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Research and National Progress.

SIR ALFRED MOND, in a speech at the anniversary dinner of the Chemical Society on March 17, said that the attitude of the House of Commons towards research was much the same as that which led to the loss of the dye industry to this country, and it was manifested recently in the attacks made upon his proposal to spend a few hundred pounds on a laboratory where investigations could be carried out on the behaviour of concrete under different conditions. It is evident, therefore, that there are still people in positions of authority who do not understand the significance of research, and prefer the experience of a practical man to the results of the most careful scientific inquiry. Under the stress of competition such experience often represents the principle of the survival of the fittest, and has, therefore, to be given careful consideration; but more often it carries with it many vestigial characters which can be discarded without loss of function, and possibly with profit.

Research does not, however, signify merely the scientific testing of designs and methods with the object of discovering the factors essential to the fulfilment of a particular purpose. It is true that the chief part of industrial research is concerned with problems of this kind, but though the results thus obtained may improve a product or make a process more profitable, they rarely have more than a limited influence upon industrial progress. The greatest advances are made, not by increasing the effectiveness of known instruments or methods, but by the opening up of completely new fields, and this is more often accomplished by independent and incidental scientific discovery than by the study of particular problems in the light of existing knowledge.

The functions of the industrial research worker are, indeed, those of inventors who, like one of the groups of fellows in Francis Bacon's Solomon's House, devote themselves to the application of experiments "to draw out of them things of use, and practice for man's life, and knowledge." Such workers have a definite object in view, and cannot depart from it into the by-paths which in purely scientific research frequently lead to the most fertile regions. The publications of scientific societies abound in rich fruits of fact and principle garnered from these fields, and from them the inventor or industrial research worker selects what seems to him likely to satisfy his needs. It is the joy of the chase which inspires the scientific huntsman to continue the pursuit of new knowledge, and he is usually content to let others make use of the spoils.

The desire to discover and the insight which discerns practical possibilities in results obtained are thus complementary faculties. To one, progress signifies contributions to the sum of human knowledge; to the other, their profitable exploitation. One type communicates freely to the world whatever it has learned by research; the other seeks to secure patent rights and personal reward for what it devises. Oersted's discovery of the magnetic action of an electric current led eventually to the electric telegraph; Faraday's work on magneto-electricity to the dynamo, and all that is associated with it; Clerk Maxwell and Hertz's to wireless telegraphy; Crookes's tube to X-rays; Fleming's studies of the Edison effect to thermionic valves; the production of ductile tungsten to metallic filament electric lamps, of Perkin's mauve to the synthetic dyes industry, of acetylene to the oxyacetylene welding process, of potassium to the whole electrolytic industry, and of various rare metals to a series of alloys of prime industrial importance. In these and hundreds of other similar examples the seeds were first found by purely scientific workers, and it was usually not until some years later that they were planted and cultivated by ingenious practical men so that the human race could benefit by the fruits from the great trees that have sprung from them.

Just as wealth has to be created before it can

be distributed, so new knowledge has to be gained before it can be applied. The political party which concentrates attention upon inequalities in the distribution of wealth, and neglects to take its production into consideration, presents the same attitude to progress as does the industrialist whose outlook is limited by what he can observe now, and who sees no profit in the extension of it by research. Yet a slight knowledge of modern social and industrial history would be sufficient to convince the most indifferent mind that pure and applied science is the life-blood of a nation in these times. But for this we could not have existed during the past century. After the Napoleonic wars this country was left in much the same difficult and troublous condition that it finds itself in to-day. Then, as now, we came out of the conflict with our soil inviolate, but were faced with widespread social and industrial unrest, due partly to the avarice of landowners and manufacturers, and partly to the ruin of village industries by the use of mechanical power in factories. We were saved from financial disaster at that time by increased output due to the invention of the steam engine, by which mines were freed from water, and coal, iron, and copper were rendered abundantly available. Textile trades were provided with the means for great expansion by the use of factory machinery in connection with the inventions belonging to them, and the advent of the railway and the steamship created further demands for iron and steel, and the coal necessary for their production. Thus it was that, while there was almost constant unrest in every European State, and heavy taxation had produced a condition approaching semi-starvation over a large part of the country, we were able to maintain our credit.

