol. 14, Parts 11 to 14: On some Indian Coleoptera. Part 11: A new Genus and a new Species of Melasidae and a New Species of Elateridae, by E. Fleutiaux; Part 12: A new Genus and Two new Species of Longhorn Beetles from India (Coleoptera: Cerambycidae: Subfamily Lamiinae), by W. S. Fisher; Part 13: Immature Stages of Indian Coleoptera (7), by J. C. M. Gardner; Part 14: Three new Species of Lycidae, by R. Kleine. Pp. iii+17+3 plates. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1*s.* 9*d.*

FOREIGN.

United States Department of Agriculture. Circular No. 145: *Tiphia popilliavora* Rohwer, a Parasite of the Japanese Beetle. By J. L. King and J. K. Holloway. Pp. 12. 10 cents. Technical Bulletin No. 215: A Biological Study of *Trichogramma minutum* Riley as an Egg Parasite of the Oriental Fruit Moth. By Alvah Peterson. Pp. 22. 5 cents. (Washington, D.C.: Government Printing Office.)

Report of the Director of the Institute for Biological Research. V., 1929-1930. Pp. 11. (Baltimore, Md.: Johns Hopkins University.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 13, No. 6, November. Pp. 369-397. (Tokyo and Kyoto: Maruzen Co., Ltd.) 1.00 yen.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry). Vol. 19, No. 4. Pp. 365-472. (Tokyo and Sendai: Maruzen Co., Ltd.).

U.S. Department of Commerce: Coast and Geodetic Survey. Serial No. 481: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Sitka, Alaska, in 1923 and 1924. By W. N. McFarland. Pp. ii+102+10 plates. (Washington, D.C.: Government Printing Office.) 50 cents.

Mitteilungen des Geologischen Instituts der Landbouwhoogeschool in Wageningen (Holland). No. 16: i. Vergleichende mikroskopische, physikalische und chemische Untersuchungen von einem Kalkstein- und einem Löss-Bodenprofil aus den Niederlanden; ii. Vergleichendes Studium von einem Kalkstein-Bodenprofil aus Holland und einem Kalkstein-Bodenprofil aus Java. Unter Mitwirkung von Prof. A. Te Wechel, Dr. L. Möser und C. van Aggelen. Bearbeitet von Prof. J. van Baren. Met een Beknopte Samenvatting in de Nederlandsche Taal. Pp. 105+20 Tafeln. (Wageningen: H. Veenman en Zonen.)

CATALOGUE.

Radio-Malt. Pp. 14. (London: The British Drug Houses, Ltd.)

Diary of Societies.

FRIDAY, JANUARY 30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. D. Hunter: Changes in the Bones in Hyperparathyroidism and Hyperthyroidism.

INSTITUTION OF ELECTRICAL ENGINEERS (West Wales (Swansea) Sub-Centre) (at Corporation Electricity Showrooms, Swansea), at 6.—J. Urmston: The Electrical High-Pressure Testing of Cables and the Localisation of Faults.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—C. F. Christensen: The Whaling-Factory Ship *Vikingen*, with Some Notes on Whaling.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—W. Fish: Modern Methods of Production of Small Machined Work.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. M. Trevelyan: The First Defence of Gibraltar by the English, Oct. 1704-April 1705.

ROYAL AERONAUTICAL SOCIETY (Hull and Leeds Branch).—Col. the Master of Sempill: Gliding and Soaring.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section).—D. K. Colledge: Dyeing for the Scottish Tweed Trade.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section).

SATURDAY, JANUARY 31.

BRITISH MYCOLOGICAL SOCIETY (in Botanical Department, University College), at 11 A.M.—Dr. A. S. Horne: (*a*) Nuclear Division in *Spongospora*; (*b*) Preliminary Study of the Fungus Flora of the Air.—N. M. Nitimargi: Factors Influencing Spore Formation.—L. N. Seth: Factors Influencing Fungal Growth.—W. C. Moore and Dr. A. Smith: Notes on Some Interesting Fungi Recently Recorded.—A. A. Pearson: A Fungus Foray in Spain.

MATHEMATICAL ASSOCIATION (at Bedford College for Women), at 3.—Annual Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish Art (2): Breughel.

MONDAY, FEBRUARY 2.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Sir E. A. Sharpey-Schafer: Observations on the Relative Rate of Growth of the Nails of the Right and Left Hands respectively: on Seasonal Variations in the Rate, and on the Influence of Nerve Section upon it.—Dr. F. J. W. Whipple: A Note on the Secular Changes of Rock Temperature on the Calton Hill.—*To be read by title*:—Prof. E. L. Ince: Zeros and Turning Points of the Elliptic Cylinders.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—H. H. Woollard: The Potency of the Pharyngeal Entoderm.

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

SOCIETY OF ENGINEERS (at Geological Society), at 6.—H. W. Towse: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Cardiff), at 7.—D. B. Hoseason: The Cooling of Electrical Machines.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Prof. W. Rothenstein: The Decoration of Buildings.

