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Internationalism.

AT the outbreak of war in 1914 it was widely proclaimed that the Allies were fighting for the integrity of small nations. The war was fought and won to no small extent through appeal to the spirit of nationality. At the time of the Armistice small peoples sprang up here and there—as, for instance, in the Caucasus—clamouring for "the recognition of their national aspirations"; and the minor wars and disputes which have followed have arisen largely from the encouragement afforded to national ambitions by the attempt to fix boundaries or to allocate territory in those areas in which "ethnological affinities" are uncertain or the distribution of races is ill defined. Concomitantly with this quickened sense of nationality there grew up an idea which is necessarily, to some extent, in conflict with it. The desire to avert the recurrence of a catastrophe which rapidly assumed such proportions as to imperil the whole world turned the thoughts of men to the conception of an international union which should exercise such control over its members as to prevent precipitancy in action and in the ultimate resort be in a position to exert such force as to check an appeal to the arbitrament of war.

In a sense, the League of Nations represents a compromise between the two ideas. It aims at a comity of nations without undue interference with the sovereignty of the constituent States. Springing from a desire that the war should end war, to use the common phrase, the League has become an expression of a broader humanitarian ideal. The duties of the mandatory Powers are a "sacred trust," and this spirit animates the whole conception. The more influential supporters of the League, in this country at least, have approached the problem in no doctrinaire spirit. They recognise that progress must be slow, and that the keystone of success lies in the education of the peoples of the several States, upon whom the continued existence of the League must ultimately depend. The fact that members of the League have transgressed both the spirit and the letter of the Covenant does not necessarily condemn the League. Its position is not yet sufficiently assured to resist the stress of abnormal conditions.

To Mr. H. G. Wells, however, the League of Nations merely represents a number of vague movements for a world-law, world-disarmament, and the like among intellectuals; and in his work, "The Salvaging of Civilization," he proposes a different type of international unity. Holding that there cannot be any world-control without a merger of sovereignty, he plumps boldly for a world-State as the sole possible preventive of a series of wars which will come to an end only when knowledge has perished and we have sunk into a state of barbarism. To avoid this contingency, or rather certainty, Mr. Wells would arouse in mankind a recognition of the fact that the world has become one community, and as such should be regulated by a world-law. That such an attitude of mind is not an impossible ideal is indicated by the feeling which was aroused even in the remotest parts of the world by ex-President Wilson's first proposal for a League of Nations. To attain this acceptance of a world-law Mr. Wells relies upon education, particularly of the young, in accordance with a scheme which he has sketched in outline.

While in many respects this scheme of education may be suitable for a highly civilised Western people, it ignores differences of outlook and culture. "Schooling," says Mr. Wells, "is, in fact, . . . the expansion and development of the primitive savage mind, which is still all that we inherit, to adapt it to the needs of a larger community." This statement is at best but a half-truth. The highly civilised races of Europe and America have centuries of development behind them, and notwithstanding the "speeding up" which has become possible with the development of modern conditions, the less advanced races, even of parts of Europe, such as the Balkan Peninsula, are not likely to assimilate these ideals for some time to

come, while in the case of the really backward races the premature application of modern culture and educational methods would spell disaster. Wise supporters of the League of Nations do, at any rate, recognise that part of the "sacred trust" of a mandatory Power is to provide for the education and training of the races under its tutelage on lines suitable to their stage of development.

Criticism of any scheme of internationalism is easy, and the difficulties which have to be overcome are enormous. The verdict of history on the whole is adverse. But against this must be set the fact that the world has never been faced with conditions similar to those of to-day, or with the possibility of a crisis such as would be involved in another war. Is the realisation of the danger which threatens civilisation strong enough to overcome the jealousies, the bickerings, and the rivalries of States which are loosely joined in a confederation, or even united under a "world-law"? Present conditions are not favourable to the probability of success. Although we may speak of nations as if they were individuals, one of the strongest of social forces which operate in the case of the majority of the individual members of a community is absent. Nations, like corporations, have no conscience, and the force of the moral judgment and the opinion of others is not operative. Whereas in a civil society public opinion largely determines conduct and force is the ultimate sanction, in a confederacy of nations force is the only sanction. The balance of power alone will influence any member or group of members who may wish to defy the body as a whole.

It is no answer to criticism to say that in a world-State, or in the conditions of international amity towards which the supporters of the League of Nations would wish to progress, such occasions for misunderstanding would not arise. Apart from the differences in degree of culture, there is among nations as they exist to-day a variety in outlook which is the outcome of history, tradition, education, and environment. The effect of this variety in outlook was patent to those who, during the war, took part in operations with the composite armies which fought on some of the Allied fronts. The outward semblance of unity of action was attained only by a constant smoothing away of difficulties and misunderstandings arising out of national differences of temperament and outlook.

Differences of temperament are easy to note, but difficult to reduce to a scientific formula. Nor do we know how far they are fundamental and ineradicable. The comparative study of racial psychology on modern scientific lines is almost an unexplored field. National character, in so far as it is the product of tradition and education, may be susceptible of modification. Most nations to-day are the result of a fusion of races the members of which live more or less in amity, and this lends support to the view which holds to the ultimate possibility of a wider unity. Against this, however, must be set the view of some anthropologists who are inclined to attach increasing importance to race as a persisting element in character. In this country, for instance, notwithstanding common environment, common tradition, and common institutions, differences of occupation and of class feeling seem, in a general way, to go with differences of racial type. Should a more extended observation tend to confirm this view, it would suggest that any form of international confederation which aims at obliterating nationality and race would scarcely attain enduring success.

What Relativity in Science Implies.

The Reign of Relativity. By Viscount Haldane. Pp. xxiii+430. (London: John Murray, 1921.) 21*s*. net.

THERE is no need to begin this notice of Lord Haldane's book with a general reference to its scope and purpose. It is well known that, though the book deals with many problems of science, it is not scientific in the technical meaning of the term; it is philosophy, and, as philosophy, it includes every realm of human experience, and, therefore, science, in its synopsis. It will be more interesting to readers of NATURE to select certain particular problems of science which are also problems of philosophy.

The first part of the book deals mainly with the principle of relativity, the metaphysical basis of which is brought out with wonderful clearness. Lord Haldane achieves this, not so much by his direct exposition, which is thorough, as by his delicate and subtle critical comparison of two methods of applying the principle in mathematics and physics, that of our English mathematician, Prof. Whitehead, and that of Einstein himself. His exposition of both these writers is masterly. The chapter on Einstein is the clearest account of his theory and method that has yet appeared; possibly it appears clearer than it otherwise would from the fact that it follows the account of Whitehead, which is certainly more difficult. This does

not mean that Lord Haldane's exposition has made either writer easy to understand, but it has made it possible for anyone who cares to give the necessary attention and concentration to understand them both. Those who have argued *a priori* that any exposition of the principle of relativity by Lord Haldane must be defective and inconclusive because he is not a mathematician and therefore does not use or know how to use the language which enables mathematicians to express their equations have only shown that they mistake both the purpose and the nature of the value of mathematical methods. It is just because mathematics is restricted to abstract quantitative measurements that its system of symbols is so effective an instrument. Mathematicians are the first to acknowledge this. They know it is they who are handicapped when it comes to laying bare the metaphysical concept, handicapped by the very ease with which they are able, by the manipulation of symbols, to simplify the most complex and complicated quantitative equations.

When we say of anything that it is relative, the question immediately follows: Relative to what? Absolute relativity is either a contradiction in terms, as if one should say a round square, or it is an expression for that extreme form of scepticism which professes to be a universal negation. Now, undoubtedly the first impression we receive of the general principle of relativity does dispose us to identify it with the principle of universal doubt. On this aspect of the great problem Lord Haldane is clear and pronounced from the first sentence of his preface to the end of his book. To the question, Relative to what? he replies, Relative to knowledge; and knowledge is not itself an abstract relation, but a concrete universal. In this he is following Hegel, who first brought to light, in its modern form, the dialectical nature of thought. "Knowledge," says Lord Haldane, "is dynamic. It is an effort to transcend the apparently given. It is always pointing beyond itself" (p. 140). It is from this point of view that the comparison of Whitehead and Einstein is instructive. Both are concerned, and concerned only, to present to us a science of Nature. Both reject the absolute: there is neither a space-time system nor a material, dependent or independent of the observers attached to it, which can serve as a norm by which to regulate the relations of different space-time systems. Both reject the principle of action at a distance: it is inconceivable as fact and useless as a principle. An interesting, though perhaps a minor, point in which Lord Haldane notes a difference between them is that, while for Whitehead the element out of which our concept of Nature is constructed is the event, and the object is a derivative notion, for Einstein the event seems to depend on the notion of object. In this Lord Haldane thinks Whitehead is more faithful than Einstein to the fundamental principle of the four-dimensional space-time continuum. Apart from this, it is Einstein who has made the greater advance to the full philosophical concept. Whitehead halts. He cannot surrender the notion that Nature in its existence is self-contained, that it stands for a reality which in the last analysis is closed to mind. Is this concept of a reality closed to mind a necessity of mathematical and physical science? Some philosophers would agree with Whitehead in saying, Yes. They are the new realists, and are here criticised from that point of view. On the other hand, Einstein and Eddington seem very definitely to say, No, and to be able to prove it. Lord Haldane suggests that Whitehead's own persistent question, in regard to any and every specified point-event —the question, Whose space-time? or, What space-time system?—in its implications is the negation of his own conclusion. This brings out Lord Haldane's foundational fact. Knowledge is a universal within which all distinctions fall. It is not, and cannot be, conceived as an abstract relation between two self-subsistent and existentially exclusive realities, mind and Nature.

Let us now turn to another question, which is equally pressing as a scientific problem, and equally significant as a philosophical problem—the quantum theory. Lord Haldane makes only a brief reference to it (p. 106), but it is in a certain sense even more relevant to the concept which it is his main purpose to expound, the concept of degrees of reality, than the principle of relativity itself. For the quantum theory shows that in scientific explanation, however far we are able to pursue it, we are brought up finally against a fact which positively forces us to appeal to a character of knowledge in plain contradiction of our scientific principle of explanation.

On p. 114 there is a delightful account of the curious statue erected to Gauss and Weber in Göttingen. It is made the occasion of expounding the work of those mathematicians who, as Lord Haldane says, "nearly three-quarters of a century since, prepared the way for thinkers like Einstein and the interpreters of the doctrine of quantitative relativity." But it is also curious to remember that at the same time there was living in Leipzig another Weber, the philosopher and psychologist who has given his name to the famous law of

psycho-physics. Weber's law was the first definite discovery of the fact on which the quantum theory rests. He discovered that in sensible experience changes are not continuous—that is, do not correspond to the continuity of the changes of the physical stimulus, but occur in discrete quanta. He was a parallelist, and thought that changes in the physical environment were concomitant with changes in sensation. He never suspected, probably would have found it difficult to conceive, that changes in the physical world are discrete. Planck's quantum theory is the discovery that the same fact which Weber found to characterise the psychical world characterises the physical world; that energy is emitted, not continuously, but in discrete quanta; that, as Lord Haldane says, we may even have to regard space as a discrete manifold. This comparison is not a fanciful notion, nor purely imaginary. The whole problem was discussed by Henri Poincaré in "Science et Hypothèse" before Planck's discovery. Poincaré cites Weber's law as actual proof that the concept of mathematical continuity is only a postulate, declares that it is unverifiable, and suggests that it may be disproved or superseded. This is peculiarly significant in regard to Lord Haldane's concept of the concrete universal, the concept that reality is relative to the character of knowledge.

The practical gain in such a concept when we are dealing with biology and with the mental sciences is the topic of chap. vi. of the book. The most striking thing about the new scientific revolution is the havoc it is making of the once unchallengeable and universally accepted notions at the basis of the purely mathematical sciences. It is not, for example, Newton's law of inertia, primarily and mainly based on empirical observation, which is suspect. It is the much more fundamental law, the law of the equivalence of action and reaction, a purely rational principle, which seems now to be on its trial. The whole direction of scientific speculation in the nineteenth century was towards the conscious goal of mechanical interpretation. Scientific advance was practically identified with the confident anticipation that all the biological and mental sciences, even including such purely human interests as art and religion, would be mechanistically explained. The new spirit and the new direction in scientific speculation at least recognise that the abstract can never comprehend the concrete; and this recognition more than anything else is bringing about the *rapprochement* between science and philosophy, so long and so unreasonably estranged.

H. WILDON CARR.

A New Book on Cactaceæ.

The Cactaceae. By N. L. Britton and J. N. Rose. Vol. ii. (Publication No. 248.) Pp. vii+239+40 plates. (Washington: The Carnegie Institution of Washington, 1920.)

ALL cultivators of cacti and all botanists who are interested in this remarkable family of plants will feel satisfaction in knowing that at last we have in the English language a standard up-to-date monograph of the natural order Cactaceæ, which is universally recognised as being the most difficult of all flowering plants to study. With the exception of a few scattered but excellent papers upon them by Drs. Britton and Rose, Dr. Engelman, and Berger, this is the first work in the English language that gives a complete account of the order as we know it to-day. This fine book is so excellently planned and so fully illustrated as to be a long way in advance of the very unsatisfactory German works that have hitherto held the field, and will be found to be a real boon to all who study these plants.

From the introduction to the first volume (a notice of which was published in NATURE for September 11, 1919) we learn that Drs. Britton and Rose at first intended to monograph only the Cactaceæ of North America, but, happily, upon a proposal made by Dr. D. T. MacDugal, the plan was extended to include the whole of the family. Extensive preparations were made and a large army of workers was enlisted to collect and photograph the species in their native habitats, the result being that the authors have had at their disposal a larger amount of living and other material, accompanied by field-notes, drawings, etc., than any other students of this group have ever been able to obtain. As the types (when existing) of the older as well as of modern species have also been consulted, the authors have been able to detect and correct many errors of determination that are found in existing monographs.

Vol. ii. is of quarto size, well printed and profusely illustrated with photographs, drawings, and coloured plates, which, it is a pleasure to note, are nearly all originals. There are good keys to the tribes, subtribes, genera, and species, so that, taking into account the aid afforded by the figures, there should be no great difficulty in naming cultivated specimens when in flower.

Each tribe, subtribe, and genus is separately characterised, and the type of each genus indicated. Under each species the synonyms, with the date of their publication, a description, men-

tion of the type locality, the general distribution, references to illustrations, and general notes are given. All the descriptions are in English, and written in a correct but very simplified style, so that anyone can easily understand them. Latin descriptions find no place in this admirable work, which is designed to be useful to the multitude rather than to the botanist alone.

In the first volume the Cactaceæ are divided into the three tribes Pereskieæ, Opuntieæ, and Cereæ. The tribe Pereskieæ contains only the single genus Pereskia, of which nineteen species are described. The Opuntieæ are divided into seven genera, of which Opuntia is the largest, containing 240 species; the other genera have only one or a few species in each. These two tribes fill the first volume, and the Cereæ, which comprise the bulk of the order, are being dealt with in the remaining volumes. The first portion of the Cereæ is accounted for in the present volume, where the plants that are commonly known by the generic title of Cereus are described and illustrated.

It has long been recognised that different species of Cereus produced different types of flower, and since, in other natural orders, differences in floral structure are recognised as being of generic value, some botanists have founded genera upon some of the different floral types found among Cerei. These genera have not hitherto found much favour among botanists or horticulturists, because the plants, when not in flower, often present a great similarity to one another. The authors of "The Cactaceæ," however, have accepted the view that a difference in floral characters should constitute a generic distinction; they have had this view constantly in mind, and carried it to a logical conclusion, so that they have divided the old genus Cereus into no fewer than forty-seven genera, containing 275 species. Twenty of the genera are proposed for the first time in this volume. Whilst there can be little doubt that the plants which have been placed in the genera Heliocereus, Aporocactus, Cleistocactus, etc., should be separated from Cereus, it may be questioned whether those placed in the genera Dendrocereus, Harrisia, Acanthocereus, etc., should be held to constitute more than sectional groups under Cereus. This, however, is a matter of opinion, and time alone will show if the numerous genera maintained in this work will be generally accepted. Whether they are accepted or not, their adoption in "The Cactaceæ" in no way invalidates the usefulness of that splendid work. The reviewer has had considerable experience in the use of existing monographs, and has found "The Cactaceæ" very far in advance of them; it can be recommended with confidence to students.

The only noticeable fault in the work is the rather serious one that exceptions are always neglected in the keys. This, however, is a fault appertaining to most botanical works, and invariably leads the novice astray. For example, should a novice desire to find out, by means of the key given on p. 1 of vol. ii., the subtribe in which the authors place the globose, spineless plant cultivated under the name *Echinocactus* (and *Anhalonium*) *Williamsii*, no place for it will be found. The only spineless plants mentioned in that key belong to the subtribe Epiphyllanæ, which have flat, many-jointed stems. This fault is so easily remedied by including exceptions and variable characters again and again under the headings of different parts of the key that perhaps the authors will endeavour to correct this defect in the continuation of their work. They are to be congratulated heartily upon the manner in which they have so far carried out their very difficult task of evolving order out of the very confused synonymy found in other works upon this group of plants. N. E. BROWN.

A Study in Geo-chemistry.

The Enrichment of Ore Deposits. By W. H. Emmons. (Bulletin 625. United States Geological Survey: Department of the Interior.) Pp. 530. (Washington: Government Printing Office, 1917.)

UNDER the above modest guise the United States Geological Survey has published a volume of the greatest value to the student of ore deposition, which may fairly claim to rank as one of the most interesting of recent contributions to this very difficult branch of economic geology. The author points out that two phases in the formation of economically important ore deposits require independent investigation, namely, the formation of the primary ore deposits and the subsequent modifications which the more superficial portions in many cases undergo.

The present work is devoted exclusively to a comprehensive investigation of the second of these phases, the genesis of the primary ore deposits being considered indirectly only. The author reviews successively the conditions that make for enrichment, such as amount of rainfall, surface contours, permeability of the rocks, the nature of the underground circulation of water, and in particular the oxidation of sulphide deposits. He lays very great stress upon the last-named, and ascribes the solution of the various minerals

affected almost exclusively to the action of sulphuric acid produced by the oxidation of sulphuretted ores. This thesis is developed in detail in a series of chapters devoted to the chemistry of enrichment, in which the conditions of solution and precipitation, so far as the more important metals are concerned, are worked out in full detail. This section is an admirable contribution to geochemistry, and will well repay careful study. It is perhaps possible that the author pins his faith somewhat too exclusively to the action of sulphuric acid and somewhat underrates the possible effect of other solvents. In part this may be due to the fact that he has confined his studies to the North American continent and to the chemical changes that characterise the temperate zones; thus it is significant that the word "lateritisation" is not even once mentioned, and that this phenomenon, which has played an important part in the secondary modification of certain ore deposits in tropical and sub-tropical regions, is here quite disregarded.

Each of the more important metals is then considered in detail; the principal ores of each, their solubilities and mode of occurrence, are discussed, and the influence of enrichment is illustrated by descriptions of a number of representative deposits of each metal; finally, the non-metallic or gangue minerals are treated in the same way. It will be obvious, even from this brief sketch, that the author has done his work with great thoroughness, and it is easy to foresee that this volume will remain for a long time the standard text-book (for such it really is) on the subject.