The country was then saved by invention, and we should have maintained the same lead in the chemical and electrical industries if our manufacturers had been alive to the practical value of scientific research, or our politicians had stimulated enterprises associated with its application instead of strangling them with unnecessary legislation. The thing to remember is that, whether we like it or not, we must advance if we are not to be left behind other progressive nations. The only way to keep in the van of modern industrial forces is to provide what other people want which they cannot produce for themselves either so cheaply or so excellently as we can. In view of international competition, it is not possible, in the neutral and open markets of the world, to increase the selling price of goods which can be produced by other nations unless they are decidedly superior in quality. Craftsmanship counts for something in securing this superiority, but the richest promise in these days lies in the discovery of new knowledge by research and the application of it to industry.

The output of British scientific workers is to-day larger than ever it was, and if industrial development does not proceed from it, the fault will not lie at their doors. Neither can they be blamed if social conditions are not improved by the increase of national wealth through the use of science. Their function is to discover, and faithfully they are performing it; it is for statesmen to see that this creative work is given every encouragement, for manufacturers to make profitable use of it, and for social reformers to ensure that the fruits are used to promote national well-being. Only thus can we make progress and in the future avoid the reproach that science necessarily signifies the desecration of Nature, and the degrading social conditions of the factory towns brought into existence by its users a century ago.

Matter and Motion.

Matter and Motion. By the late Prof. J. Clerk Maxwell. Reprinted with notes and appendices by Sir Joseph Larmor. Pp. xv+163. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) 5*s*. net.

IN a recent article a well-known musical critic has remarked with perfect truth of musicians—and the same is undoubtedly true of other classes of intellectualists, including men of science—that a man is immune from criticism if by popular acclaim, or in some other way, he has been provided with a halo! If he has such a decoration it is a part of him; he cannot appear without it—whatever he does is right; all his sayings, whether or not they are couched in pure and pellucid English without fault or flaw of expression, are accepted without cavil or question. If an adventurous critic dares to moot some opposing view, it is suggested with the greatest deference and profound apology.

The mode in which this glittering, or rather glistening, appendage is obtained is sometimes obvious enough; at other times it is obscure and mysterious. The recipient may be silently and unanimously received in recognition of his merits into the ranks of the great ones, of course without any ceremony of canonisation, for in science there is no official pontiff. In some other cases of a lower grade of sainthood he is received as

the more equivocal result of the applause of a crowd of allies and sympathisers, members perhaps of the same university, pupils and admirers, supporters of all kinds. As a rule, a halo-wearer can do no wrong. This royal prerogative is sometimes mildly disputed, but the disputer generally gets the worst of the discussion, and, unless he is pachydermatous, is duly sorry for himself.

One of the most reverenced of halo-wearers is Clerk Maxwell, who holds his great place by patent given from the highest source of all such dignity. In his writings originality of thought was accompanied always by felicity of phrase and expression, tempered with a savour of wit which is found only in men of subtle and penetrating humour, that wit which is, above all things, a saving grace in literature, and especially in science. Read his address "On the Mirror Galvanometer," supposed to be delivered to a pupil in an alcove with drawn curtains; in spite of the somewhat unpromising subject, it is as good as—nay, some would say it is much better than—its prototype, "The Splendour Falls on Castle Walls," or, indeed, almost any other lyric in Tennyson's "Princess."

From time to time Clerk Maxwell wrote on elementary science in a way which attracted the attention and enchained the admiration of everyone. The first of these writings was "The Theory of Heat"; the second, published in 1877, was "Matter and Motion." Both were unique. In various respects—*e.g.* in the question of entropy—the book on heat was open to objection, but as a presentation of thermodynamic theory it was, and has remained, unrivalled. We prefer the thermodynamic relations in the form which they take when the steps of temperature, pressure, volume, etc., are infinitesimal, and the notation (easily explained and understood) of infinitesimals is used; but this is a detail of no great importance. Nothing could exceed the elegance of the discussion, the importance of the semi-graphical, semi-analytical treatment of the energetics of the subject, and the theme of available energy.

In "Matter and Motion" the subject was really Newtonian dynamics, a theme which, in spite of the silly exaltations by the popular Press of Einstein above Newton, still remains supreme in dynamics. The first edition had poor and exasperating diagrams, and was not well printed; the present edition has been issued under the editorship of Sir Joseph Larmor, who has given the work everywhere, and in all details, the utmost care and attention. When we consider that the reprint of the original edition is contained in the small compass of 136 of the new pages, it appears marvellous that a view of dynamics so complete in itself in many respects could be compressed into so few pages of print.