ROYAL SOCIETY OF ARTS, at 8.—Prof. L. C. Martin: Some Modern Developments in Microscopy (Cantor Lectures) (2).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (jointly with Faraday Society and Chemical Engineering Group) (at Chemical Society), at 8.—Dr. E. B. Maxted: The Specific Activity of Catalysts.—Prof. E. K. Rideal: Specific Catalytic Surfaces.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 8.30.—Miss Ella Freeman Sharpe: Sublimation: A Correlation between the Experiences of an Educator and Psychoanalyst.

TUESDAY, FEBRUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. J. W. T. Walsh: The Art of Illumination (3).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. Nellie B. Eales: The Development of the Mandible in the Elephant.—A. D. Middleton: A Contribution to the Biology of the Common Shrew (*Sorex araneus* Linn.).—F. C. Baker: The Classification of the Large Planorboid Snails of Europe and America.—S. Maulik: On the Larva of the Poisonous Chrysomelid Beetle of N'gamiland, Africa.—Dr. C. Crossland: The Reduced Building Power and the Variations in the Astrean Corals of Tahiti; with a Note on *Herpetolitha limax* and *Fungia* sp.—Dr. Marie V. Lebour: (*a*) Further Notes on Larval Brachyura; (*b*) The Larvæ of the Plymouth Caridea. I. The Larvæ of the Crangonidæ. II. The Larvæ of the Hippolytidæ.

INSTITUTE OF METALS (Birmingham Section) (at Chamber of Commerce, Birmingham), at 7.—C. E. Moore, I. A. Bailey, and others: Discussion on Refractories.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Judge: Some Early Experiments in Colour Photography.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—Dr. W. H. Hatfield: Rustless Steels as applied to Automobiles and Aircraft.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. M. Herskovits: The New World Negro as an Anthropological Problem.

WEDNESDAY, FEBRUARY 4.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—T. P. Dunhill: Malignant Disease of the Thyroid Gland—the Relation of the Incidence and Spread to its Embryology and Prognosis.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—P. K. Turner: Some Measurements of a Loud-Speaker *in vacuo*.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. L. H. Lampitt and J. H. Bushill: Some Factors affecting the Solubility of Milk Powder.—S. Marks and Dr. R. S. Morrell: (*a*) The Determination of the Hydroxyl Content of Organic Compounds: Estimation of Castor Oil; (*b*) The Determination of the Carbonyl and Aldehyde Content of Organic Compounds: Estimation of Phenylhydrazine.—Dr. A. van Raalte and J. Straub: Food Control in Holland.—H. R. Ambler: The Determination of Small Quantities of Methane.—R. Bhattacharya and Dr. T. P. Hilditch: The Fatty Acids and Component Glycerides of Indian Ghee.

ROYAL SOCIETY OF ARTS, at 8.—C. Le Maistre: The Effect of Standardisation on Engineering Progress.

ROYAL SOCIETY OF MEDICINE (Surgery and Pathology Sections), at 8.30.—V. Z. Cope and P. H. Mitchiner (Surgery), Dr. A. Fleming and Dr. T. H. C. Benians (Pathology): Special Discussion on Indications for and the Value of the Intravenous Use of Germicides.

ROYAL MICROSCOPICAL SOCIETY (Biological Section) (in B.M.A. House, Tavistock Square).

THURSDAY, FEBRUARY 5.

ROYAL SOCIETY, at 4.30.—C. F. Jenkin: The Pressure Exerted by Granular Material.—F. L. Arnot: The Diffraction of Electrons in Mercury Vapour.—S. Rama Swamy: On the Transmission of Light by Thin Films of Metal.—*Papers to be read in title only*:—S. Goldstein: The Forces on a Solid Body Moving through Viscous Fluid (Notes by J. M. Burgers).—D. C. Colbourne: The Diurnal Tide in an Ocean Bounded by Two Meridians.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. M. Bernhauer and Dr. H. Scott: Abyssinian Staphylinidæ.—S. Savage: On a Recently-discovered Letter from Linnæus, dated 1750.—I. H. Burkill: Photographs of *Dioscorea esculenta* taken in Siam by Dr. A. F. G. Kerr.—Dr. T. A. Sprague and C. V. B. Marquand: The New Flora of Gore Cliff Landslide.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. G. N. Watson: Ramanujan's Note Books (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. Dingle: The Nature and Scope of Physical Science (3).

BRITISH ASSOCIATION OF REFRIGERATION (at Institution of Mechanical Engineers), at 5.30.—Dr. Ezer Griffiths: Some Instruments for Refrigeration Work.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—P. J. Ryle: Two Transmission Line Problems: Suspension Insulators for Industrial Areas in Great Britain; Conductor Vibration.