It need scarcely be said that there are a number of highly contentious points upon which it would be hopeless to expect any general agreement amongst geologists. Perhaps the phrase to which most will take exception is a statement on p. 15: "Many of the rich deposits of gold are primary." It is not too much to say that the exact opposite of this will be more in accord with the experience of most students of the subject, and that the statement, "*None* of the rich deposits of gold are primary," would meet with far more general acceptance. A gold deposit that has not undergone secondary enrichment is quite exceptional, and many examples where such enrichment has assumed a scale of great importance are familiar to all economic geologists, *e.g.* the Witwatersrand and in Western Australia.

Far more difficult and more debatable is the question whether the author has drawn rightly the line of demarcation between the phenomena that ought and those that ought not to be included in the list of secondary enrichment. There are numerous cases where material too poor to be economically workable (which the author, following Ransome, designates as "protore") has been enriched until it is worth working and thus becomes a true ore. Few will object to the inclusion amongst cases of secondary enrichment of those protores that have been converted into ores by the addition of valuable mineral matter, as, for example, the monzonite copper ores of Bingham, Utah, Ely, Nevada, etc.; it is, however, far more doubtful whether the term can fairly be applied to deposits which have been enriched by the leaching out or dissolving away of gangue material. Thus the important deposits of brown hæmatite of Santander, Spain, have been derived from ferriferous dolomite, containing only some 3 per cent. of iron, by the solution of the carbonates of lime and magnesia. It would probably be more correct to designate these as primary deposits than to look upon them as enriched protore. Many writers classify them as "residual deposits." Obviously, if Mr. Emmons carried his method to its logical conclusion, he would include also clastic deposits, seeing that these are the result of the concentration or mechanical enrichment of mineral deposits that will in many cases have been protores.

It is interesting to note that the author has confined his attention to secondary enrichment, and makes no specific reference to secondary impoverishment as such; necessarily he discusses the phenomenon as antecedent to enrichment, but there are certain cases in which the subject deserves attention for its own sake.

Perhaps reference to such controversial points as the above will serve better than anything else to bring out the difficulties of the subject that Mr. Emmons has so ably dealt with in this volume, and both he and the United States Geological Survey are to be congratulated upon this important contribution to the study of the phenomena of ore deposition. H. LOUIS.

Our Bookshelf.

The Elements of Theoretical and Descriptive Astronomy. By C. J. White. Eighth edition, revised by P. P. Blackburn. Pp. xi + 309 + ix plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 17*s.* 6*d.* net.

THIS book is something of a curiosity, if only because it has reached an eighth edition. The first edition was published in 1869 for the benefit of the students of the U.S. Naval Academy. It was an elementary primer giving the simple geometrical facts of astronomy. So far as can be

judged from its latest successor, the work was done neither better nor worse than usual. That the original author's effort has proved more enduring than Bismarck's may be accounted for by its privileged sale in a particular institution.

Had the book been confined to the permanent geometrical elements, and, after the introduction of more modern numerical data and the excision of all archaic matter, offered for sale at one-third of the price, it might have been worthy of attention. The new editor claims to "have endeavored to bring it up to date." The following quotation, giving the latest information on radial velocities, will afford a measure of the reviser's success:—"Mr. Huggins, using a spectroscope of large dispersive power, and carefully comparing the spectrum of Sirius with that of hydrogen, found that the line F in the spectrum of Sirius *was displaced,* by about 1/250th of an inch."

This from America in 1920! To a very fair account of the disappearance of Saturn's rings is appended the remark: "The last disappearance took place in 1907; the next will take place in 1922." Perhaps, on the whole, it is well that the price of the volume should be prohibitive.

Radioaktivität und die neueste Entwicklung der Lehre von den chemischen Elementen. By Prof. K. Fajans. Dritte Auflage. (Sammlung Vieweg: Tagesfragen aus den Gebieten der Naturwissenschaften und der Technik. Heft 45.) Pp. viii+124. (Braunschweig: Friedr. Vieweg und Sohn, 1921.) 6.50 marks.

IN this book Prof. Fajans gives a simple and clear account of the advances in chemical theory which have resulted from the study of radio-activity. A brief description of the radio-active bodies and their transformations is followed by an account of their chemical properties, leading to their classification in the periodic system, and the recognition of the existence of elements which, though differing in atomic weight, are identical in chemical behaviour. The author shows how Moseley arrived at a number which is a more fundamental characteristic of an element than its atomic weight, and, developing the Rutherford theory of atomic structure, identifies the Moseley number with the value of the charge on the nucleus of the atom. He is then able to give an explanation of the nature of isotopes and of the periodic classification. A description of Aston's mass spectrograph for the investigation of the isotopes of ordinary elements is given in an appendix.

The book is, on the whole, well written, and the matter has been carefully limited to the essential facts and their explanation on the nuclear theory. Full references are given to the original papers.

Relativitätstheorie und Erkenntnis Apriori. By H. Reichenbach. Pp. v+110. (Berlin: Julius Springer, 1920.) 14 marks.

THE author states that the theory of relativity contradicts the critical philosophy of Kant, in reference both to the concept of time and to the relation of physical fact to Euclidean geometry. There are only two possibilities, he says: either the relativity theory is false, or the philosophy of Kant needs amending at the points at which it is in contradiction with Einstein. The first possibility seems ruled out after the brilliant success of the relativity theory, both in its double confirmation in experience and in its theoretical contribution to physical thought. Accordingly, the author sets out to analyse the exact point at which it is at variance with critical philosophy, and finally claims to carry through such a modification of the concept "a priori" that the conflict is resolved. His conclusion is: "We can no longer maintain that the idea of 'a priori' is independent of all experience, but we must hold that 'a priori' principles alone constitute the world of experience." This book will repay reading by those who are specially interested in the philosophical aspects of the relativity theory.

Les Etoiles Simples. By Dr. F. Henroteau. (Encyclopédie Scientifique: Bibliothèque d'Astronomie et de Physique Céleste.) Pp. xi+244. (Paris: Octave Doin, 1921.) 10 francs.

As a guide and index to the great advance in knowledge of the stellar system that has taken place in the last thirty years, this volume will be found extremely useful. Commencing with constellations and star-catalogues, the author proceeds to spectral types and schemes of evolution, notably the giant and dwarf hypothesis that holds the field at present.

The chapter on photometry contains a full description of the photo-electric cell, with instructions for its manufacture. Colour-indices are defined, and systems of colorimetry, both visual and photographic, are explained.

The great increase in the accuracy of stellar parallax determination due to the photographic method, with various refinements suggested by experience, is described in sufficient detail; indirect methods—the spectroscopic of Adams, the moving-cluster method of Boss and others, and the hypothetical-mass method applicable to binaries—are then explained. The remaining chapters deal with proper motions, radial velocities, and stellar distribution.

The book is wonderfully complete considering its small size. Each chapter is followed by a useful bibliography, which will enable students interested in special branches of the subject to carry their researches further.

A. C. D. CROMMELIN.

Psyche's Lamp: A Revaluation of Psychological Principles as Foundation of All Thought. By Robert Briffault. Pp. 240. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1921.) 12*s.* 6*d.* net.

THERE is no doubt excellent matter in this book, but the author's method and dogmatic manner are likely to be very irritating to the inquiring student. As the title indicates, the appeal is rhetorical rather than scientific or logical.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Pathogenic Organisms in the Pollen of Flowers and Disease in Bees.

THE observations of Dr. Rennie and his co-workers have established an association between Acarine infection and Isle of Wight disease in bees. There still remains, however, the question of the part played by bacillary infection in this and other diseases which affect bees. In this communication I desire to direct attention to two aspects only of this complex problem.

(1) In the course of an inquiry during the last three years into an epidemic having many of the features of the so-called Isle of Wight disease, which has caused the loss of a number of my own hives and other stocks in the Midland area, an aerobic short spore-bearing and gram-negative bacillus resembling *B. pestif. apis,* as described by Dr. Malden in the *Journal of Agriculture,* vol. xv., No. 11, February, 1909, was obtained in large numbers from the fæces of affected bees from all the diseased stocks, and was readily grown, sometimes in pure culture, in broth, or on agar or serum agar.

In 1919 I also found that the same organism could be cultured from the sealed cells of the honey-combs from infected hives. A number of cells were opened by removing the cap with a sterilised instrument, and platinum loops of honey taken from these sealed cells were added to broth or smeared on an agar or serum agar slope and incubated at 37° C. for 36 hours. Numerous colonies of the spore-bearing, gram-negative bacillus were obtained from many of the cells. The organism seems to exist in the honey in the spore form only, no bacillary forms being detected before culture, and no cloudiness or discoloration of the honey being produced. In two cases it grew readily when obtained from infected honey cells which had remained sealed for more than twelve months.

The colonies grown from honey resemble those obtained by culture from the fæces of affected bees. They are smooth and white when small, but soon show a corrugated brain-like surface, and may become slightly yellow or pinkish at a later stage.

The fact that, as Dr. Malden showed, the same organism can be obtained from the intestinal contents of apparently healthy bees is important, and I have also grown it from sealed honey cells from apparently healthy hives. Under these conditions the colonies are generally much fewer in number.

This fact is of interest as bearing on the question of bacillary infection in bees, and also on the problem of the inhibitory effect of honey as a culture medium on the growth of organisms, and their persistence in the spore form.

The same organism has also been cultured on the same media from the compressed pollen removed from the thighs of the honey-bee and from several species of humble bee, and also in one case from honey taken from the nest of *Bombus lapidarius.*

(2) The second point has reference to the life-history of the organism outside the body of the bee and the honey cell.

In 1919 I commenced to investigate pollen from various kinds of flowers frequented and avoided by bees, and in the case of frequented flowers both before and after the opening of the flower.

It is impossible here to describe in detail the large number of experiments carried out on different kinds of flowers. Speaking generally, the spore-bearing, gram-negative bacillus described above, together with other bacillary, and in some cases coccal, forms, were frequently grown from the pollen of flowers frequented by the honey-bee, various species of wild bee, and some other insects, while colonies were absent or were sparsely grown from unopened flowers and from flowers such as the edible and sweet pea and others which are not visited by bees to the same extent. Pollen from the pine and other wind-fertilised trees gave very few colonies. From the pollen at the bottom of the spathe of an arum (*Arum maculatum*), in which numerous flies were imprisoned, a small coccus grew freely, in addition to the bacillus form.

There can be no doubt that the anthers and pistils of flowers visited by bees and other insects provide the chief sites of implantation and dispersal grounds for organisms which pass a portion of their life-history in the alimentary canal of bees and in stored honey.

Further investigation is necessary to decide what effect, if any, exposure to atmospheric conditions and to pollen and to plant secretions exercise on the growth of these organisms.

It seems probable that many kinds of flowers, especially open flowers, frequented by bees and other insects harbour enormous numbers of organisms, some of which at any rate are pathogenic to bees under certain conditions, and that a further study of the bacterial flora of flowers would shed light on the diseases of bees and other insects, and possibly on some diseases which affect animals and even man.

C. J. BOND.

The Nature of the Electrical Conductivity of Glass.

IN the course of some work on the electrical conductivity of some dielectrics, which was recently described before the Royal Dublin Society and forms the subject of a forthcoming paper in the *Philosophical Magazine,* the question arose as to the possible electrolytic nature of the current in the case of materials such as glass. The following simple experiment, which is, I think, new, seems worthy of record as affording evidence against this view.

A thin glass bulb about 1·8 cm. in diameter was blown at the end of a piece of tubing, the whole being then filled with a dilute neutral solution of calcium chloride containing a little phenolphthalein. The bulb was immersed in a small beaker of tap-water placed on an insulating stand. Electrodes were placed in the upper part of the tube and in the beaker, one being connected to a source maintained at about −8000 volts with the aid of rectifying valves, and the other to earth through a sensitive galvanometer. Thus a known current could be passed through the glass wall of the bulb in either direction. Currents leaking along the exterior surface of the glass tube were prevented from passing through the galvanometer by an earthed strip of tinfoil gummed round the tube as a guard ring.

The bulb and tube were filled the day before the test was made, and in the interval a slight pink colour had developed, indicating the solution of a little alkali from the glass. The central electrode was first used as anode, so that the glass of the bulb acted as cathode to the solution. If the bulb conducts like a metal, we should expect a red colour to develop on its surface owing to electrolysis of the solution. If, however, the current through the glass

is purely electrolytic, we should expect the alkalinity to be neutralised by the acid radicle ions driven into solution from the glass. The initial current was 8·5 micro-amperes, rising at the end of fifteen minutes to 13 micro-amperes. By this time the solution in contact with the thinner parts of the bulb was a deep pink. The current was then reversed, the initial value being now 16 micro-amperes. After six minutes the solution in contact with the glass was very nearly, if not quite, colourless. If the current in the glass were electrolytic, there can be little doubt that sodium ions would have been driven into solution, thus maintaining the pink colour. The large changes in the conduction current with time and reversal of direction are probably attributable to alteration and polarisation effects in the glass. The thin parts of the bulb carrying most of the current probably represented an area of only 2 or 3 sq. cm., so that the current density was comparatively large, and the potential gradient probably between 1 and 2 megavolts per cm. The evidence of the colour changes, which were repeated several times, is strongly in favour of the view that under such gradients and at air temperature the conduction current is largely, if not entirely, of a non-electrolytic nature.

HORACE H. POOLE.

Royal Dublin Society, June 20.

The Displacement of Spectral Lines by a Gravitational Field.

ACCORDING to the theory of relativity the paths of moving particles or light pulses are geodesics in a four-dimensional Riemann space defined by the metric

$$ds^2 = g_{\mu\nu} dx_\mu dx_\nu .$$

The resulting abstract kinematics is brought into relationship with the facts of experience by the identification of the Gaussian co-ordinates x with the observer's space-time co-ordinates in a Newtonian-Euclidean system. Since the spaces are Euclidean, and since the velocity of light is the same for each observer, it follows that the systems of two different observers are similar, but not necessarily on the same scale.

Consider the field of a single gravitating centre. The metric is given by

$$ds^2 = -\gamma^{-1} dr^2 - r^2 [d\theta^2 + \sin^2\theta d\phi^2] + \gamma dt^2 .$$

Taking the unit of ds as the fundamental unit, and measuring radial and transverse lengths and times at two different points of the Riemann space, we see that throughout the space the local scale is constant for transverse lengths, varies as $\gamma^{\frac{1}{2}}$ for radial lengths and as $\gamma^{-\frac{1}{2}}$ for times. Since the separated space-time systems of different observers are to be similar, it is clear that their scales cannot be obtained by carrying over the scales of the Riemann space at the observers' world-points. Assume that the observer's time-scale bears to the time-scale at his world-point in the Riemann space the ratio $1 : f(r)$. The scales of the Euclidean systems of two different observers then vary inversely as $\gamma^{\frac{1}{2}} f(r)$.

This variation of scale has no effect on the mercury problem or on the deflection of a beam, but it is of fundamental importance in the third crucial phenomenon, the displacement of the spectral lines.

The usual argument shows that

$$\gamma_S^{\frac{1}{2}} dt_S = \gamma_E^{\frac{1}{2}} dt_E ,$$

where dt_S, dt_E are measured in the units of the Riemann space. If we transfer to the Euclidean spaces of local observers, the equation becomes

$$\gamma_S^{\frac{1}{2}} f_S dt_S = \gamma_E^{\frac{1}{2}} f_E dt_E .$$

Eddington's argument on p. 129 of "Space, Time, and Gravitation" shows that the time-period *as measured in the units of any one observer* is transmitted by the radiation. Hence dt_S can be compared with dt_E by observation. The measurement of the displacement of the spectral lines determines the function f.

No displacement is to be expected if $f = \gamma^{-\frac{1}{2}}$. In this case, if dt is a time-interval in the Riemann space, $\gamma^{\frac{1}{2}} dt$ is the corresponding observer's interval, and $\gamma^{\frac{1}{2}} dt$ or ds is propagated by the radiation as suggested in my letter of March 10. H. J. PRIESTLEY.

University of Queensland, Brisbane, May 11.

The Measurement of Single and Successive Short Time-Intervals.

THE following modification of the well-known method of determining small time-intervals by the discharge of an electrical condenser does not appear to be generally used, judging from some inquiries I have had. Though the modification possibly has been published somewhere—the man who can claim originality in these days is fortunate—this letter may be a help to some other workers.

The well-known method to which I refer consists in so arranging the circuit with a condenser and ballistic galvanometer that the former is charged or discharged during the interval. The potential of the condenser is measured before and as soon after the interval as possible by the galvanometer, and the duration of the interval is proportional to the difference of the logarithms of these quantities.

The modification I first used during 1915 in connection with the measurement of the velocity of detonation of explosives consists in connecting one side of the condenser to the string of a Laby string electrometer. The displacement of the string is proportional to the potential of the condenser, so that during an experiment the string falls from one position to another, and the logarithm of the ratio of these displacements from the zero position is proportional to the time. The accuracy of the method can be increased by using a moving plate and photographing the string's position; it can be increased up to the limit imposed by the accuracy within which the condenser capacity and discharging resistance are known by measuring the displacements on the plate with a microscope.

The advantages of this method as compared with the ballistic method are: (*a*) the procedure and circuit are much simplified, (*b*) small leakage is of no importance or embarrassment, (*c*) the whole process being self-recording, the result is available for measurement at any time, and, further, the inertia of the string or its natural period of vibration does not affect the result.

Its disadvantage in common with the ballistic method is the disturbing influence of the inductance of the circuit upon the rate of flow. It may be possible in some applications to calculate this, or to allow for it by calibration.

If a bicycle ball suspended by a long thin wire be allowed to impinge against, and rebound from, the vertical face of an anvil until it comes to rest, the resulting record with its gradually diminishing steps, corresponding to the several durations of contact, affords a pretty example of the application of this method to the measurement of rapidly successive short time-intervals. ALAN POLLARD.

The Imperial College of Science and Technology, South Kensington, S.W.7, June 14.

Sex-change in the Native Oyster (O. edulis).

IT is well known that sex-change in the native oyster (*O. edulis*) occurs at some period of its life. This mollusc apparently always begins life as a male, and may change into a female at the age of one or two years. Very little is, however, known about the change of sex afterwards. In following up the indications given from a general study of breeding (see J. H. Orton, "Sea-temperature, Breeding, and Distribution in Marine Animals," Journal of the Marine Biological Association, vol. xii., July, 1920, pp. 339–66), it seemed certain that an oyster ought to continue breeding in the same season even after becoming white-sick, *i.e.* after extrusion of ova into the mantle cavity. Thus if a breeding oyster were marked and examined afterwards, it should be possible to find out something about a possible *annual* change of sex. Accordingly on July 30, 1920, two white-sick oysters were isolated in a tank at Plymouth, and one of them was cut open and examined on August 26, 1920. At the latter date the one examined [1] was found to have its gonad full of wholly ripe sperm-morulæ, which disintegrated into separate active and apparently ripe sperm as soon as they were placed in sea-water. Thus a female-functioning oyster had changed into a male-functioning oyster within less than a month. An indication of this change had already been given on July 29, when the gonad of a white-sick oyster—examined at the moment when it contained embryos in the mantle cavity—showed developing sperm-morulæ and some actively tailed sperm-morulæ.

The occurrence of developing sperm-morulæ in microscopic sections of "white-sick" or "black-sick" oysters has, indeed, been already observed by P. P. C. Hoek in a practically unknown and very valuable piece of work on the oyster ("Rapport over de Oorzaken van den achteruitgang in hoedanigheid van de Zeeuwsche oester," p. 175. Uitgegenen Door Het Ministerie van Waterstaat, Handel en Nijverheid, 's Gravenhage).

This year the observations on "white-sick" oysters have been repeated, and all the oysters examined have shown either some sperm-morulæ with active tails which disintegrate into separate sperm in sea-water, or developing sperm-morulæ. It is seen, therefore, that even at the time an oyster is carrying its own embryos it is changing into a male-functioning form, which will apparently function as a male within a very short time.

An endeavour is being made this summer to carry out on a larger scale the isolation in the sea of oysters of known sex at a particular moment with the view of determining the sex at a later date. It is hoped in this way to investigate also the possible change of an oyster which is male-functioning at the beginning of the breeding season into a female-functioning form at a later period in the same season.

J. H. ORTON.

Marine Biological Laboratory, Plymouth,
June 18.

[1] The other specimen kept for examination this year died at the end of May.

A New Acoustical Phenomenon.

I HAVE read Dr. Erskine Murray's letter in NATURE of June 16, p. 490, with very great interest, but I think there are two difficulties in the explanation that he has there advanced:—

(1) It is hard to see how or why an aeroplane should emit a series of pairs of double sound impulses; and (2) even if they were emitted, the ear would find it difficult to observe any change in pitch as the distance from the ground was varied; for it is found by experiment that pairs of sound impulses cause a sensation of pitch which is sufficient for the identification of a note as being high or low, but is too indefinite for the appreciation of small differences of wave-length.

I should like to suggest instead that the phenomena observed by Dr. Erskine Murray are due to the presence of a series of stationary sound-waves of various wave-lengths lying parallel to the ground, analogous to the stationary waves of light employed in Lippmann's colour photography. These stationary sound-waves would be produced by reflection at the surface of the ground, the nodes occurring at a distance from the ground inversely proportional to the pitch.

This suggestion fits in with the observed facts (1) that the note heard varies inversely as the height of the observer's ear from the ground; (2) that the effects are best observed when the aeroplane is nearly overhead; (3) that the note heard at a given height varies with the angle of elevation of the aeroplane; and (4) that the surface of the ground must be smooth.

As to the source of these series of notes of different wave-length, it would seem that the turbulent air behind wings, framework, and propeller must be responsible, and the fact that wind passing through a tree can create similar phenomena would seem to confirm this view. With regard to the physiological aspect, it has long been known that double sound impulses do give a crude sensation of pitch, and both theories of hearing have offered suggestions to account for it.

H. HARTRIDGE.

King's College, Cambridge.

DURING the war and since I have often noticed how the apparent pitch of aeroplane noise changes suddenly as an aeroplane travels over the street in which one is standing. I had put this down to reflection, but not on the lines followed by Dr. Erskine Murray in his letter in NATURE of June 16, p. 490. As the problem is of practical importance to such bodies as the War Office and Admiralty, in, for example, recognising aircraft at night or in fogs, it seems worthy of discussion.

If the sound from an aeroplane were a pure tone no amount of reflection could give the sensation of the octave, for two harmonics of equal period combine into an harmonic of the same period. If the sound is impure and has overtones, combination of direct and reflected waves could have the effect only of altering the quality by suppressing some components and reinforcing others. I suggest that Dr. Murray heard the upper tones because of interference between the direct and reflected waves of the lower. That the noise from an aeroplane, though often of musical quality, is not a pure tone is clear. Exhaust noise, in spite of the approximately harmonic motion of the pistons and valves, is not a pure tone. Complications arise from the explosive emission of the gases. Moreover, in addition to the dominant exhaust noise, there are secondary noises from propeller, fuselage, etc.

H. S. ROWELL,
Director of Research, The Research Association of British Motor Manufacturers.

15 Bolton Road, Chiswick, W.4, June 20.

THE acoustical phenomenon described by Dr. Erskine Murray in NATURE of June 16, p. 490, is fully discussed by F. A. Schulze in a paper which appeared in the *Annalen der Physik* in 1916 (vol. xlix., p. 683). References to earlier work on the subject are

given in this paper, and it appears that the effect was observed and described by Savart as early as 1839. W. B. MORTON.

Queen's University, Belfast, June 21.

An Algebraical Identity.

THE values of the coefficients of Y and Z are given in Prof. Mathew's "Theory of Numbers," p. 218, for the primes 3 to 31. I have calculated the values for the primes 37 to 61 by the method given by Prof. Mathews on p. 216 of his book. My result in the case of $p=37$ agrees with that given in NATURE of June 9, p. 456. The other results are as follows, the coefficients being given to the middle term inclusive when that exists, and in the other case to the first of the pair of terms at the middle :—

$p=41$; Y, 2, 1, 11, 16, 14, 29, 30, 22, 36, 34, 20 ;
Z, 1, 1, 2, 4, 3, 4, 6, 4, 4, 6.

$p=43$; Y, 2, 1, −10, 6, 16, −20, −4, 27, −15, −7, 17 ;
Z, 1, 0, −2, 2, 2, −4, 1, 3, −3, 1.

$p=47$; Y, 2, 1, −11, −17, −9. 6, 29, 37, 20,
Z, 1, 1, −1, −3, −4, −3, 1, 4,
−2, −16, −11 ;
4, 2, −1.

$p=53$; Y, 2, 1, 14, −6, 8, −14, −4, 19, −12,
Z, 1, 0, 2, −2, 0, 0, −1, 4,
24, −9, −11, 27, −25 ;
−2, 1, 1, −3, 5.

$p=59$; Y, 2, 1, −14, 8, 7, −35, 22, 12, −33,
Z, 1, 0, −2, 3, −1, −4, 4, −1,
18, 23, −29, 14, 18, −29 ;
−4, 3, 1, −4, 4, −1.

$p=61$; Y, 2, 1, 16, −7, 32, −20, 63, −33, 72,
Z, 1, 0, 3, −2, 6, −3, 9, −6,
−54, 89, −62, 88, −89, 95, −81 ;
10, −7, 12, −10, 11, −11, 13.

The first case where Legendre's rule fails is $p=41$. H. C. POCKLINGTON.

5 Well Close Place, Leeds, June 12.

THE result for $p=37$ given in NATURE of June 9, p. 456, was found to conform to Legendre's rule; since this rule fails in the case of $p=61$, it is interesting, as noted by Prof. Mathews, to know if this is the lowest prime for which the rule fails.

I have worked out the case for $p=41$, and find the expression of the 20th degree in x for Y to have the following coefficients :—

$$2+1+11+16+14-12-11-19-5-7+20-7-5$$
$$-19-11-12+14+16+11+1+2.$$

And since X is of the 40th degree in x, each coefficient being +1, I find $(Y^2-4X)/41$ of the 38th degree in x with the following coefficients :—

$$1+2+5+8+12+2-12-28-20-14+15+18+19$$
$$-24-23-36+9+28+72+28+9-36-23-24+19$$
$$+18+15-14-20-28-12+2+12+8+5+2+1.$$

Putting $x=1$, the sum of these coefficients equals −4, hence $(Y^2-4X)/41$ cannot be a square, so that the rule fails, 41 being the lowest prime for failure.

J. CULLEN, S.J.

Stonyhurst College, June 17.

Artefacts and their Geological Age.

IN NATURE of June 9, p. 458, Mr. J. Reid Moir describes some flint implements found *embedded in the surface* of the ferruginous "pan" at the base of the cliff near Sheringham, and he bases certain conclusions upon this find. From his description of the occurrence of the flints it seems clear that in this case they may not be of the same age as the "pan," in the upper surface of which they were found embedded. A little while ago, on the beach at Flamborough, a small deposit of ferruginous conglomerate was found, in which there was embedded a typical Neolithic "scraper," as well as several pebbles, and the conglomerate proved to be formed upon a horse-shoe. But no one here assumed that the horse-shoe was Neolithic in date, or that the scraper was made during the past fifty years. More recently, on an excursion to South Ferriby, on the Humber shore, firmly embedded in a ferruginous "pan," immediately at the base of a cliff of Boulder Clay, was a trouser button. It had to be extracted with a hammer. But no Yorkshire geologist is likely to write to NATURE to try to prove that pre-Glacial man in the Humber district wore trousers. T. SHEPPARD.

The Municipal Museum, Hull, June 27.

Iron Currency-Bars.

IN NATURE of May 19, p. 372, reference is made to iron currency-bars and "early British water-clocks." The discovery of the true nature of the currency-bars is not, as is implied, a recent one, but was made in 1905 by Mr. Reginald Smith (see his paper, Proceedings of the Society of Antiquaries, vol. xx., pp. 179–94). Similarly, the "early British water-clocks" were first authoritatively dealt with by Mr. Smith in 1907 (see his paper, *ibid.*, vol. xxi., pp. 319 *sqq.*). I understand that Dr. Newton Friend made this quite clear in the paper referred to, and gave his references.

It may be of interest to add that a hoard of currency-bars has recently been found near Winchester, and that the site is now being excavated by a band of volunteers under the direction of Mr. R. W. Hooley, hon. curator of the Winchester Museum. The currency-bars were exhibited at a recent meeting of the Society of Antiquaries.

June 20. O. G. S. CRAWFORD.

History of the Churn.

IN No. 23 of the *Agricultural Ledger*, issued by the Government of India, and published in July, 1895, there is a *précis* of official correspondence on the Indian churn which begins: "In a letter addressed to the Government of India, Herr B. Martiny, of Berlin, asked for information regarding the Indian Churn. He there announces that he is engaged writing a history of the Churn, and is desirous of obtaining certain particulars regarding 'the old Indian Churn,' of which he furnished a drawing." Has this "History of the Churn" been published in book form, or in the journal or transactions of any society? May I ask readers of NATURE if they can afford any information on the subject? If Herr Martiny addressed similar communications about native or ancient forms of churns to European, American, and Far Eastern Governments, and had his inquiry as fully replied to as it was by the Government of India, there must be pigeon-holed somewhere a mass of interesting data. R. HEDGER WALLACE.

June 17.

Cosmogony and Stellar Evolution.[1]

By J. H. JEANS, SEC.R.S.

II.

The Evolution of Stellar and Planetary Systems.

IN the last lecture we followed up, so far as is permitted by modern theoretical and observational research, the train of ideas on which Laplace had based his nebular hypothesis. Theoretically we found that a shrinking mass of rotating gas ought in time to assume a lenticular shape, after which further shrinkage would result in the ejection of matter from the sharp edge of the lens. It is suggested that the spiral nebulæ form instances of this process, the spiral arms being the ejected matter and the central nucleus the remnant of the original rotating mass of gas. The spiral arms are observed to break up into condensations, a process of which a theoretical explanation can readily be given. But on inserting approximate numerical values it is found that each condensation must have a mass comparable with that of a star. In the spiral nebulæ we are watching, not the birth of planets, which Laplace attempted to explain by his nebular hypothesis, but the birth of the stars themselves. The process is, in its main outlines, identical with that imagined by Laplace, but is on a more stupendous scale.

The separate stars when set free from the parent nebula are themselves shrinking and rotating masses of gas; they may be thought of as small-scale models of the nebula which gave them birth. We naturally inquire whether the process of evolution of these small-scale models will be the same as in the parent nebulæ. The answer is provided by a mere inspection of the physical dimensions of the formulæ which govern the dynamical processes of evolution. It is found that, as regards the central mass of lenticular shape, the small-scale model operates precisely like the bigger mass. Any rotating mass of gas, provided only that it is sufficiently great to hold together under its own gravitation, will in due course assume the lenticular shape and discharge matter from its equator. But as regards the ejected matter, the small-scale model does not work in the same way as the bigger mass. If the matter ejected from a big mass forms a million condensations, the matter yielded from a small mass of one-millionth part of the size will not form a million tiny condensations—it will form only one condensation, and will, moreover, form this one only if other physical conditions are favourable. In actual fact, when regard is had to numerical values, it is found that other physical conditions are not favourable. The matter will be ejected at so slow a rate that each small parcel of gas will simply dissipate into space without any gravitational cohesion at all. Some molecules will probably escape altogether from the gravitational field of the central star, while the remainder will form merely a scattered atmosphere surrounding the star. For this reason, in addition to others, the conception of Laplace does not appear to be capable of providing an explanation of the genesis of planetary systems.

So far we have studied the way in which a mass of gas would break up under increasing rotation. As a matter of theoretical research it is found that a mass of homogeneous incompressible substance, such as water, would break up in an entirely different fashion. It is further found that there are only these two distinctive ways in which a break-up can occur, so that if a mass the rotation of which is continually increasing does not break up in one way it must break up in the other. As a star, from being a mass of gas of very low density, shrinks into a liquid or plastic mass of density perhaps comparable with that of iron, it passes through a critical point at which there is a sudden swing over from one type of break-up to the other. This critical point occurs when the density of the star has become such that the ordinary gas-laws are substantially departed from throughout the greater part of the star's interior. This density is, however, precisely that which marks the demarcation between giant and dwarf stars. Thus the general conclusion of abstract theory is that a giant star will break up under increasing rotation in the way we have already had under consideration, but that a dwarf star will break up in the same way as a homogeneous incompressible mass, such as a mass of water.

The discovery of the method of break-up in this second case forms one of the most difficult problems of applied mathematics. In spite of the labours of many eminent mathematicians, among whom may be mentioned Maclaurin, Jacobi, Kelvin, Poincaré, and G. H. Darwin, the problem is still far from complete solution. It is found that as the rotation of a homogeneous mass increases the boundary remains of exact spheroidal shape until an eccentricity of 0·8127 is reached, at which the axes are in the ratio of about 12 : 12 : 7. With a further increase of rotation the boundary ceases to be a figure of revolution; it becomes ellipsoidal and retains an exact ellipsoidal shape until the axes are in a ratio of about 23 : 10 : 8. Beyond this it is impossible for the mass to rotate in relative equilibrium at all, and dynamical motion of some kind must ensue. At first a furrow forms round the ellipsoid in a cross-section perpendicular to the longest axis, but the cross-section in which the furrow appears does not divide the figure symmetrically into equal halves. The furrow deepens, and at this stage the problem eludes exact mathematical treatment. It appears highly probable, although it cannot be rigorously proved, that the furrow will continue to deepen until it separates the figure into two unequal masses. On the assumption that this is what

[1] Lectures delivered at King's College on May 17 and 24. Continued from p. 560.

would actually happen we may conjecture that the process we have been describing is that of the fission of a single star into a binary of the familiar type, but the conjecture is beset by many difficulties. To mention one only: if we have truly described the history of a star before fission, the star ought during a moderate part of its life to possess an ellipsoidal figure, and as this rotated the light received from the star ought to vary to an extent which just before fission might amount to 0·9 magnitude. Yet I believe there are only three known stars whose variation of light is such as could possibly be accounted for by an ellipsoidal surface, and even in these cases the interpretation is doubtful. On the other hand, very considerable reassurance is provided by the researches of Russell on multiple stars. After a star has broken into two parts by fission both parts will continue to shrink, so that either or both may in turn again break up, and a triple or quadruple system be formed. Russell finds that in a multiple system which has been formed in this way the distance between the stars formed by subsequent fissions cannot be more than a small fraction, at most about one-fifth, of the distance between the pair generated by the original fission. A mere glance at a catalogue of multiple stars will show that this condition is fulfilled by the majority of observed systems. On account of foreshortening the apparent separations will not always appear to conform to the rule, but Russell has shown, as the result of a careful statistical discussion, that the exceptions agree, both in kind and in number, with what might be expected from foreshortening.

We have now traced out the life-history of a rotating and shrinking mass from beginning to end, from its start as a gaseous mass of very low density, through its assumption of a lenticular shape and its first break-up as a spiral nebula, through its subsequent condensation into separate stars, to their final fissions into binary and multiple systems. The picture has been distressingly incomplete, and it cannot be denied that the story is beset by many difficulties and uncertainties. The mathematical investigation is far from perfect; gaps in theory have frequently been bridged by nothing more substantial than conjecture; in many cases there has been room for grave doubt as to the identification of observed formations with those predicted by theory; in one instance at least a formation predicted by theory, the ellipsoidal star, is practically unknown to the observing astronomer. But, after allowing for all imperfections, we have a tolerably complete knowledge, so far as the main outlines are concerned, of the whole chain of configurations which will be assumed in turn by the rotating shrinking mass of Laplace, and on this chain there does not appear to be any room for the solar system.

Apart from this, there are weighty reasons for thinking that our system has not been formed as the result of a rotational break-up. The angular momentum of a system remains constant during a process of breaking up, and, as was pointed out by Babinet in 1861, even if the whole angular momentum of the solar system were now concentrated in the sun it would still have less than a quarter of the angular momentum requisite for breaking up at its present density. Except in the improbable event of the solar system, since fission, having been robbed by a passing star of by far the greater part of its angular momentum, its rotation can never have been sufficient to cause a break-up. Clearly there is a case for examining whether some other agency cannot produce a system such as ours.

The sun and moon, as we know, raise tides on our earth the height of which forms only an inappreciable fraction of the earth's radius. If our earth were replaced by a mass of liquid or gas of low density the fraction would be greater, varying inversely as the density of the mass. If the sun and earth were placed much nearer to one another than now the tides would be increased in the ratio of the inverse cube of their distance apart. We can easily imagine conditions under which the heights of the tides would be comparable with the radius of the earth, and here the simple formulæ which the mathematician uses to calculate the heights of terrestrial tides become useless. The general investigation of the succession of shapes which will be assumed by a gaseous or plastic mass as the tidal forces on it continually increase presents a difficult but not altogether intractable problem for the mathematician.

It is found that the tides will be of the general type with which we are familiar on the earth until a certain critical height of tide is reached. This critical height is comparable with half the radius of the mass, being greater or smaller according as the mass is of more or less uniform density. After this critical height has been passed, there is no longer a configuration of equilibrium under the tidal forces. Dynamical motion ensues, and the general nature of this motion will consist in the ejection of two arms or jets of matter, one towards the attracting mass and one, which may be smaller, or may be absent altogether, in the exactly opposite direction. If the tide-generating forces should be suddenly removed at this stage the jets would, of course, fall back into the mass from which they emerged, and this would in time resume its spherical form. But if the tidal forces persist, the jets will continue to be thrown out, and it can be shown that a continuous distribution of density in these jets would be unstable, just in the same way, and for similar reasons, as in the case we previously discussed of the jets thrown out from a rotating mass of gas. Condensations would form in the jets, and ultimately the jet would break up into separate detached masses.

According to the tidal hypothesis of the origin of the solar system, the sun was at some past time subjected to intense tidal forces from a passing star, the sequence of processes we have just described took place, and the emitted jet broke

into fragments which are our present system of planets. From the mathematical investigation on which this hypothesis is based, it appears that the fragments would each be comparable in mass with the original sun if the matter of the sun had been of approximately uniform density, but would be very small by comparison if the sun had been gaseous with high central condensation. The smallness of the masses of the planets in comparison with that of the sun must, therefore, be taken as indicating that the sun was in a gaseous state with high central condensation when the planets were born. The jets of matter thrown out would also be gaseous, but would rapidly cool in the process of ejection, and might soon liquefy or even solidify. It can be shown that the planets which would be formed out of the middle portion of such a jet ought to be much more massive than those formed near the ends, and this may possibly provide an explanation of the comparatively great masses of Jupiter and Saturn. We imagine that the planets at first described orbits under the combined gravitational action of the sun and the passing star by which the cataclysm was caused, but as this star receded they were left revolving, as at present, around the sun. During their earlier motion they may themselves have been broken up by the tidal action of one or both of the big masses present, and such a process may explain the origin of the satellites of the planets.