INSTITUTE OF CHEMISTRY (Manchester Section) (at "Manchester, Ltd.", Manchester), at 7.—Prof. F. L. Pyman: Paper.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (jointly with Institute of Fuel) (at Bristol University), at 7.30.—M. H. Lewis: Recent Development in the Economic Production of Steam from Factory Boiler Plants.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (jointly with South Wales Section of Institute of Chemistry and Microscopical Society of Wales) (at Cardiff Technical College), at 7.30.—C. A. Seyler: The Microstructure of Coal.

CHEMICAL SOCIETY, at 8.—J. W. Baker: Salt-forming Characteristics of Doubly and Singly Linked Elements of the Oxygen Group. Part I. The Carbonyl Group in Benzaldehyde and Acetophenone.—J. W. Baker and W. G. Moffitt: Salt-forming Characteristics of Doubly and Singly Linked Elements of the Oxygen Group. Part II. The Nitration of Benzaldehyde and Acetophenone in Sulphuric Acid Solution.—Prof. T. M. Lowry and G. Jessop: The Properties of the Chlorides of Sulphur. Part V. Metastable States.—J. W. Cook: (*a*) Polycyclic Aromatic Hydrocarbons. Part II. The Non-existence of 1:2:7:8-dibenzanthracene; (*b*) Part III. Derivatives of 1:2:5:6-dibenzanthracene; (*c*) Part IV. Condensed Derivatives of 1:2-benzanthracene.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology and Disease in Children Sections), at 8.—Dr. A. Castellani and Dr. G. W. Bray (Tropical Diseases), Dr. A. R. Neligan and Dr. H. S. Stannus (Disease in Children): Special Discussion on The Adaptation of European Women and Children to Tropical Climates.

FRIDAY, FEBRUARY 6.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—Sir St. Clair Thomson, F. C. Ormerod, and others: Discussion on Tuberculosis of the Ear.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—The Escape of Radiation from the Atmosphere. Chairman, Sir Gilbert Walker. Opener, Dr. G. C. Simpson, followed by Sir Napier Shaw, Dr. F. J. W. Whipple, and Prof. E. A. Milne.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.30.—Discussion on The Treatment of Frontal Sinusitis.

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5.—H. E. Beckett: The Radiation-Reflecting Powers of Rough Surfaces.—E. B. Moss: A Ballistic Recorder for Small Electric Currents.—F. J. Scrase: The Instrumental Phase Difference of Seismograph Records.—Demonstrations by G. L. Addenbrooke.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Manchester Section of Institution of the Rubber Industry) (at Engineers' Club, Manchester), at 7.—A. Fraser: Plant Used in the Manufacture of Synthetic Resins.—Dr. E. E. Walker and E. A. Bevan: The Effect of Certain Factors upon the Electrical Properties of Moulding Powder and Synthetic Resins.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—R. Davis, G. W. Bowdler, and W. G. Standring: The Measurement of High Voltages, with special reference to the Measurement of Peak Voltages.—Dr. L. E. Ryall: The Construction and Operation of a Simple Neon-Tube High-Tension Crest Voltmeter.—S. Whitehead and A. P. Castellain: Sphere-Gap Calibration.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.—Prof. W. Cramp: The Birth of Electrical Engineering (Faraday Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.—Members' Evening.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Informal Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—J. W. White: Aerial Wire Ropeways.

GEOLOGISTS' ASSOCIATION (in Botany Theatre, University College) (Annua General Meeting), at 7.30.—Prof. W. W. Watts: Bournes (Presidential Address).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—J. M. Keynes: The Internal Mechanics of the Trade Slump.

SATURDAY, FEBRUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. E. Cammaerts: Flemish Art (3): Rubens.

PUBLIC LECTURES.

SATURDAY, JANUARY 31.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Most Ancient Egypt.

MONDAY, FEBRUARY 2.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—J. C. Dawes: Public Cleansing: The Disposal of House and Trade Refuse.

TUESDAY, FEBRUARY 3.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.—Dr. P. Manson-Bahr: The Dawn of Tropical Medicine, being an Account of the Life and Work of Sir Patrick Manson.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.15.—Dr. W. Cramer: Filterable Tumours. (Succeeding Lecture on Feb. 10.)

WEDNESDAY, FEBRUARY 4.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. W. G. Savage: Food Poisoning.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. C. G. Darwin: The Foundations of Atomic Mechanics. (Succeeding Lectures on Feb. 5 and 6.)

KING'S COLLEGE, LONDON, at 5.30.—Prof. A. P. Newton: The Great Age of Discovery (3): Christopher Columbus and his Rivals.

BELFAST MUSEUM AND ART GALLERY, at 8.—E. Godfrey Brown: Wind Instruments.

THURSDAY, FEBRUARY 5.

KING'S COLLEGE, LONDON, at 3.—C. J. Gadd: Babylonian Religion.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Lady Chatterjee: Indian Labour Problems.

SATURDAY, FEBRUARY 7.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Prof. E. J. Salisbury: Some Rarer British Plants and their Distribution.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. F. A. Bather: The Cuttle-Fish and its Ancestors.