Such, in its main outlines, is the tidal theory of the genesis of the solar system. So far as can be seen, a vast amount of further mathematical research is needed before it can be either definitely accepted or finally condemned. For myself, I find it more acceptable than the rotational theory, or any other hypothesis so far offered, of the origin of the solar system. Time does not permit of a discussion of its difficulties, but I may perhaps conclude by stating what seem to me to be its main advantages over the rotational theory.

(i) It escapes the well-known criticism of the rotational theory that the present angular momentum of the solar system is too small to be compatible with a previous rotational break-up, and I do not know of any similar quantitative criticism which can be brought against the tidal theory.

(ii) The solar system is arranged with reference to two planes—the invariable plane of the system, which contains the orbits of the outer planets, and a second plane inclined at about 6° to the former plane, which contains the sun's equator and the orbit of Mercury. A system which had broken up by rotation alone ought to be arranged symmetrically about one plane—the original invariable plane of the system. On the tidal theory the two planes of the solar system are readily explained as being the plane in which the tide-raising star moved past the sun, and the original plane of the sun's rotation.

(iii) Theoretical investigations suggest that there is only one possible end for a rotating system, namely, a binary or multiple star of the type familiar to astronomers, and it is quite certain our system is not of this type. Similar investigations on tidal action suggest that the final end of a system broken up by a tidal cataclysm ought to show many of the features of our present solar system.

The Edinburgh Meeting of the British Association.

By PROF. J. H. ASHWORTH, F.R.S.

LOCAL ARRANGEMENTS.

THE British Association meeting to be held during the week September 7–14 is the fifth meeting of the Association to be held in Edinburgh, the previous meetings having been in 1834, 1850, 1871, and 1892. The last of these, under the presidency of a distinguished son of Edinburgh—Sir Archibald Geikie—was a memorable and successful meeting, and the citizens of Edinburgh are anxious to make the forthcoming meeting no less notable and successful.

As at the last Edinburgh meeting, the reception room, the headquarters of the Association, and the bureau of information will, by permission of H.M. Office of Works, be the Parliament Hall, in which the Scottish Parliament met until the Treaty of Union in 1707. One of the courts adjacent to the hall will be used for the meetings of council and of other administrative committees, and by permission of the Faculty of Advocates rooms in the advocates' library, which is adjacent to Parliament Hall, have been provided for the use of the president and general officers, and the advocates' writing-room has been placed at the disposal of members. The attention of members is directed to the rule prohibiting smoking in any part of the library and in Parliament Hall; a smoking-room is provided near the reception room. The usual postal (including telegraphic) facilities will be provided in the post office at the entrance to the reception room.

The sectional meetings will be held in the lecture rooms of the University. Six of the sections will meet in the Old College, two in the adjacent departments of natural philosophy and engineering, three sections and the conference of delegates in the University New Buildings (the medical school of the University), and the remaining two in the department of agriculture and forestry, which is within four minutes' walk of the University New Buildings and of the Old College. In connection with several of the sectional meetings, laboratory accommodation will be available for apparatus and specimens which members may desire to exhibit to illustrate their communications to the sections.

Writing-rooms will be provided in the University and in the Unions. The University library in the Old College is to be open so that members may consult books and the principal literary and

scientific journals. The Upper Library contains many objects of literary and scientific interest, including Charles Darwin's class-cards for the lectures which he attended in the University in the years 1825–26, and will be available as a withdrawing-room and additional writing-room. At the Royal Society of Edinburgh, 22 George Street, members may see the principal scientific journals and consult books in the library.

The inaugural meeting and the evening discourses will take place in the Usher Hall, which is an ideal hall for the purpose and has excellent acoustic properties. The hall has spacious corridors, foyers, and cloak-rooms; its interior is well proportioned, and as the grand circle and the gallery above it are constructed on the cantilever principle there are no pillars to obstruct the view of any member of the audience. In this hall also will be given three of the public lectures to citizens. Sir Oliver Lodge will give the opening lecture on "Speech through the Ether, or the Scientific Principles Underlying Wireless Telephony"; Prof. Dendy will lecture on "The Stream of Life"; and Prof. H. J. Fleure on "Countries as Personalities." A special lecture, arranged in collaboration with Section M (Agriculture), for agriculturists will be given in the Natural History Theatre in the Old College of the University on the afternoon of market day (Wednesday, September 7) by Dr. E. J. Russell on "Science and Crop Production."

The Lord Provost, magistrates, and council of the city will give a reception in the Royal Scottish Museum on the Thursday evening; there will be a special graduation ceremonial in the M'Ewan Hall on the Tuesday afternoon, and a garden party immediately afterwards, which the local committee hopes to give in the Zoological Park.

The handbook is not quite on traditional lines; it is not an account of the history, topography, and organisation of the city—this information is accessible elsewhere—but will give an account of the place of Edinburgh in scientific progress. Owing to the present high cost of printing, the book must be kept within the modest limits of about 230 pages, but it is hoped that the authors who are collaborating in its production will be able to give within this compass an adequate account of the main lines in the advancement of science which have been especially associated with Edinburgh.

In order to give members an opportunity of visiting the more important places of historical and general interest round Edinburgh, arrangements are being made for excursions on the Saturday (*a*) to Loch Lomond, the Trossachs, and Stirling, (*b*) to Melrose Abbey and the Scott country, and (*c*) by river to Alloa and Stirling. Shorter excursions have been planned for other days. One of these is to H.M. Dockyard, Rosyth, by kind permission of Admiral Sir Herbert Heath; another is to Dunfermline, where the party will not only be able to inspect the historical abbey and church, but also those interested in sociology will have an opportunity of seeing the work of the Carnegie trustees; and another is to Linlithgow, where, in addition to historical interests, the party will be able to comprehend, from a commanding point of view, the manner in which the Forth valley has been eroded. Other excursions will be arranged to Swanston (the former home of Robert Louis Stevenson) and Craigmillar Castle, and to the Castle and Chapel of Roslin and to Hawthornden. Those interested in the architecture and picture galleries of the noble houses of Scotland will enjoy the excursion to Dalkeith Palace, the residence of the Duke of Buccleuch, and to the Marquis of Lothian's seat at Newbattle Abbey.

Edinburgh itself has not been forgotten in these arrangements; small parties will be conducted over the "Old Town," especially the "Royal Mile" from the Castle to Holyrood, and the member who avails himself of this opportunity will visit, under the guidance of Prof. Baldwin Brown, Dr. John Harrison, and other experts, the scenes of many of the most moving events in Scottish history.

The city and the surrounding country present many features of interest to the geologist, the biologist, the engineer, the geographer, and the student of the growth of cities. Sectional excursions to the chief points have been planned.

It has often been stated that Edinburgh is not an industrial or commercial city, probably because the reputation which it has enjoyed in other respects has overshadowed this aspect of its activities. In point of fact, however, banking, insurance, and financial interests are strongly represented, and the city has important industries. It has long been celebrated for book and map production, and among other industries are brewing and distilling, shipbuilding, engineering, rubber and chemical works. Arrangements have been made for the sections concerned to visit works representative of these industries.

The first list of hotels and lodgings is now ready, and can be obtained either from the London office, or from the Local Secretaries, The University, Edinburgh. Members should bear in mind that September is a busy month for ordinary tourist traffic in Edinburgh, and that they should therefore make their arrangements early. Some accommodation in hostels, at moderate charges, has been placed at the disposal of the local executive committee. Ladies and gentlemen desiring such accommodation should address their applications to the local secretaries direct before the end of July, by which time it is expected that the available places will be allotted. Preference will be given to scientific workers.

Luncheon and tea will be obtainable at moderate charges in the University Union and the University Women's Union, both of which are adjacent to the sectional meeting-rooms. Gentlemen who are members of the Association will be honorary members of the Union for the week, and ladies who are members will be honorary members of the Women's Union. In each case the honorary members will have the usual privileges, and may introduce one or two guests—ladies or gentlemen.

For the convenience of members arriving on Wednesday evening, September 7, who will have only a short time at their disposal between the time of their arrival and the inaugural meeting, arrangements have been made with the station-masters at the Caledonian and Waverley Stations to establish inquiry offices of the Association at which membership tickets will be issued. These offices will be opened at 5.30 p.m. for about an hour and a half, but members who anticipate arriving in Edinburgh after 5 p.m. would do well to obtain their tickets by post beforehand so as to avoid any congestion at these temporary offices.

Annual Visitation of the National Physical Laboratory.

THE annual visit to the National Physical Laboratory of the members of the General Board took place on June 28. A large number of guests were present, and were received by Prof. C. S. Sherrington, president of the Royal Society, the chairman of the General Board, and by the director of the laboratory, Sir Joseph Petavel.

An interesting ceremony preceded the visit, when a bas-relief in bronze of the late director, Sir Richard Glazebrook, was presented to the laboratory. The presentation was made by Sir Joseph Thomson, Master of Trinity College, Cambridge, and received on behalf of the laboratory by Prof. Sherrington. The bas-relief is the gift of a large number of friends of the late director, including many past and present members of the General Board.

It is now more than eighteen months since Sir Richard was succeeded by Sir Joseph Petavel, who has carried on very actively the work of his predecessor. Some buildings planned in 1918 are still in process of erection at Teddington, and the work of the laboratory continues to increase in magnitude and importance. The Admiralty has erected a research laboratory within the grounds of the National Physical Laboratory, so that much of its special work may be carried on in close co-operation with it.

As on previous occasions of this kind, the laboratory was thrown open to the visitors, who were given an opportunity of seeing the work that is at present being conducted in the various departments.

A wind tunnel of cross-sectional area 7 ft. by 14 ft. has been completed during the course of the current year, and affords a valuable addition to the equipment of the aerodynamics department. In it a new method for the measurement of rotary derivatives on an aeroplane was demonstrated. Demonstrations in the other tunnels included the measurement of the thrust and torque on an air-screw working in front of a streamline body with the simultaneous measurement of the drag on the body; pressure plotting on an airship hull which was carried out by means of a number of fine steel tubes run longitudinally along the hull in grooves and made flush with wax; and the measurement of lift, drag, and pitching moment on a model aerofoil supported on wires and hung from balances on the roof of the tunnel. Several complete models of aeroplanes were also exhibited.

The engineering department exhibited a machine presented to the laboratory by Mr. C. E. Stromeyer for the rapid determination of the fatigue ranges of materials under reversals of shear-stresses. Forced torsional vibrations are given to the specimen under test by means of a rocking arm and flywheel the mass of which can be adjusted. The specimen acts as an elastic constraint between the rocking arm and the flywheel. The usual method of finding the limiting range of stress by endurance tests requires six specimens, and, with the machine running continuously, occupies a week. By the new method the limiting range of stress can be found on a single specimen by two independent means at the same time, and the total time taken for the test varies from five minutes to a quarter of an hour.

In order to investigate the distribution of the air currents produced by the present system of ventilation in the debating chamber of the House of Commons, a wood model (one-eighth full size) has been constructed. Air is supplied to this through ducts of the existing pattern from a fan, the strength and direction of the air currents being investigated by air-speed meters and smoke bands.

An experimental range has been constructed for the study of the motion of 1-in. projectiles in flight. The range is being fitted to carry this out by a series of "jump" cards, and also photographically by the spark method of Prof. Boys.

Other exhibits in this department were the following: Apparatus for studying the effect of pressure and temperature on the production of detonation in a closed explosion vessel; apparatus by means of which the temperature of the lubricant, the load on the bearing, and the speed of the journal can be varied in order to obtain the coefficient of friction of lubricants under varying conditions; apparatus for determining the distribution of frictional resistance over thin plates; and machines for various tension and compression tests.

A new apparatus for the autographic determination of changes in the electrical resistance of alloys with varying temperatures up to and beyond the melting point was exhibited in the metallurgy department. A Morgan electric melting furnace, in which a clay-lined graphitic crucible acted simultaneously as the metal container and heating element, was shown in operation. Demonstrations were given in the experimental rolling-mill, illustrating the effect on the rolling properties of certain non-ferrous alloys of unsuitable mechanical and thermal treatment prior to the rolling operation.

There were also shown in this department exhibits illustrating the macro-structure of castings in various types of moulds, graphite moulds and ingots cast in them; specimens illustrating the behaviour of pure zinc under tensile tests at various temperatures, and new apparatus for the pressure casting of china clay pots for glass melting.

In the heat division of the physics department two novel forms of optical pyrometer were shown, one a precision laboratory standard, and the other a portable instrument suitable for workshop use. Both were of the disappearing filament type in which an image of the hot object is superimposed on the filament of the pyrometer lamp and the brightness matched by varying the current through the lamp. In the standard instrument two lamps are fitted which can be interchanged exactly in the field by a simple transverse motion, and each lamp is provided with fine adjustment in three mutually perpendicular planes. The portable instrument is a self-contained unit which can be carried in the pocket. The telescope, variable rheostat, and ammeter are integral parts of the instrument, and the ammeter is graduated to read temperatures direct.

A variety of hygrometers was shown, as were also appliances for the rapid calibration of these instruments. Considerable modifications have been made in the dew-point apparatus with the view of arranging it in a form suitable for use under cold storage conditions.

In the radiology division was shown a Bragg X-ray spectrometer for the investigation of the crystal structure of materials. The spectrometer is also designed to measure accurately the absorption of X-rays of definite wave-length in different substances. The whole of the high-tension circuit is enclosed in a box covered with lead, so that the measuring instruments are entirely protected from stray radiation. The apparatus employed to investigate the measurement of the intensity of a beam of X-rays with special reference to the barium platinocyanide pastille was shown, and an improved type of tintometer for comparing the tints of pastilles was also demonstrated.

The optical division showed a new method for determining loss of light in optical instruments such as range-finders, periscopes, etc. An optical pyrometer, adapted for use as a surface brightness photometer, is employed to measure the brightness of a suitable source of light and of its image formed by the optical instrument. Two precision methods of goniometry by substitution were demonstrated. In one of these an accuracy of about 1″ of angle is readily obtained, and in the other, which is suitable only for very accurately worked prisms, it is hoped to attain an accuracy of a small fraction of a second. Among the other exhibits were an improved Lovibond colorimeter, various instruments for measurements of focal lengths and curvatures, and an interference test of the surface of glycerine showing that such a surface, even when left undisturbed for many weeks, does not become flat.

The metrology department demonstrated optical tests on the flat faces of end gauges for determining flatness, parallelism, and squareness to axis of gauge. An optical proof plane is held opposite one end of the gauge and rotated about two perpendicular axes lying in its own plane. The appearance of the interference fringes formed between the proof plane and the end face of the gauge gives an indication of the state of perfection of the flatness of the face. By observing any change in the interference pattern as the gauge rotates about its own axis, the test of squareness of the face to the axis is obtained. The method of testing the flatness of a large surface consists essentially of the comparison of the surface to be tested with the horizontal free surface of mercury.

Other exhibits in this department were a standard leading screw lathe, line standards, and a method of determining the length of an end gauge with reference to a standard scale.

In the William Froude national tank experiments were conducted in connection with the manœuvring power of ships. The experiments may be divided into two main sections, the action of the water on the rudder of a ship, which will vary with ship form features, type of rudder, etc., and the action of the rudder forces on the ship as a whole. Measurements are taken of the water moments on the rudder stock and on a second axis of the rudder, with and without propeller working, and of the initial torque on the hull, with the rudder over to any angle.

The photometry division of the electricity department showed a method of determining the distribution of light from the lenses used in ships' navigation lights. Apparatus was also shown for the polar distribution of light. This is of the ordinary two-mirror form, but with special arrangements for the ready rotation of the mirror, the holders for which rotate on ball bearings. Another exhibit was the integrating sphere-photometer. This is an Ulbricht sphere of 1 metre internal diameter, which has been designed for the measurement of lamps of ordinary commercial sizes.

The exhibits in the wireless division included closed-coil wireless direction-finding systems. The particular coil exhibited was designed and constructed at the laboratory, and is believed to be the first direction-finding coil system ever employed on aircraft, having been used for some experiments at Cranwell in 1916. A complete wireless direction-finding station was shown in operation, the set exhibited being identical with those installed by the Radio Research Board at various universities in the British Isles for experimental investigations.

There were other numerous interesting exhibits in this department, such as the Schuster magnetometer; transformers and ovens for experiments on cables at high temperature and high potential; and methods of measuring the heating of cables buried in the ground under various conditions.

Scientific Publications for Russia.

IT will be remembered that when Mr. H. G. Wells visited Petrograd in November last he found that the remnant of Russian literary and scientific workers who had survived the revolution had been brought together by the Soviet Government and housed in two institutions in Petrograd. There the scientific workers were carrying on their researches as best they could in the face of great privations owing to lack of food and clothing. What they felt even more keenly was that they were cut off from men of science outside Russia and were unable to obtain scientific literature or apparatus.

A committee was therefore formed in December under the title "The British Committee for Aiding Men of Letters and Science in Russia" to obtain some of the chief publications required. An appeal, which was published in NATURE of January 6, p. 598, was made for funds to help the project forward.

Prof. Oldenburg, permanent secretary of the Petrograd Academy of Sciences, was communicated with, and was able to provide the committee with a list of the works which were urgently required. This list contained a number of works issued by British and other publishers, together with the publications of many learned societies. The committee then communicated with the leading scientific societies which had sent their publications into Russia before the revolution, and several entrusted their publications to the committee for transmission to the House of Science in Petrograd. A number of British publishers presented volumes for the same purpose, and help was also given by universities and publishers in the United States. In addition the committee has acquired books by purchase and by gift from private individuals.

Naturally very careful inquiries were made from both the British and the Soviet authorities as to the prospect of the books reaching the men for whom they were intended. Every assurance was given that delivery would not be interfered with, and several cases of books were accordingly dispatched. It was feared that in spite of their assurances the Soviet authorities would confiscate the literature, and it is therefore gratifying to learn that an acknowledgment of their safe arrival has been received from Prof. Oldenburg. A book-list which was also dispatched has been returned signed by several notable Russian men of science, so there is now little doubt that the books were received by those for whom they were intended.

It is thought that fear of miscarriage of these books has prevented the co-operation of many well-wishers of the scheme. Now that this fear is allayed it is hoped that further subscriptions and donations will be forwarded to the treasurer of the committee, Dr. C. Hagberg Wright, the London Library, St. James's Square, S.W.1.

Friendship.

(To T. H. R.)

WERE life an empty bubble blown by chance
To glitter, mount, and burst beyond repair;
Were mind delusion, fancies rich and rare
Mere exhalations, firefly effluence;

Or should this mood be but the spirit's trance,
And one enduring Whole his Being share
By ordered gradients up the thronal stair
From atom fires to soulful radiance;

Be all philosophy beyond our ken
And nothing certain,—yet, as star draws star,
As bubbles meet and cling, electrons blend,
There sings a joy when friend meets parted friend,
Time's limitations yield, and past the bar
Life's transcendental portals ope again.

WALTER GARSTANG.

June 19, 1921.

Conference of American and British Engineers.

THE four leading engineering societies of the United States of America recently combined to form the United Engineering Society, to promote the more general interests of the profession. Fifteen delegates from these societies have come to London, partly to bring a greeting and message of friendship to British societies, and partly to present the John Fritz medal, the greatest honour the American societies can confer, to Sir Robert A. Hadfield, Bart.

The chairman of the delegation is Mr. Ambrose Swasey, who is not only a constructor of the finest machine-tools, but also the builder of the great telescopes at Mount Hamilton, at the Naval Observatory, Washington, and at the Yerkes Observatory, Wisconsin. He also built the 72-in. reflecting telescope of the Dominion Astronomical Society at Victoria (B.C.). Among the delegates are Col. A. S. Dwight (American Institute of Mining and Metallurgy), Mr. C. F. Rand (secretary of the board which awarded the medal), Dr. Ira N. Hollis (American Society of Mechanical Engineers and president of the Worcester (Mass.) Polytechnic Institute), Mr. C. T. Main (American Society of Mechanical Engineers), Dr. F. B. Jewett (American Society of Electrical

Engineers and chief engineer of the Western Electric Co., of Chicago), Mr. I. R. Freeman (American Society of Mechanical Engineers), and other distinguished engineers.

Advantage was taken of the opening of conferences at the Institution of Civil Engineers on June 29 to receive the delegates. Mr. John A. Brodie, president, welcomed the American engineers, and suggested the formation of an engineering committee to investigate the question of stoppages in production and methods for the judicial treatment of matters in dispute.

Dr. Ira N. Hollis then in an eloquent address conveyed the friendly wishes of American engineers. Those present, he said, belonged to a profession which had, through its inventions and its work, laid the foundations on which civilisation had been built. Engineers stood side by side on the battlefield, and American engineers took pride in the share of their British colleagues towards the victory for truth and justice when much that had been gained by centuries of struggle seemed likely to be lost and the freedom of the world was in danger. The great issue of the twentieth century was the right of every man to earn a living and develop his possibilities without being controlled by powerful combinations of any kind. No family and no line of families should find the door of opportunity shut. He looked forward to the day when not only American engineers, but all engineers would be banded together for the welfare of the world. He was sure that Darwin would turn in his grave if he could but know how evolution had been twisted by the Teutonic mind into glorifying war as a developer of the race. Dr. Hollis then read the address from the American societies. It expressed the feeling of brotherhood and a sense of the loss in the death of so many British colleagues on the battlefield. The American engineers rejoice to have been permitted to share with other engineers the victory over a war spirit dangerous to the rights and happiness of men.

The president of the Institution of Civil Engineers accepted the address, and Dr. W. C. Unwin, in reply to Dr. Hollis, said that the delegation which had come with so gracious a message were missionaries of kindness. British engineers recognised the great advances in engineering science in America, and admired immensely the great works of construction there carried out. In the war the United States had come to our assistance with its great manufacturing resources. The supplies of steel it sent were of immense value, and not less valuable were the remarkable machine-tools for which the United States was famous. We had been linked in war, and would not fail in trying to stabilise peace; so far as one generation could, we must endeavour to make such a war impossible in the future.

Lord Bryce laid stress on the international character of the engineering profession. Men of science belonged to the world and worked for the world, and were welcomed by their colleagues wherever they went.

Mr. Ambrose Swasey then presented the John Fritz medal to Sir Robert Hadfield. Mr. Swasey said that the delegation represented the four American national societies of civil, mining and metallurgical, mechanical, and electrical engineers. The John Fritz gold medal was instituted by the friends of the great American engineer, John Fritz, for his achievements in industrial science, and was awarded annually. Lord Kelvin and Sir William White had both received the medal previously in honour of their achievements. The award this year had been made to another distinguished engineer in Great Britain, Sir Robert Hadfield, in recognition of his scientific attainments and his eminence in metallurgical research, and for the distinguished service he had rendered in the invention and perfection of manganese steel.

In his reply Sir Robert Hadfield said that he was deeply moved by the demonstration of goodwill shown by the great honour conferred upon him by the American engineering profession. In the official announcement of the award he had been told that the distinction should be accepted by him not only for himself personally, but also, through him, as an expression to the British nation, on the part of American engineers, of their high regard and appreciation of the work of the British engineer in the war for the preservation of civilisation. That message was indeed cheering, and was a harbinger of good for the future of the race. Sir Robert thanked the delegation for its courtesy in coming to this country, when he ought to have gone to America, but considered that his inability to do so was a blessing in disguise, as evidenced by the great gathering that day. It was a great pleasure to have present their American friends, because it was in America that manganese steel first received encouragement on a large scale. It was also appropriate that the award should be made in the hall of the Institution of Civil Engineers, since his first papers in 1888, giving account of the invention of manganese steel, had been presented in the hall of the old building of the institution.

Our readers will be interested to know that Sir Robert Hadfield has had printed an address of thanks. This address contains much interesting information respecting eminent engineers, with portraits, on both sides of the Atlantic, together with illustrated notes on the founding and work of the Royal Society.

The work of the conference was carried out in seven sections:—(1) Railways, roads, bridges, and tunnels. (2) Harbours, docks, rivers, and canals. (3) Machinery. (4) Mining and metallurgical processes. (5) Shipbuilding. (6) Waterworks, sewerage, and gasworks. (7) Electricity works and power transmission. Some fifty-five papers or notes were introduced and discussed. Reference to a few of these only can be made here.

Mr. Alexander Ross laid down as propositions for discussion that on our railways the 6-ft. space should be widened to 7 ft.; if there are more than two lines of rails, the space between the original pair of rails and additional rails should not be less than 11 ft. 6 in. No overhead structure should have less clear headway than 15 ft. 6 in. above the top surface of the rails. No structure higher than 2 ft. 6 in. above rail-level should be nearer to the edge of the nearest rail than 5 ft.

Mr. Oswald G. C. Drury described the use of the Ingersoll cement-gun in carrying out repairs on the Cliftonville tunnel. The next few months will show the value of this method of grouting, but Mr. Drury thinks that the method is a practical success from the point of view of stability and speed, although the commercial value has yet to be thoroughly tested.

Mr. William W. Grierson gave particulars of the now extensive use of reinforced concrete on British railways. The use of fence-posts of this material is largely on the increase. Various designs of reinforced concrete sleepers have been experimented with, but none are successful under heavy and frequent traffic at high speeds.

The important question of the best way of protecting reinforced concrete from marine deterioration was introduced by Mr. Francis E. Wentworth-Sheilds. Our experience of this material for maritime structures now extends over twenty years, and there have been several failures. These are owing to: (*a*) The concrete has become softened by the chemical action of the sea-water. (*b*) The concrete has scaled off owing to the action of frost. (*c*) The concrete has worn off by attrition by travelling shingle and stones. (*d*) The concrete has split and cracked by the rusting of the enclosed steel and its consequent increase in volume. The last is the most common type of failure.

Mr. George E. W. Cruttwell presented an interesting note on the use of a model for investigating the movements in the River Thames between Teddington and Shoeburyness. The first model of this kind was employed by Prof. Osborne Reynolds, and the present improved model gave very good results. Mr. Cruttwell suggests that the greater part of the model and the whole of the working apparatus could be adapted for experimenting with other estuaries at a trifling cost, and that it would be most advantageous to the engineering profession if the National Physical Laboratory or some similar institution could install the necessary apparatus, which could then be adapted to suit any particular case. The cost of the Thames model was about 300*l.*, and a moderate fee would cover the cost of the necessary adaptations and investigations.

In dealing with the bearing power of soils Mr. Arthur L. Bell made reference to the various theories of earth-pressure. Advance in earthwork problems had been, in the main, due to individual experiment and speculation, and Mr. Bell considers that the best hope for the future lies in the encouragement and aid of individual inquiry. Engineers seek a sound and preferably simply theory which can be successfully applied, not to one only, but to all the multitudinous varieties and conditions of soil.

The influence of the automatic and semi-automatic machine on the skill and resourcefulness of the mechanic and operator was the subject of a note contributed by Mr. Arthur H. Hall. Such machines are set ready for work by a skilled mechanic and operated by another person. Mr. Hall considers that the designer has precluded the operator from the display of resource, but that a reasonable amount of skill is required. The mechanic must display great resource, the amount varying with the degree of responsibility allotted to him by the management in the matter of design and lay-out of tools. His skill in making these is of the kind usually expected of a highly trained workman, but in setting them up he may exhibit qualities not readily capable of comparison with those required in other work.

Sir Robert Hadfield presided in the mining and metallurgical section, and said that the world was literally hungering at the present time for a hundred million tons of iron and steel. Iron was the standard of all modern comfort, and to economise in its use meant to reduce our civilisation. Take away this metal, and the world would relapse into almost a state of barbarism.

Dr. John W. Evans introduced the subject of the employment of water-power in the development of the mineral industry. During the war there was a remarkable advance in Sweden, where the number of electric furnaces increased from eight in 1914 to twenty-eight in 1918, and the output of pig-iron obtained from them increased from 5786 tons in 1911 to 75,684 tons in 1918. The day is at hand when electrolytic methods will enable metals to be extracted with commercial success from ores which are too poor to be dealt with by smelting operations.

Fabricated ships were dealt with in notes by Mr. Maurice E. Denny and Mr. John C. Telford. These notes consider the problem from the labour-saving point of view. The premier requirements to make fabricated ship construction a success are several vessels all alike, standardised so as to make the detail reproduce itself many times over; also (*a*) careful work in the drawing office and template loft, (*b*) accurate workmanship in the shops, (*c*) close inspection, and (*d*) the provision of ample means for checking the several parts with jigs and templates as the work proceeds.

Obituary.

Abbott H. Thayer.

ALL naturalists, and especially those of the English-speaking world, will learn with great regret of the death of the distinguished and original artist-naturalist, Mr. Abbott H. Thayer, announced in *Science* for June 10. Many of us will lament the loss of a dear friend who sympathised with our sorrows and difficulties as if he had been one of us, and, long before his country joined the struggle on behalf of freedom and civilisation, came to England in the hope that he could induce the authorities to accept his help in the methods of "camouflage" by land and sea.

Thayer's great fundamental discovery was of course the interpretation of the white undersides of animals as the elimination of shadow by counter-shading. I once asked him how he came to think of it, and his answer showed that the discovery sprang from the artist side of his nature. He observed, he said, that animals in the wild state were elusive and ghost-like, and that when the artist wished to paint them so that they might be easily seen in the picture he had to employ an unnatural illumination or to represent them silhouetted against the sky. He was thus led to investigate, and finally to discover, the cause of

this great factor in protective resemblance. The artist in him first saw the well-nigh ever-present effects, and then found the cause, which, indeed, had been suggested some years earlier by one who failed to recognise its far-reaching importance and thus missed a great discovery.

Thayer's artistic temperament also led him to resent any limits to the application of his principles and to attempt to explain by them all examples of warning and mimetic coloration. When the review of the first edition of his work, "Concealing Coloration in the Animal Kingdom," appeared in NATURE (1910), it was many months before he could bring himself to read it. Yet when at length he made the effort he was pleased, and wrote a kindly letter to the reviewer.

Science needs the help of such men whose approach is from a widely different point of view, and science owes much to Thayer and will gratefully preserve his memory. E. B. P.

THE death is announced, at eighty-three years of age, of PROF. VIKTOR VON LANG, formerly professor of physics at Vienna University and a past-president of the Austrian Academy of Sciences.

Notes.

AT the meeting of the Royal Society of Edinburgh held on Monday, July 4, the following were elected honorary fellows:—*British Honorary Fellows:* William Henry Perkin, Sir Ronald Ross, Sir Ernest Rutherford, and Sir Jethro J. H. Teall. *Foreign Honorary Fellows:* Reginald Aldworth Daly (Cambridge, Mass.), Johan Hjort (Bergen), Charles Louis Alphonse Laveran (Paris), Heike Kamerlingh Onnes (Leyden), and Salvatore Pincherle (Bologna).

THROUGH the generosity of the Rev. Dr. Winifrith, of Hythe, a memorial tablet has just been placed on the house—31 High Street—in that town in which Sir Francis Pettit Smith was born. Of all the numerous inventors of screw propellers, Smith, perhaps, is the best known. Born in 1808, he began life as a farmer, but was always given to mechanical invention. His first patent for a screw propeller was dated May 31, 1836, and his screw was first fitted in the *Francis Smith,* and then in the epoch-making vessel s.s. *Archimedes.* Brunel was among the converts to Smith's ideas, and he discarded paddle wheels for the *Great Britain,* which, in 1845, was the first screw-driven vessel to steam across the Atlantic. The same year the screw sloop, H.M.S. *Rattler,* was added to the Navy List, and for some years afterwards Smith was employed by the Admiralty installing his screws in the converted line of battleships, many of which were in service in the Crimean War. He made little money out of his invention, but the shipbuilding and marine engineering world in 1858 raised a subscription of nearly 3000*l.* for him, and gave him the fine silver salver and jug which are in the Science Museum. During the latter part of his life—he died in 1874—Smith was curator of the Patent Office Museum.

GLASGOW UNIVERSITY, in accordance with the policy of establishing separate buildings for its scientific departments which was initiated by the erection of the Botanical Institute, has signed a contract for a zoological building, which has been planned by Prof. J. Graham Kerr and the architects, Messrs. John Burnet, Son, and Dick. The building will be near the new medical department on part of the former athletic ground. It will cover 3000 square yards, and include a lecture-room with accommodation for 260 students, an elementary laboratory with tables for 150 students, and special laboratories for advanced work, protozoology, research, and experimental zoology. There will be a large museum, to which will be transferred the zoological collections now in the Hunterian Museum, leaving space there for extensions of the departments of geology and archæology. Above the museum will be two large tank-rooms for living marine specimens, and land animals will be accommodated in a courtyard. A room will be provided for the departmental library and a suite of rooms for the staff. The building is estimated to cost 130,000*l.*, and it is hoped that the lecture-rooms and laboratories will be ready for the winter session of 1922–23. Under Prof. Graham Kerr the zoological department of Glasgow University has achieved great success, and it will now have a building worthy of its important work.

THE attention of French archæologists is now being devoted to an important series of discoveries in tombs at Martres-de-Veyre, Auvergne, which, according to M. Salomon Reinach, "are in an unprecedented state of preservation. In my experience there has never been found anywhere so many articles of leather, of wool, and of other stuffs in such good condition after being buried in graves for 1800 years." Near this necropolis is the famous fortress of Gergovia, where Vercingetorix won some temporary success against Cæsar, practically the last revolt against the Romans. The extraordinary state of preservation of the bodies found in the six tombs now brought to light calls for explanation. The body of a Gallo-Roman woman interred in a stone coffin lay as if life had only just departed, but on being exposed to the air it suddenly crumbled into dust. Ornaments and articles of the toilet were found in great abundance, while a jar of honey, vases, leather sandals, and linen and woollen fabrics were among the furniture of the graves. The articles discovered have been deposited in the museum at Clermont-Ferrand, the capital of the Department of Puy-de-Dôme, the Paris museums having wisely decided not to enter into competition with the local collections. It may be hoped that careful excavation in this district will lead to further important results.

IN the James Forrest lecture delivered on June 28 Sir George Beilby presented a review of the world's fuel situation. Coal, brown coal, peat, oil from wells

and from oil-shales, and alcohol are discussed, and the conclusion is reached that coal is likely to remain for a long time the world's chief source of fuel. Brown coal and peat are dismissed on account of the vast areas of land which are required in order to obtain adequate supplies and prepare them for use. Oil amounts to 7 per cent. of the fuel output of the world, and nearly nine-tenths of this quantity is controlled by the United States. The conclusion of the chief petroleum technologist of the U.S. Bureau of Mines, that after twenty years at the present rate of consumption the output will decline, is therefore of importance, though there is reason to expect production from oilfields in other parts of the world which have not as yet been tapped. The only method available in Great Britain for the commercial preparation of alcohol is by the fermentation of vegetable materials containing starch or sugar. Even this method, however, is not economically possible owing to the lack of available land for the cultivation of the crops required, the high cost of cultivation, harvesting, and manufacture, and the fact that the most suitable raw materials are also important foodstuffs. Some alcohol may be produced from molasses in countries where the sugar-cane is grown, but it is unlikely that more than is required for local use can be made. Falling back on coal, it is suggested that more efficient use may be secured by careful sorting at the pitheads, by improvements in boiler-firing, and by preliminary carbonisation at high or low temperatures.

THE *Daily Chronicle* announces that Prof. Edouard Branly, of Paris, is to receive this year's Nobel prize for physics.

IT is stated in the *Times* that the directors of the Nobel Foundation have submitted a proposal to the Swedish Government for increasing the value of the Nobel prizes by transferring a sum of about 100,000*l.* from their building fund.

WE learn from the *Times* that the French Société de Géographie is celebrating its centenary. There was a reception for delegates at the house of Prince Roland Bonaparte, president of the society, on Tuesday night, and in the afternoon M. Millerand, President of the French Republic, presided at the opening meeting of the celebration, a gathering at which explorers and geographers from various parts of the world were present.

THE sixty-sixth annual exhibition of the Royal Photographic Society of Great Britain will be held on September 19–October 29 at 35 Russell Square, W.C.1. There will be three sections, devoted respectively to pictorial photographs, to colour transparencies and colour prints, and to scientific and technical exhibits, natural history photographs, and lantern and stereoscopic slides.

A CIRCULAR has been issued by the Meteorological Office with reference to the summer service of forecasts of weather for agricultural purposes. Notification is given by telegraph of occasions when a spell of fair settled weather of several days' duration is anticipated. The progress of meteorological events and warning of the break-up of the fine spell are sent to the recipient as early as possible. The fee beyond the telegraphic charge is extremely small. Notification is also given of special conditions, such as spells of frost, ground-frost, smooth sea, etc.

BY invitation of Messrs. Sutton and Sons and of Prof. Percival, a field-meeting of the Association of Economic Biologists will be held at Reading on Thursday, July 14. Visits will be paid to the Royal Seed Establishment, the Trial Grounds, and the College Farm and Agricultural Botanic Gardens. It is requested that all who propose to attend the meeting will notify Mr. W. B. Brierley, the Rothamsted Experimental Station, Harpenden, not later than Monday, July 11.

BEGINNING on June 15, the wireless telegraph station at Poldhu is sending weather messages broadcast twice daily for the benefit of navigators. Each message will consist of a forecast for the western seaboard of the British Isles and the actual observations taken at Stornoway, Blacksod, Holyhead, Scilly, and Dungeness at 0700 G.M.T. (civil) and 1800 G.M.T. (civil) respectively. The messages will be sent out at 0930 G.M.T. (civil) and 2130 G.M.T. (civil). Details of the scheme are given on the Meteorological Chart of the North Atlantic Ocean for July.

A NORWEGIAN scientific expedition is leaving this summer for the island of Jan Mayen, in the Greenland Sea. According to *La Géographie* for May, the expedition will consist of six or seven persons, under the command of Mr. Ekerold. The main object is meteorological research, and it is hoped that the work of the party will lead to the foundation of a permanent observatory on Jan Mayen. A wireless telegraph station is to be erected. The last serious effort in meteorological research at Jan Mayen was in 1882–83, when an Austrian station, as part of the international scheme, was maintained on that island.

WE are glad to learn that Lyme Regis, a town classic in geology, is now provided with a public collection of local fossils. Three years ago a small museum building was bequeathed to the corporation by the late Mr. Philpot, and it is now occupied by the geological collection and library of Dr. Wyatt Wingrave, who has lately become a resident of the town, and has devoted much labour to making the museum of educational value. The fossils are arranged in stratigraphical order, with appropriate explanatory labels and diagrams, and Dr. Wingrave gives a weekly demonstration which is well attended and much appreciated.

H.R.H. THE PRINCE OF WALES has accepted the office of vice-patron of the Royal Society of Arts. The following medals have been awarded for papers read before the society during the past session:—Major-Gen. Lord Lovat, "Forestry"; Col. R. J. Stordy, "The Breeding of Sheep, Llamas, and Alpacas in Peru, with a View to Supplying Improved Raw Material to the Textile Trades"; A. F. Baillie, "Oil-burning Methods in Various Parts of the World"; Dr. W. Cramp, "Pneumatic Elevators in Theory and Practice"; Sir Kenneth Weldon Goadby, "Immunity and Industrial Disease"; W. Raitt,

"Paper-pulp Supplies from India"; Sir George Curtis, "The Development of Bombay"; A. H. Ashbolt, "Industrial Development in Australia during and after the War"; and Sir Charles H. Bedford, "Industrial (including Power) Alcohol."

WE have received a communication from Mr. W. J. Lewis Abbott in reference to a statement made in the course of the discussion on Mr. Reid Moir's paper on "An Early Chellean Palæolithic Workshop-site at Cromer," which took place at a meeting of the Royal Anthropological Institute (see NATURE of May 26, p. 406). In that discussion one of the speakers stated that the flints in question were "no more than a foreshore accumulation of flints which differed in no way from other flints found on the foreshore along the whole East and South Coast." Mr. Abbott directs attention to the distinctive coloration of the Cromer specimens, of which there are three types: (1) Those which are porcellanised or whitened; (2) those exhibiting the characteristic orange-red colour; and (3) specimens which have been changed from white to black, the white porcellanous condition being present under the black. He maintains that this peculiar feature cannot be due to beach action. In regard to the evidence for dating the finds, Mr. Abbott states that he has discovered specimens in association with remains of *Elephas* (?) *meridionalis*, in one case *in situ*. The question of the coloration of the Cromer flints is one of considerable difficulty, for which no satisfactory explanation has yet been offered, while in regard to the stratigraphical evidence, it is clear that a systematic investigation at the base of the Forest Bed series on this site, as suggested by Mr. Reid Moir himself, is extremely desirable.

"SUN-SPOTS and Weather" is the title of an article in the *Meteorological Magazine* for June, dealt with by Mr. C. E. P. Brooks. It is mentioned that the subject is again opened by the recent development of an unusually large sun-spot with associated electrical and magnetic phenomena. A bibliographical list is given of authorities on the subject, and the author states that although the literature is enormous, we are still far from definite conclusions. So long ago as 1651 Riccioli claimed that temperature rose with decreasing sun-spots and *vice versa*. The discovery in 1844 of an eleven-year periodicity in spots caused a renewal of the study, and in 1873 results of an investigation by Köppen were published showing that temperature reaches a maximum shortly before spot minimum and a minimum about spot maximum. A positive correlation of sun-spots with rainfall has been found in the tropics, and also with elements such as lake levels which depend on rainfall. A close parallelism has been demonstrated between sun-spots and tropical hurricanes, and the author states that the study of eleven years' wind data in the Falkland Islands suggests that at spot maximum the storminess is greatest.

POPOCATAPETL exhibited only slight activity in the way of fumaroles and solfataras in the two centuries that followed the eruption of 1720. In 1920, however, small eruption-clouds became visible from Mexico City, and Mr. Paul Waitz has described an ascent made by him in October last (*Amer. Journ. Sci.*, vol. cci., p. 81, 1921). Considerable outbursts of steam were then taking place from the crater, accompanied by a small quantity of stones and ashes, and

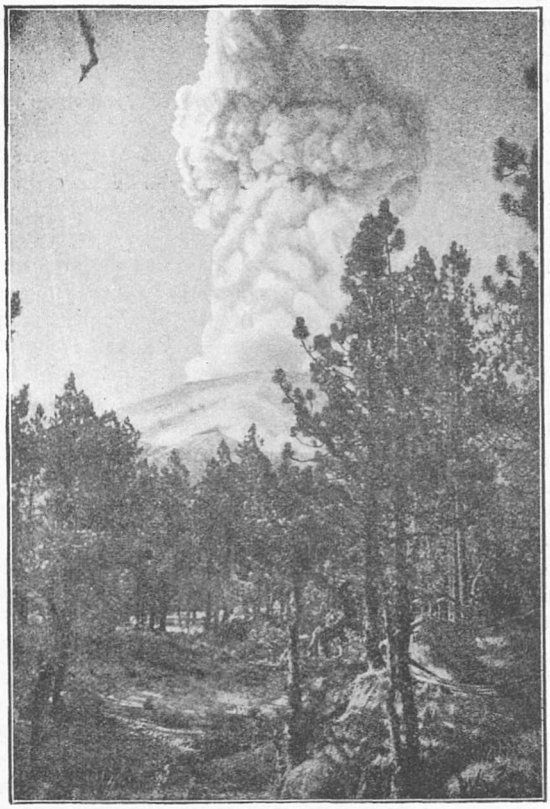


FIG. 1.—Cauliflower clouds of a steam eruption of Popocatapetl, October 12, 1920. From the *American Journal of Science*, January, 1921.

it appears that the old central plug of 1720, formerly concealed by a lakelet, is now being pushed upward in the crater-floor. Two fine photographs accompany the paper, one of which is here reproduced.

THE current issue of the Journal of the Institute of Petroleum Technologists contains, among other papers, some interesting details by Capt. Paul H. Mangin on boring in Palestine in search of water during the progress of military operations from 1917 to 1919. Although both drilling *personnel* and equipment were initially somewhat crude, very creditable results were achieved, no less than a gross total of 5500 ft. being drilled in the putting down of forty-five wells, from which something like 1,500,000 gallons of water per day were obtained. The area in which the wells were sunk borders the coast between the Egyptian frontier (at Rafah) and Mount Carmel on the north. The chief difficulties encountered apart from those mentioned were the loose nature of the sands penetrated and the prevention of their caving in and blocking up the hole. Five types of drilling rig were used, but the best results were obtained by the hydraulic percussion system with mud flush. An important feature of the work was the excellent log kept of each well, which, together with samples of the formations met with, have been preserved for future reference. Although having no

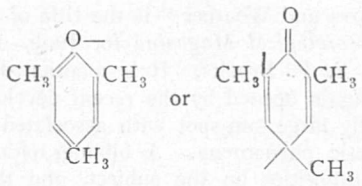
direct bearing on oil, the results of this work are of great interest to petroleum technologists generally, and also presumably to those who are optimistic enough to believe in Palestine as a potential oilfield.

PART 2 of vol. xxii. of the Transactions of the Optical Society contains the address of the president, Mr. R. S. Whipple, which deals with the design and construction of scientific instruments. Such instruments must have as their principal characteristic the property of giving results of a constant prescribed accuracy, and all the important sources of inaccuracy in them should be known. Errors should be capable of elimination by adjustment of the instruments themselves, or if elimination is not possible, they should be measurable by the instruments. The design of an instrument involves the consideration of the magnitudes of the errors to which it may be liable, and it is this preliminary survey which prevents the cost of manufacture being increased by the removal of insignificant errors while others more serious are allowed to remain. Examples of well-designed slides, rotating parts, screws, and nuts are given, and it is clearly shown why they are good. A nut of unsound design used on gun clinometers which the authorities preferred to one designed on geometrical principles is also shown. The address will repay reading by all instrument-makers who wish to meet the new demand for scientific instruments in industry.

THE fourth report of the Conjoint Board of Scientific Societies shows that the board has received evidence that scientific investigation is being seriously hampered by the heavy cost involved in the publication of results. An exceptional number of papers is being communicated to the scientific societies, including many held up during the war, while the resources of the societies, which have not increased, are insufficient at present prices to publish even the normal pre-war number. The country is thus in danger of being seriously handicapped at a time when the rehabilitation of industry is in most serious need of scientific assistance. Much of the report is occupied with an abstract of the third report of the Committee on the Water-Power Resources of the Empire. It is shown that too little is being done to ascertain the total resources or to secure uniformity in investigation and record. It is urged that steps should be taken to convene an Imperial Water-Power Conference in London, at which the various Dominions and Dependencies of the Empire should be represented. The outcome of such a conference might well be the creation of an Imperial Water-Power Board, with extensive powers to carry out a comprehensive policy for stimulating, co-ordinating, and, where necessary, assisting development throughout the Empire. The board has also dealt with questions relating to the formation of national research committees in connection with the International Research Council formed in 1919, with the collection of scientific data in the former German colonies, and with instruction in technical optics. The research on glues and other adhesives initiated by the board as a war measure, at the instance of the Air Ministry, has now been taken over by the Department of Scientific and Industrial Research.

THE trials of the motor vessel *Yngaren* were run successfully off the Tyne on Tuesday, June 14, and an account appears in *Engineering* for June 24. The main engine of this vessel is of the opposed piston type, with four cylinders 22·8 in. diameter by twice 45·6 in. stroke. When running at its normal speed of 77 revs. per min. the engine develops 3000 indicated horse-power (2700 brake horse-power), or 675 brake horse-power per cylinder, and is therefore the highest-powered Diesel cylinder as yet installed in any ship. The ship is also notable on account of having but one propeller. In view of the large power per unit and of there being but one engine, the designers were conservative, and the metal and sections are more than ample for the working stresses, with a large factor of safety. The weight of the main engine is 375 tons, and of the whole installation 600 tons. Starting is exceptionally easy to accomplish, and contributory to this result are hot pistons and hot jackets. During the sea trials the outlet temperatures from the pistons and cylinder jackets were 140° to 160° F. The fuel injection into the main engine cylinders works on the solid injection principle, and is effected at pressures of 8000 to 10,000 lb. per sq. in. at full power and speed.

THE preparation of a compound which may contain univalent oxygen is announced by C. W. Porter and F. H. Thurber, of the University of California, in the April issue of the Journal of the American Chemical Society. The substance is obtained by the oxidation of mesitol (2 : 4 : 6-trimethylphenol) by silver oxide. A red crystalline product was obtained, the molecular weight of which indicated that it contained in combination equimolecular amounts of unoxidised mesitol and an oxidation product corresponding to one of the formulæ:



It may, therefore, contain either univalent oxygen or tervalent carbon. It is reduced to a saturated product by the addition of an uneven number of hydrogen atoms, indicating that it contains an odd electron, and has therefore the characteristic properties of a free radical.

IN consequence of the greatly increased cost of production, the Association of Economic Biologists has issued an appeal for financial assistance towards the publication of the eighth volume of the *Annals of Applied Biology*. In order that the present standard of quality of the *Annals* may be maintained, it is necessary that the sum of 250*l.* should be raised. Workers in applied biology are therefore earnestly invited to contribute to the appeal fund. Any contribution, however small, will be acceptable, and should be sent to the honorary treasurer of the association, Dr. A. D. Imms, Institute of Plant Pathology, Rothamsted Experimental Station, Harpenden.

MESSRS. MACDONALD AND EVANS, 29 Essex Street, W.C.2, are about to begin, under the editorship of Mr. G. W. de Tunzelman, the publication of a new

series of manuals entitled "The Reconstructive Technical Series," the aim of which is to diffuse the new knowledge and enlarged technical skill gained during recent years, and so to make it available for to-day as a means towards greater all-round efficiency and increased competitive power in the world's markets. The first volume—"Engineering Steels: An Exposition of the Properties of Steel for Engineers and Users to Secure Economy in Working and Efficiency of Result," by Dr. L. Aitchison—will be published almost immediately.

IN recent correspondence on the subject of picture-hanging wire, copper or brass wire has been recommended. Mr. N. M. Richardson now writes to condemn these materials for this purpose on account of the brittleness which develops in the course of a few years. He advises the use of galvanised iron wire, which can be painted a suitable colour if desired. Such wire has been found to be very trustworthy and permanent unless it is exposed to damp.

ADMIRERS of the late Sir William Abney will be interested to learn that the Abney memorial lecture by Mr. Chapman Jones (delivered before the Royal Photographic Society of Great Britain on April 26 last) is printed in full in the July issue of the *Photographic Journal*. Copies of the journal are obtainable from the publishers, Messrs. Harrison and Sons, Ltd., 45 St. Martin's Lane, W.C.2, or the Society, 35 Russell Square, W.C.1.

WE have received from Mr. R. S. Frampton, 37 Fonthill Road, N.4, a catalogue (No. 26, 1921) of second-hand books dealing with science—mainly natural history and gardening. Some 1056 works are listed, and the prices asked are low. The catalogue is obtainable upon application to the bookseller.

MESSRS. GEORGE BELL AND SONS, LTD., announce the publication by them in the autumn of a full report of the proceedings of the Congress of the Universities of the Empire now in progress.

Our Astronomical Column.

THE CAPE OBSERVATORY.—Expression is given by Sir Joseph Larmor, in a letter to the *Times* of July 4, to the apprehensions that are felt among astronomers as to the effect of the proposed transference of the Cape Observatory from the Admiralty to the South African Government. Judging by the condition of the Australian observatories, which at all stages of their existence, and never more than at present, have been greatly hampered through lack of funds, the change would not be to the advantage of astronomy. Further, the suggested transfer would greatly weaken the close bond of reciprocity that has from the first linked the Greenwich and Cape Observatories. It is greatly to be desired that the proposal, which would be little short of a disaster to astronomy, may yet be averted.

THE COMET PONS-WINNECKE.—This comet has now passed out of sight of northern observers, but ephemerides have been sent to southern observatories, where it may be observed for two or three months more. Mr. G. Merton has revised the orbit by using observations extending from April 12 to June 2. He finds

$$\left.\begin{aligned} T &= 1921\ \text{June}\ 12{\cdot}8985\ \text{G.M.T.} \\ \omega &= 170^\circ\ 12'\ 34'' \\ \Omega &= 98^\circ\ 12'\ 37'' \\ i &= 19^\circ\ 1'\ 7'' \end{aligned}\right\} 1921{\cdot}0$$

$$\log a = 0{\cdot}52957$$
$$e = 0{\cdot}69242$$
$$q = 1{\cdot}0411$$

The most uncertain element is $\log a$, for which the above value is almost certainly too large. It gives a period of 6·23 years, whereas the true value is unlikely to exceed 5·93 years. But the other elements would not be greatly altered by this change.

Mr. Denning writes:—"On the night of June 28 I saw some bright meteors, several of which presumably belonged to the shower from Pons-Winnecke's comet. It is desirable to procure duplicate observations of these objects if possible, for the purpose of working out their real paths, and ascertaining whether or not their radiant points nearly coincide with that computed for the above comet.

"The following are the times and apparent paths of six of the more noteworthy meteors seen here, and if any of them have been observed elsewhere I shall be very glad to receive such details as were recorded. It need only be said with reference to the objects that No. 4 in the list was a splendid fireball, and that No. 5 is included on account of its exceedingly slow motion. No. 2 was not accurately observed, owing to its flight being partly intercepted by a building. Nos. 1 and 4 were directed from radiants far distant from that of Pons-Winnecke.

Meteors recorded June 28, 1921.

No.	G.M.T. h. m.	Mag.	From ° °	To ° °	Notes.	Radiant ° °
1	11 49	> ♃	236+48½	212+45½	Rapid, streak	303+24
2	11 56	> 1	318− 1	327− 7½	Slow, white	? P.-W.
3	12 22	1	293+15	298+ 5	Slowish	P.-W.
4	13 18	5×♀	339+33	348+18	Slow	P.-W.
5	13 30	2	311+67	330+61	Very, very slow	P.-W.
6	13 34	♃	319+19½	312+ 2	Rapid, white	70+66

THE FIGURE OF THE EARTH.—An article on this subject by Prof. T. J. J. See (*Astr. Nach.*, Nos. 5103-4) is interesting as an historical summary of the progress of knowledge on the subject. Sir Isaac Newton recognised that the compression was considerably less than 1/230, the figure for equilibrium with a homogeneous fluid earth. The three chief methods have been (1) the measurement of arcs of latitude, (2) lunar perturbations, and (3) pendulum observations. In 1751 La Condamine published the value 1/303·6, deduced from measurement of arcs of latitude in France and Peru. In 1802 Bürg found the value 1/305·05 from method (2). These two values were surprisingly good for that early period, but still not entitled to any weight compared with modern determinations, although Prof. See assigns some to them. The figure 1/293·465 was published by Clarke in 1878, and generally superseded Bessel's value of 1/299·1528, although the latter now appears to be closer to the truth. In recent years methods (1) and (3), in the hands of Helmert, Hayford, Bowie, and others, have given very consistent results, from which the weighted mean 1/298·3 is deduced. Prof. See gives a useful table for obtaining geocentric latitude and radius vector on this assumption, and notes that in his opinion the value 1/294, adopted in Brown's Lunar Tables, is decidedly too large.

Sir Ernest Shackleton's New Expedition.

SIR ERNEST SHACKLETON announces in the *Times* and *Daily Mail* a new Antarctic expedition to start under his leadership in August. The region to be explored is that missing part of the Antarctic coastline which lies between Drygalski's Wilhelm Land and Bruce's Coats Land. In this stretch the only land known with certainty is the bold headland of Cape Ann, or Enderby Land, discovered by J. Biscoe in 1831, but never visited. Cape Ann probably marks the edge of the continent. Kemp Land, a little further east and also on the Antarctic Circle, was reported in 1833, but its existence needs verification. Cook (1773), Biscoe (1831), Bellingshausen (1820), and Moore (1845) were each thwarted by pack in their attempts to push southwards to the west of Cape Ann. In lat. 68° 5′ S., long. 16° 37′ E., Bellingshausen was probably not far from land, but these early navigators took no deep soundings. A large bight in the coastline in this region is improbable, but glacier tongues may occur, and, by obstructing the free movements of the pack along the coast, make approach and landing difficult. Sir E. Shackleton hopes to avoid wintering in the south, and plans to sail northwards from Coats Land through the more open eastern part of the Weddell Sea to the South Sandwich group and South Georgia. After refitting he proposes to sail eastward *via* Bouvet and Heard Islands to New Zealand, taking deep-sea soundings on the way. It will prove no easy matter to sound in the stormiest seas in the world, but it is to be hoped he will be successful and so amplify the work of the *Valdivia* and *Scotia*, and further east that of the *Challenger* and *Gauss*. On the way home soundings are to be taken in high latitudes in the south-eastern Pacific.

In addition to his Antarctic work Sir E. Shackleton proposes to visit a number of isolated islands and to search for others the existence of which is doubtful. In the latter category is Dougherty or Keates Island, which was reported in lat. 59° 40′ S., long. 110° 45′ W., in 1841, and since has been sighted only once and several times searched for in vain. It probably has no existence. Search is also to be made for Tuanaki, a legendary island in lower latitudes in the South Pacific. Of the other islands in the expedition's list, a few afford scope for exploration, but others are well known, even if seldom visited. St. Paul's rocks, near the Equator, have been explored by a number of scientific expeditions, from that of the *Beagle* (1832) to that of the *Scotia* (1902). Their geology, birds, and scanty plant-life are well known. South Trinidad achieved fame from Mr. E. F. Knight's cruise in the *Alert*, and was visited in 1902 by the *Discovery*; little new can be expected there. Gough Island, or, more correctly, Diego Alvarez, 280 miles south-east of Tristan da Cunha, promises more interest. The only scientific expedition that has ever visited that island was the *Scotia*, which in 1904 secured several new species of birds and plants. Heard Island was explored by the *Challenger*, but Bouvet Island, discovered in 1739, and sighted again and even photographed in 1898, is quite unknown. It appears to be ice-capped and is said to be inaccessible. Interesting work will be done in the South Sandwich group, which is imperfectly explored, even if known to sealers at one time. In South Georgia work remains to be done on the east and south coasts.

The expedition is to be equipped for oceanographical work, which will be conducted throughout the voyage. Meteorological research will be assisted by the use of a specially constructed seaplane and pilot balloons.

In the *Quest* the expedition has a first-rate ship for the work. She is a Norwegian wooden vessel of some 200 tons, built four years ago, and thoroughly tested in hunting and trading in the Barents Sea and Spitsbergen waters. The *Quest* has auxiliary engines, and will be rigged as a brigantine. Sir E. Shackleton will be accompanied by six members of his former expeditions, including Mr. F. Wild, Capts. F. Worsley and J. R. Stenhouse, Dr. A. H. Macklin, and Mr. L. Hussey, meteorologist. No other names of the staff are announced, but the *personnel*, which is to be small, is said to be complete. The expedition is financed by Mr. J. Q. Rowett, and will be styled the Shackleton-Rowett Oceanographical and Antarctic Expedition. Mr. F. Becker has also given generous support.

R. N. R. B.

Milk Customs of Bunyoro, Central Africa.

ON June 21 the Rev. J. Roscoe read a paper on "The Milk Customs of Bunyoro" at a meeting of the Royal Anthropological Institute. Mr. Roscoe, after a brief account of the distribution of the main groups of peoples in Central Africa, described the chief social and religious ceremonies of the Bunyoro, of which the ritual of the milk formed a part. These ceremonies have become obsolete under the influence of Christianity, but they were revived and re-enacted so far as possible in order that Mr. Roscoe might have an opportunity of witnessing them.

The King of Bunyoro is expected to put an end to his own life as soon as he feels his powers failing through illness or old age. His death is announced by one of the milkmen of the sacred cows in the words, "The milk is spilled," pronounced from the roof of a hut and accompanied by the breaking of a pot of milk. This man and the boy whose duty it is to bring the cows to the royal enclosure to be milked are thereupon put to death in order that their spirits may serve the king in the next world.

The princes who lay claim to the throne now take to arms and fight until only one is left alive. This survivor claims the body of the king, which lies in the royal enclosure unburied until he comes. Mourning then begins, and the dead king is buried in a pit filled up with barkcloths in a specially built hut. Two of his widows are buried alive with him. The country is then purified by the new king's sister, who sprinkles the people and cattle gathered in the royal enclosure with a mixture of water, white clay, and milk. A sham king is appointed for the purpose of removing sorrow and sickness. He is set on the throne, receives homage and gifts, and is then taken aside and strangled by the chief minister. The new king then moves to a new royal enclosure and begins his reign.

The king, as the chief priest for the people and cattle, has a constant succession of ceremonial duties to perform. His food is milk from nine sacred cows brought in from the royal herd and milked with much ceremony. While the king drinks everyone in the royal enclosure kneels down and hides his face; a cough or sneeze is punishable by death. Later in the day the king has a meal of four pieces of meat served by the royal cook, who has to place them in the

king's mouth with a fork; should the fork touch the king's teeth the cook is instantly put to death. All who have to do with the king's food, either milk or meat, are specially purified, and have their faces, chests, and arms whitened. Daily the king has to pass through a series of seven sacred huts for the purpose of herding three of the sacred cows in a special enclosure. The rest of the day he is occupied largely with royal duties, receiving and judging his people.

At every appearance of the new moon there are festivities which last nine days. The king, as soon as the new moon appears, pronounces a blessing on the people, and dancing and music begin, continuing day and night for a week. On the second day the king proceeds through the seven sacred huts to the place where he daily herds the sacred cows, and there he receives any member of the Sacred Guild who has offended. The mark of pardon is to be allowed to kiss the king's hands, and, however kindly the king may address the man, unless he holds out his hands to be kissed, the man knows that he has only a few days to live.

The admission of a new chief to the Sacred Guild is also a milk ceremony of importance, for the new chief has to drink some of the king's sacred milk in the presence of the king. The experience is so trying that men sometimes faint under the ordeal.

The king holds an annual celebration of his accession to the throne, when to defeat his enemies he shoots arrows to each quarter of the globe from a special bow strung with sinews cut from the shoulder of a living man. Once a year also the king calls for a blessing on the land by offering pieces of meat to each of the four quarters of the globe.

In reply to questions asked after the reading of the paper, Mr. Roscoe said that the reason for these ceremonies, as given by the natives themselves, was purely economic. The aim was to promote the well-being of the cattle and the crops.

Trees and Shrubs of Mexico.

THE first instalment of an account of the woody plants of Mexico, by Mr. Paul C. Standley, is issued as vol. xxiii., part 1, of the Contributions from the United States National Herbarium. The work is based upon the extensive series of Mexican plants in that institution. The botanical features of Mexico have attracted attention from the days of the earliest explorers, and many botanists have visited the country within the last hundred years, yet the flora is still but imperfectly known. The plant formations are remarkably diverse, including the wet tropical forests of the southern lowlands, the temperate deciduous and coniferous forests of the central plateau and of the ranges of the Sierra Madre, the alpine zones of the high peaks like Orizaba and Popocatepetl, and the great barren or cactus deserts in the northern States. For anything approaching a complete account of the flora of Mexico we have hitherto had to rely on Dr. Hemsley's list in the "Biologia Centrali-Americana," published nearly forty years ago; much botanical work has been done in the country since that time, and a descriptive flora which will give an account of present knowledge and serve as a starting-point for further work is a desideratum.

Mr. Standley deals only with the trees and shrubs, the larger number of which, especially those of economic importance, are probably already represented in herbaria. In his introduction he gives an interesting account of several of the earliest enterprises for the botanical exploration of Mexico, including that of Francisco Hernandez, 1570–77, and that of Martin Sessi and Jose Mocino more than two centuries later. Large collections of plants and sketches were made in connection with both these expeditions, and extensive accounts prepared in manuscript, but the work of Hernandez was not published until long after his death, and then only in an abridged form; while Mocino's "Plantæ Novæ Hispaniæ" and "Flora Mexicana" were issued by the Sociedad Mexicana de Historia Natural in 1886 and 1888 respectively, by which time their interest had become merely sentimental.

The present instalment of Mr. Standley's work deals with the ferns, gymnosperms and monocotyledons, and a few families of dicotyledons. By an oversight no clue to the general systematic arrangement has been given; there is an elaborate key to the families, which should have been given numbers. Keys to the genera are supplied under each family and to the species under each genus; references to the original description of genus and species are given, the range of each species so far as it is known is indicated, and in some cases short descriptive notes are added; the native names and economic uses are also mentioned. The ferns (elaborated by Mr. W. R. Maxon) are nearly all tree-ferns; the conifers include twenty-six species of pine, and a few cypresses, junipers, ephedras, and others. There are a few grasses—bamboos, reeds, etc.—eighteen genera of palms, and, though strictly herbaceous, three genera of climbing aroids are included. Prof. Trelease has been largely responsible for the account of the liliaceous and amaryllidaceous plants, types characteristic of dry country, including the yuccas and agaves, species of the latter genus numbering 170. The dicotyledons include fifty-nine species of Piper, poplars, willows (sixteen species), walnut and hickory, and alders (six species).

University and Educational Intelligence.

BIRMINGHAM.—At a degree congregation held on July 2 the Chancellor (Lord Robert Cecil) conferred the following degrees:—*D.Sc.*: Fred Johnson; *M.D.*: John Shaw Dunn; *Ph.D.*: H. D. K. Drew, Abd el Rahman El Sawy; *M.Sc.*: F. Adcock, C. F. Allpress, H. Burgess, V. A. Collins, W. A. P. Challenor, J. G. H. Frew, C. V. Hackett, Lucy E. Hardcastle, W. J. Hickinbottom, T. L. Ibbs, D. H. Ingall, F. James, L. A. Jones, E. W. Pratt, E. A. F. Reeve, H. S. Rooke, F. G. Srawley, R. C. Watson, Dorothy Webster, and E. H. Wells.

In addition 134 candidates were admitted to the degree of B.Sc.

The Chancellor announced that the recent appeal had brought in 285,062*l.*, besides increased grants from education committees in the surrounding counties.

A generous donation of 5000*l.* from Mr. C. Hyde has enabled the University to acquire a house, to be converted into a hostel for about seventy men students.

CAMBRIDGE.—A travelling fellowship of 200*l.*, offered to past students of Girton College, and tenable at any foreign or colonial university, has been awarded to Miss M. G. Tomkinson, assistant lecturer in chemistry, Girton College. Miss Tomkinson proposes to work in the chemical laboratory of the University of Toulouse, under the direction of Prof. Sabatier.

DUBLIN.—Mr. D. Clark, lecturer in civil engineering and chief assistant to Prof. Moncur in the Royal Technical College, Glasgow, has been elected to the chair of civil engineering at Trinity College.

The honorary degree of LL.D. has been conferred

upon Sir R. A. Falconer, president of the University of Toronto, and that of D.Sc. upon Prof. E. Borel, of the University of Paris. The ordinary D.Sc. degree has been conferred upon Mr. J. H. J. Poole and Mr. G. de P. Cotter.

DURHAM.—The honorary degree of D.Sc. has been conferred upon Sir E. H. Tennyson-d'Eyncourt, director of naval construction, the Admiralty.

It is proposed to confer the following honorary degrees on the occasion of the forthcoming meeting of the British Medical Association at Newcastle-upon-Tyne:—*D.C.L.:* Sir William Macewen, Sir Thomas Oliver, and Sir Humphry Davy Rolleston. *D.Hy.:* Mr. T. E. Hill and Dr. J. W. Smith. *D.Sc.:* Sir Arthur Keith. *D.Litt.:* Sir Dawson Williams.

LEEDS.—The gas plant specially designed for experimental purposes which Mr. Henry Woodall is erecting as an adjunct to the Department of Coal Gas and Fuel Industries of the University of Leeds, and as a memorial to the late Sir Corbet Woodall, is now in process of construction. Mr. A. G. Glasgow, having expressed his desire to associate himself with this memorial, has made a donation of 500 guineas for the purpose.

OXFORD.—Mr. W. C. Burnett, Worcester College, has been appointed secretary of the Delegacy of Local Examinations in succession to the late Mr. H. T. Gerrans.

Mr. P. H. Martin, New College, has been elected to the Theodore Williams scholarship in anatomy, the annual value of which is 50*l.* and tenable for two years.

MR. A. W. SHEEN has been appointed professor of surgery in the Welsh National School of Medicine.

THE Joint Committee of the Royal Society and the University of Sheffield has appointed Dr. N. K. Adam to the Sorby research fellowship.

PROF. H. C. PLUMMER, Royal Astronomer of Ireland, and Andrews professor of astronomy in the University of Dublin, has been appointed professor of mathematics at the Ordnance College, Woolwich.

THE London County Council has adopted a recommendation of the Education Committee that the Board of Education and the Senate of the University of London be invited to explore the possibilities of the Holland Park site before further action is taken relating to the Bloomsbury site

ANNOUNCEMENT is made of the following gifts:—Bristol University has received from Mr. H. H. Wills the sum of 200,000*l.* to build and equip a new physics laboratory; and Glasgow University and the Royal Technical College, Glasgow, have received 10,000*l.* each under the will of the late W. J. Chrystal, chemical manufacturer.

AN election to the Ackroyd memorial research fellowship in the University of Leeds is to be made shortly. The selected candidate will be expected to carry out an approved scientific investigation of a biological, physical, or chemical nature bearing, directly or indirectly, upon the production or properties of wool or other textile materials, or upon the manufacture of textile fabrics. The fellowship is of the annual value of 300*l.* It is tenable for one year, and renewable for a second or third year. Applications must be made to the Registrar of the University by, at latest, July 28.

Calendar of Scientific Pioneers.

July 7, 1854. Georg Simon Ohm died.—The fame of Ohm rests mainly on the small pamphlet, "Die galvanische Kette mathematisch bearbeitet," published by him in 1827, when he was professor of mathematics at the Jesuit College, Cologne. His well-known law was first enunciated a year or two earlier.

July 8, 1784. Torbern Olof Bergmann died.—The contemporary of Scheele, Bergmann from 1767 held the chair of chemistry at Upsala. He made improvements in the methods of chemical analyses, and in 1775 published his essay on "Elective Attractions."

July 9, 1716. Joseph Sauveur died.—The great pioneer worker in acoustics, Sauveur was educated for the Church, but in 1686 became professor of mathematics in the Collège de France. His study of sound covered the last twenty years of his life.

July 9, 1856. Amedeo Avogadro, Conte di Quaregna, died.—Of noble parentage, Avogadro, from 1809 to 1821, was professor of physics and mathematics at Vercelli, where in 1811 and 1814 he published the memoirs containing the law which bears his name.

July 10, 1910. Johann Gottfried Galle died.—When assistant to Encke at Berlin, Galle and D'Arrest, at Leverrier's request, searched for Neptune with the aid of Bremiker's map. Galle first saw the planet on September 23, 1846. Afterwards he was for many years director of the Breslau observatory.

July 11, 1807. George Atwood died.—A distinguished Cambridge mathematician, Atwood first described his well-known machine in 1784 in his treatise on the rectilinear motion and rotation of bodies.

July 11, 1909. Simon Newcomb died.—One of the most distinguished astronomers of recent times, Newcomb, in 1857, at the age of twenty-two, entered the office of the American Nautical Almanac, of which from 1877 to 1897 he was director. Like his colleague Hill, he was a great master of dynamical astronomy.

July 12, 1682. Jean Picard died.—Picard has been called "the father of French astronomy." He was an assistant to Gassendi, visited Tycho Brahe at Hven, edited the "Connaissance des Temps," measured a degree of the meridian, and first used the telescope with the quadrant.

July 12, 1851. Louis Jacques Mandé Daguerre died.—One of the inventors of photography, Daguerre was a successful scene painter, and part owner of a diorama in Paris. Six years after the death of Niepce, with whom he had collaborated, Daguerre, in 1839, obtained sun pictures on silver plates covered with a film of iodide.

July 13, 1762. James Bradley died.—Recognised as one of the greatest astronomers of the first half of the eighteenth century, Bradley became Savilian professor of astronomy in 1721, and in 1742 succeeded Halley as Astronomer Royal. His discovery of aberration was made known in 1729; that of nutation in 1748. His Greenwich observations are of great importance, and were reduced first by Bessel and then by Auwers.

July 13, 1896. Friedrich August Kekulé von Stadonitz died.—The friend of Gerhardt and Williamson, Kekulé was especially known for his speculations on structural chemistry. His work on the benzene theory has been described as "the most brilliant piece of scientific prediction in the whole range of organic chemistry." His statue stands outside the fine chemical institute at Bonn. E. C. S.

Societies and Academies.

LONDON.

Zoological Society, June 7.—Prof. J. P. Hill, vice-president, in the chair.—Major S. S. **Flower**: Remarks upon *Testudo Leithii* and *T. ibera*.—Dr. P. Chalmers **Mitchell**: Remarks upon a photograph of the death-mask of a young gorilla.—Dr. F. M. **Chapman**: The distribution of bird-life in the Urubamba Valley, Peru.—S. **Maulik**: New Indian Drilid beetles.—Prof. J. P. **Hill**: Some marsupial embryos, especially the koala (Phascolarctos) and the wombat (Phascolomys).—R. I. **Pocock**: The external characters of the koala (Phascolarctos) and some related marsupials.—Dr. C. F. **Sonntag**: The comparative anatomy of the koala (Phascolarctos) and the vulpine phalanger (*Trichosurus vulpecula*).—C. T. **Regan**: The Cichlid fishes of Lake Nyassa.

Royal Meteorological Society, June 15.—Mr. R. H. Hooker, president, in the chair.—G. M. B. **Dobson**: The causes of errors in forecasting pressure gradients and upper winds. The usual method of checking the accuracy of forecasts by finding their absolute error is misleading, particularly when the weather is very settled. It would be better to find the improvement obtained by "forecasting," *e.g.* to compare the absolute error of the forecast, made for twenty-four hours ahead, with the actual change of direction in the twenty-four hours. Trial forecasts of the pressure gradient when checked thus showed but small improvement; the inaccuracy in estimating the future positions of centres of high and low pressure is a large factor, but a greater error is due to the small irregularities of pressure which are local and transitory, and which, therefore, seem almost impossible to forecast.—R. F. **Granger**: The physical structure of cloud form in the lower atmosphere. Beginning with a constructive criticism of the theory of cumulus formation, the behaviour of eddy-formed stratus sheets, the possibility of outward radiation at night, causing cloud formations, and the formation of sub-strata underneath various types of cloud sheet are discussed. The last part of the paper deals with cyclonic nimbus, and describes the cloud structure of a cyclone while rain is falling: that actual rain-producing cloud is formed by the ascent, *en masse*, of the eddy-formed damp layer. A cirrus-like cloud forms at low altitude during the passage of one air current over another if the movement set up by friction causes the elevation of a damp layer in the upper air current. The interpretation of cloud form in terms of physical structure will probably have a place in the weather forecasting of the future.—N. A. **Comissopulos** and J. **Wadsworth**: Variability of temperature over Europe and North America (1900–9). The variability of temperature is measured in this paper by standard deviations from the mean of ten values of the annual mean temperature from 1900 to 1909 for a large number of European and North American stations. The small number of years considered is an objection, but consistent results have been obtained. No correlation is found between altitude and temperature variability, but a fair connection is indicated between latitude and temperature variability. Charts of isopleths representing variability of temperature show generally an increased variability towards the north, but a decrease towards the coasts. Secondary maxima and minima occur, the positions of which follow the configuration of the land in Europe; maxima occur over N.E. Russia, W. Germany, France, and Spain, and minima over the Atlantic and Mediterranean. A chart of S.W. Europe for 1890–99 showed the same general features as that for 1900–9, but with different absolute values for the various isopleths.

Royal Statistical Society, June 21.—Sir R. Henry Rew, president, in the chair.—Mrs. W. J. **Barton**: Women's minimum wages. The main sources of the figures given were the wage rates for unskilled women collected in the *Labour Gazette* and those settled by the Trade Boards. The rates quoted were all minima, and it was difficult to ascertain the proportion of workers earning more than the prescribed rates. The paper dealt with the groups of women workers affected by Trade Board legislation; *e.g.* the distributive trades, sewing trades, laundries, sugar, confectionery, and fruit-preserving trades, paper and printing trades, and the metal trades. Each trade was examined in detail; tables were submitted showing the Trade Board rates payable in different districts and the changes therein at different dates, and where possible the various wages paid by voluntary agreement between employers were given for comparison with the legal rates. Trade Boards had raised the wages of the lowest paid workers, and uncontrolled trades had been strongly influenced, while several trades possessing Trade Boards had agreed upon rates considerably above the legal minimum. A minimum standard wage for the unskilled work of women and girls had been created.

Mineralogical Society, June 21.—Dr. A. E. H. Tutton, past president, in the chair.—Dr. H. **Hilton**: A note on crystal measurement. Labour could be saved by measuring the angles between zones through two faces instead of the angles between zones through one face and the angles between this face and the rest.—A. **Brammall**: The trend of reconstitution processes in shales, slates, and phyllites. The author correlates microscopical data with data deduced from chemical analyses. The finely powdered rock is extracted with (*a*) 20 per cent. of hydrochloric acid, (*b*) 50 per cent. of hydrochloric acid, and the extracts are analysed and discussed with reference to the molecular proportions of the bases present. The residual slime is treated with dilute hydrofluoric acid, freed from silica gel, and thoroughly washed. Free carbon particles are floated off by the froth produced on vigorously shaking up the slime with water to which a few drops of amyl alcohol, paraffin, and sodium silicate have been added. Samples of coarse-grade and fine-grade sericite are separated by elutriation and analysed. Heavy or insoluble residues are obtained and examined. Data referring to Bolivian rocks and the Skiddaw Slate are discussed. The general trend is towards the establishment of a metastable ternary system of white mica, chlorite, and quartz by a process of molecular differentiation: (*a*) Monad-oxides, type R_2O, allied with alumina, silica, and water (mica); (*b*) diad-oxides, type RO, allied with alumina, ferric oxide, silica, and water (chloritic matter); and (*c*) free silica (quartz). In the early stages this differentiation is imperfect: the mica contains iron oxides, magnesia, etc., and the chloritic matter adsorbs alkalis. The identity of mineral species evolving from the chloritic matter depends partly upon the molecular ratio R_2O_3 : RO, and this in turn depends partly upon the reduction of ferric oxide to ferrous oxide. The development of rutile, ilmenite, epidote, etc., is probably subordinate to the main trend.—W. A. **Richardson**: The micropetrography of the rock-gypsum of Nottinghamshire. A wide range of structural types, including many metamorphic types, are found. The evidence supports the view of B. Smith that the main series is of sedimentary origin, and that the nodular deposits are

segregations. The metamorphic effects appear to be due to pressure caused by the partial or complete hydration of the anhydrite.

EDINBURGH.

Royal Society, June 6.—Prof. F. O. Bower, president, in the chair.—By request of the council, Lt.-Col. W. Glen **Liston** gave an address on plague and rats. After a brief historical survey Lt.-Col. Liston traced the course of events by which after the discovery of the bacillus in 1898 the connection between rats and the disease was established. The link connecting the plague in rats with the plague in men had still, however, to be found. A curious experience of a friend who had been attacked by a swarm of cat fleas on entering a part of a house which had been disused for some time suggested the possibility that the rat flea might be the agent of transmission of the disease. Some little time later, in a certain tenement in Bombay, rats began to die from plague, and as the rats became scarce, rat fleas began to trouble the inhabitants, and cases of plague began to develop among them. Lt.-Col. Liston received a sample of thirty fleas caught in these circumstances. Of these fourteen were rat fleas. Previous experience had shown that out of 246 fleas caught on men, only one was a rat flea. Evidently the rat fleas, deprived of their normal host, had fastened on man. Another link in the chain of evidence was provided by an outbreak of plague among some guinea-pigs kept in Victoria Gardens. An examination proved that the guinea-pigs, which normally seldom harbour rat fleas, were infected with many of these, and that plague bacilli were found in the stomachs of some of them. Further experiments were made, and while these were in progress the Plague Research Commission was appointed by an advisory committee of members nominated by the Royal Society of London, the Lister Institute, and the India Office. The findings of this Commission, consisting of Major Lamb, Drs. Rowland and Petrie, and Lt.-Col. Liston, have been universally accepted, proving that rats are the chief cause of plague, and that the plague is transmitted from rat to rat, and from rats to men, through the agency of rat fleas.

June 20.—Prof. F. O. Bower, president, in the chair.—M. M'C. **Fairgrieve**: The annual incidence of intelligence and its measurement by the American Army tests. While many boys of high mental ability have their birthdays in the late spring months, there is a distinct risk that boys born in these months may prove to have intelligence rather below the normal. This result, previously indicated by an application of the Burt tests to a limited number of boys, has been confirmed by the application of an American Army test to as large a number of boys as was available. Norms suitable for the application of the Army tests to other schoolboys are also given, as well as some evidence that the average intelligence of public-school boys increases up to an age of twenty years rather than the earlier limit of eighteen or sixteen years given elsewhere.—J. M. **Wordie**: Shackleton Antarctic Expedition, 1914–17: Geological observations in the Weddell Sea area. (1) A description is given of the ice-bound nature of Coats Land, where there are 250 miles of barrier (shelf-ice) cliffs without bare rocks of any sort. (2) Elephant Island, South Shetlands, consists of metamorphic schists, striking N. 70° E. Mr. Tyrrell examined the rocks petrographically for comparison with other West Antarctic rocks, but found no resemblances; he considers them to have been in part volcanic ashes originally, but now much silicified and chloritised. (3) South Georgia is given a different interpretation from that of Mr. Ferguson. Exception is taken to his attempt at subdividing the rocks and to his interpretation of the structure. Instead of monoclinal folds and block-faulting, one sees extremely complicated folds striking N.W.–S.E. An igneous complex was found at the south-east end of the island. Prof. J. W. Gregory's claim of Palæozoic rocks is not considered proved, a Mesozoic age for the whole series being regarded as much more likely on the fossil evidence. There is nothing to show that an arc comparable with the Antilles connected the islands of West Antarctica. The necessary link, however, between the geologically similar regions of Graham Land and Patagonia may perhaps be found, as Prof. Gregory first suggested, more to the west than South Georgia.—Dr. H. **Levy**: The criterion for stable flow of a fluid in a uniform channel. On experimental grounds O. Reynolds found that a simple critical relation exists between the velocity and the size of the channel and the viscosity of the fluid flowing along it, which corresponds to the passage from steady to turbulent eddying motion. Aero- and hydro-dynamical experiments during the past few years indicate the existence of such a critical relation in general. Many curious aerodynamic phenomena centre round the explanation of this critical state. In the present paper, where the question is regarded from a new point of view, it is shown on general grounds that if a distribution of vorticity is imposed on a viscous fluid, a critical relation should exist between the velocity and size of the boundaries and the strength of the vorticity, separating the stable from the unstable state. The case of a channel along which fluid is flowing with a parabolic distribution in velocity is considered in detail, and the critical relation due to the imposition of a symmetrical pair of vortices deduced and discussed.—Prof. P. **Macnair** and C. M. **Leitch**: The genus Clisiophyllum. The representatives of this genus of fossil corals are exceedingly abundant at certain horizons in the Carboniferous rocks of the West of Scotland, especially in that known as the Blackbyre Limestone. These corals were collected, sectioned, figured, and described by a Glasgow geologist, James Thomson, who created a very large number of new genera and species. The type-specimens were afterwards presented to the Kilmarnock Museum, and were involved in the fire that destroyed that institution. The materials studied by the authors include those specimens that were salvaged from the fire and other collections in which the different genera and species had been named by Thomson. These are now in the Kelvingrove Museum, Glasgow. After the examination of several thousand specimens, nine genera and something like eighty species have been included in the genus Clisiophyllum, four variations of which have been suggested round which the genera may be grouped. Eight of these genera were founded on the axial column, and it is on this structure that the four types of variation depend for their significance. The authors hoped they had shown that these variants are linked together in an ontogenetic sequence, and that this is also a phylogenetic sequence. They believed that the elaboration of species and their supposed values as time-indices, as upheld by the late Dr. Vaughan and his disciples, had been carried to a length wholly unjustified by the available evidence, and urged a return to simpler and more natural methods of stratigraphical and palæontological classification.

PARIS.

Academy of Sciences, June 13.—M. Georges Lemoine in the chair.—G. **Bertrand**: Fredholm equations with principal integrals as used by Cauchy.—H. **Mineur**: Functions admitting a theorem of algebraic addition.—J. **Kampé de Fériet**: Hypercylindrical functions.—

J. **Andrade**: Rolling resistance and optical mirror method.—J. **Le Roux**: The law of gravitation and its consequences. A criticism of the theory of relativity.—A. **Foch**: The phenomena of resonance in aspiration turbines. An indication of the danger of resonance phenomena and of the modifications necessary to avoid them.—M. **Rateau**: Remarks on the preceding communication.—R. **Jarry-Desloges**: Contribution to the study of the bright Martian areas. The observations of G. Fournier at Sétif show that on April 25, 1920, when the white polar cap was at a minimum, the eccentricity was sufficient to leave the pole free from white, but in general the eccentricity is less marked.—J. **Popesco**: The value of the surface tension of mercury in various gases. In a vacuum the surface tension of mercury is constant, and the value found, 44·4 mgr. per mm., agrees with the earlier figure of M. Stöckle. In air, ammonia, and sulphur dioxide the surface tension falls rapidly during the first ten minutes, then more slowly, finally after twenty-four hours reaching a figure lower than in a vacuum. The phenomenon is reversible, since on removing the gas the surface tension recovers its original vacuum figure. The change in the surface tension is probably not due to a chemical action of the gas on the mercury.—P. **Lambert**: The use of polarised light for the examination of old pictures. By the use of polarised light the surface reflections can be suppressed, the colours become brighter and details clearer. The method gives an indication whether a picture can be improved by modifying its varnish.—M. and Mme. E. **Henriot**: The double refraction of compressed glass. It is usually admitted, on the basis of Wertheim's experiments, that the dispersion of the double refraction of compressed glass is negligible. The authors' experiments show that there is dispersion in crown glass, and agree with the values calculated by Havelock's law.—L. **Décombe**: The enunciation of the principle of equivalence in thermodynamics.—G. **Déjardin**: The production of the argon spectra by slow electrons.—P. **Loisel**: Rapid method of measuring natural leakage of an electroscope in view of the estimation of radium emanation.—E. **Darmois**: The molybdomalates of ammonium and sodium. The rotatory power is at a maximum when molybdic anhydride, malic acid, and ammonia are present in the molecular proportions 2 : 1 : 2. Sodium salts give the same ratio.—L. **Meunier** and P. **Caste**: The action of sodium carbonate on solutions of chrome alum.—A. **Portevin** and P. **Chevenard**: The retarded solution and premature precipitation of iron carbide in steels, and the influence of the initial state on these phenomena.—Mlle. J. **Apolit**: The dehydration of phenyldimethyl butanol and diphenyldimethyl propanol.—M. **Pariselle**: The composition of French essence of turpentine; α-pinene bromide. α- and β-Pinene have been isolated from 15 litres of French turpentine by long fractional distillation under reduced pressure; the physical constants have been redetermined, and the action of bromine on the hydrocarbons studied. Even when no hydrobromic acid is evolved, the action of bromine on pinene always gives a complex mixture of substitution and addition products, the hydrobromic acid produced being absorbed by the pinene.—A. **Brochet** and R. **Cornubert**: The tetrahydronaphthols.—G. **Tanret**: The influence of ammonium molybdate on the rotatory power of mannite. A complex compound has been isolated by crystallisation of mannite and ammonium molybdate, and this possesses rotatory power. It is unchanged by water, but immediately decomposed by dilute alkalis into ammonium molybdate and mannite, with loss of the rotatory power.—H. **de Pommereau**: The reduction of ethyl naphthoate and a case of reduction of an alcohol to hydrocarbon by sodium and absolute alcohol. Ethyl naphthoate is reduced by sodium and ethyl alcohol, not to the corresponding alcohol, but to a dihydromethylnaphthalene. α-Naphthyl alcohol is reduced under the same conditions to the same hydrocarbon.—J. F. **Durand**: The decomposition of metallic alcoholates and phenates by heat. Sodium methylate on heating splits up nearly quantitatively into hydrogen, sodium acetylide, sodium carbonate, and carbon. Potassium methylate behaves similarly, and there is evidence that at one stage potassium vapour is present. Sodium ethylate and phenate follow a different reaction.—M. **François**: The stereoscopic photography of crystals.—J. **Bourcart** and R. **Abrard**: Some crystalline rocks of Albania.—L. **Lutaud**: Tectonic observations in the pre-Riffian zone of northern Rharb, Morocco.—L. **Cayeux**: The magnetic iron minerals of the Longwy-Briey basin.—S. **Stefanescu**: The correlation of the alveolar cavities, movements, and structure of the last molars of mastodons and elephants.—A. **Boutaric**: Actinometric and polarimetric measurements at high altitudes. The intensity of the solar radiation received at the surface of the soil, for equal thicknesses of atmosphere, varies in the same sense as the polarisations.—P. **Lesage**: Experimental cultures of *Fegatella conica* and some other Muscineæ.—Mme. E. **Bloch**: Modifications of roots and stems by mechanical action.—L. **Lapicque**: The nutritive exchanges of animals as a function of their body weight.—A. **Thooris**: Contribution to the biological study of divers. A physiological study of two men capable of remaining under water several minutes.—A. **Polack**: The effects of chromatism of the eye in complex colour vision.—L. **Roule**: A new deep-sea fish, *Scombrolabrax heterolepis*, caught near Madeira. A detailed account of a new fish caught at a depth of between 800 and 900 metres.—H. **Hérissey**: The synthetic action of α-methyl-*d*-mannosidase.—E. **Kayser**: The influence of the nitrogenous material elaborated by the Azobacter on the alcohol ferment.—C. **Levaditi**, A. **Marie**, and S. **Nicolau**: The virulence for man of the spirochæta of the spontaneous spirillosis of the rabbit. This organism is not pathogenic for man.

MELBOURNE.

Royal Society of Victoria, April 14.—Prof. A. J. Ewart, president, in the chair.—F. **Chapman**: The age of the ironstone beds of the Mornington Peninsula. The author collates the previous evidence, based on the fossils, as to the age of the widespread ironstone beds, and by the recent discovery of certain restricted fossils, shows the beds at Landslip Point and Baxter to belong to the Janjukian stage, intermediate between the older, Balcombian, and the younger, Kalimnan. The fossiliferous ironstone from Baxter is a metasomatised polyzoal limestone, the calcareous portion being entirely replaced by limonite.

CAPE TOWN.

Royal Society of South Africa, May 18.—Dr. J. D. F. Gilchrist, president, in the chair.—Sir T. **Muir**: Note on the product of any determinant and its bordered derivative.—P. A. **van der Bijl**: Some South African stereums. South African fungi of the genus Stereum were described.—P. A. **van der Bijl**: A fungus, *Gibbelula Haygarthii*, sp.n., on a spider of the family Lycosidæ. A fungus belonging to the genus Gibbelula, Cavara, found on a spider, belongs to a species hitherto undescribed, and the name *G. Haygarthii* is suggested.—W. A. **Norton**: Circumcision regiments as a native chronology. The Bechuana circumcision regiments show that a military organisation of native tribes based on the successive circumcision companies of the youth was very widespread in South Africa. In the case of the

Baralong and other tribes, the regiment lists, running back to 1750, indicate where the split between different branches occurred. It is sought to carry them far enough back to illustrate the fission of the tribes now distinct from one another, to which tradition points, but the rapid passing of the old people makes this increasingly difficult and urgent. These lists are of value to history and philology, for they aid in dating events.

Books Received.

Nedbøriakttagelser i Norge utgitt av det Norske Meteorologiske Institutt. Middelverdier, Maksima og Minima. Pp. ix+61+17 plates. (Kristiania: H. Aschehoug and Co.) Kr. 6.00.

Valenzkräfte und Röntgenspektren zwei Aufsätze über das Elektronengebäude des Atoms. By Prof. W. Kossel. Pp. iv+70. (Berlin: J. Springer.) 12 marks.

Transactions of the Royal Society of Edinburgh. Vol. lii., part iv. (No. 31). Shackleton Antarctic Expedition, 1914–1917: The Natural History of Pack-Ice as Observed in the Weddell Sea. By J. M. Wordie. Pp. 795–829+4 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 8*s*.

Tier und Pflanze in Intrazellularer Symbiose. By Prof. P. Buchner. Pp. xi+462+2 Tafel. (Berlin: Gebrüder Borntraeger.) 114 marks.

Les Ressources du Travail Intellectuel en France. By E. Tassy and P. Léris. Pp. xxi+711. (Paris: Gauthier-Villars et Cie.) 50 francs.

Prices and Wages: An Investigation of the Dynamic Forces in Social Economics. By P. Wallis and A. Wallis. Pp. xii+456. (London: P. S. King and Son, Ltd.) 25*s*. net.

Studies of the Development and Larval Forms of Echinoderms. By Dr. Th. Mortensen. Pp. iv+261+xxxiii plates. (Copenhagen: G. E. C. Gad.)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1920. Pp. iv+384+41. 10*s*. net. Additional series XI.: General Index to the Volumes of the Kew Bulletin for the Years 1887–1918. Pp. 202. 7*s*. 6*d*. net. (London: H.M. Stationery Office.)

Technology of Cellulose Esters. By E. C. Worden. (In 10 vols.) Vol. i. Part i., Cellulose, Starch, Cotton. Pp. cxxv+664. Part ii., Nitric, Sulfuric, Mixed Acids. Pp. cxxvii+665–1566. Part iii., Nitrocellulose: Theory, Practice. Pp. cxvii+1567–2376. Part iv., Historical Development. Pp. cxvii+2377–3086A. Part v., Index. Pp. 3087–3709. (London: E. and F. N. Spon, Ltd.) 10*l*. 10*s*. net (5 parts).

Manuel de Vannerie: Technologie Vannière. By E. Leroux and Prof. R. Duchesne. Pp. 376. (Paris: J. B. Baillière et Fils.) 10 francs.

The Journal of the Institute of Metals. Vol. xxv., No. 1, 1921. Edited by G. Shaw Scott. Pp. xiv+522+xxvii plates. (London: The Institute of Metals.) 31*s*. 6*d*. net.

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1920. Pp. 102+4 plates. (Bristol.)

Primitive Society. By Dr. R. H. Lowie. Pp. viii+453. (London: G. Routledge and Sons, Ltd.) 21*s*. net.

Thermionic Tubes in Radio Telegraphy and Telephony. By J. Scott Taggart. Pp. xxiii+424. (London: Wireless Press, Ltd.) 25*s*.

Geological Literature added to the Geological Society's Library during the Year ended December 31, 1913. Pp. 247. (London: Geological Society.) 5*s*.

Life of Alfred Newton, Professor of Comparative Anatomy, Cambridge University, 1866–1907. By A. F. R. Wollaston. Pp. xv+332. (London: J. Murray.) 18*s*. net.

The Physical Society of London: Proceedings. Vol. xxxiii., Part iv. Pp. 207–285. (London: Fleetway Press, Ltd.) 6*s*. net.

Diary of Societies.

THURSDAY, JULY 7.

MEDICO-LEGAL SOCIETY (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.30.—Prof. A. Louise McIlroy: Some Factors in the Control of the Birth-rate.

MONDAY, JULY 11.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. R. Bickerton: The Generic Simplicity and Great Importance of Basic Principles in all Scientific Work. II. The Importance in Biological Science of a Clear Comprehension of the Orbit and Axial Inclination of the Earth.

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