On various interesting topics, such as Gravitation and Light and "The Principle of Least Action," Sir Joseph Larmor has added appendices, while he has inserted as chap. ix. a discussion of "The Equations of Motion of a Connected System," which increases the size of the book by only thirty-nine of the present pages. Needless to say, these additions are models of condensation, and at the same time of absolute clearness and accuracy. The new view of the gravitational field, which Einstein's theory of space and time affords, leads to an explanation of an outstanding discrepancy of observation with theory in the motion of the planet Mercury. This involves a certain warping of the reference frame which must be set up for these motions, and this has been verified by the observations of the solar eclipse of 1919, by the fact that rays of light passing near the sun have been found to be deflected by a certain amount predicted beforehand towards that luminary.

It is difficult also to pick out what were the peculiarly interesting parts of Clerk Maxwell's "Matter and Motion." Every bit of it was distinctive and distinguished, but in some ways the discussion of the hodograph, and the question of absolute velocity of rotation, impressed us most. The chapter on the latter subject was read again and again and pondered continually. There came afterwards the discussions by Love and Mach, which, however rigidly logical and silencing, seemed to us far from convincing. Mach's book was no doubt very valuable, but the touch of the writer, if precise, seemed to lack lightness and, as compared with Maxwell's, that distinction which the magic of genius alone can confer. One might weary of Mach's excellent treatise; of Maxwell one never tired.

It is now possible to make a wider survey of the whole subject. The elegance of the hodographic theory appears very vividly in Maxwell's treatment. It is a great thing to say, but there is scarcely anything among the numerous discoveries of Hamilton in dynamics which so signally illustrates his penetrating genius. The hodograph was hit upon some four or five years before Hamilton by Möbius, as may be verified by consulting his treatise on physical astronomy, "Die Mechanik des Himmels." But application of the idea Möbius makes little or none. With Hamilton the applications are everything; the idea is used to obtain all kinds of beautiful results. That Möbius had anticipated him Hamilton was fully aware, and acknowledges (see the Life by Graves) that Möbius might have claimed the

notion; but the claim would have been a barren one.

One thing we miss in Maxwell's discussion—that is, the curious theorem of the splitting of the velocity of the particle describing the orbit into two constant components, one at right angles to the radius vector, and the other perpendicular to the major axis of the orbit. It is curious that there should be this relation.

A propos of the principle of least action, discussed in appendix ii., it is remarkable that if the major axis of an elliptic orbit, for a particle moving, as in the case of Nature, under a force along the radius vector from a focus, and varying as the square of the distance, is given, the action (the space-integral of the momentum round the orbit) is independent of the eccentricity of the orbit. It depends only on the major axis, so that it is the same for a circular orbit as for a long, narrow one. This gives a means of solving various problems.

Connected with this is another theorem that the kinetic energy of the particle at distance r from the same centre of force, in a hyperbolic orbit of semi-transverse axis a (equal to the semi-major axis of the elliptic orbit), exceeds, and in the elliptic orbit falls short of, the expansion $m\mu/r$ of potential energy, from infinity to the distance r, by the time or average of the kinetic energy of the elliptic motion.

One thing we cannot understand in the popular treatment of hodographic theory: Why is it always regarded as an affair of particle dynamics only? If we set up, or imagine set up, a sequence of vectors representing the angular momentum of a rigid body, say that of an aeroplane, the velocity of the extremity of the vector is in magnitude and direction the rate of change of the angular momentum. This might help to prevent that pernicious "ignoration" of the direction of the angular momentum vector, and its variation, which characterises so many uninstructed but apparently influential people. A. GRAY.

A Socialist Commonwealth.

A Constitution for the Socialist Commonwealth of Great Britain. By Sidney and Beatrice Webb. Pp. xviii+364. (London: Longmans, Green, and Co., 1920.) 12*s.* 6*d.* net.

IN this volume Mr. and Mrs. Webb set themselves to build "an efficiently working, genuinely democratic constitution" out of the materials that are already to hand. The distinctive feature of the Socialist Commonwealth of Great Britain will be the division of the labours of our present overworked Parliament between two co-equal bodies, the Social and the Political Parliaments, both elected on a geographical basis by all the adult citizens. The Political Parliament will deal mainly with defence, justice, and foreign affairs, and will have a keen eye to the protection of the liberty of the individual. To the Social Parliament all else falls—labour, health, education, the control of industry, and care for the interests of generations yet unborn. In the hands of the Social Parliament rests also the power of the purse; from which it may be anticipated that the Political Parliament, for all its nominal equality, will have to mind its "p's and q's."

Perhaps the most fruitful part of a very suggestive work is contained in the proposals for the reconstruction of local government. On this the authors speak with ripe experience of actual administration, as well as with their usual wide theoretical knowledge. The unit of local government is to be the ward, though different wards are to be grouped and re-grouped in such a way as to give a unit of appropriate size for the conduct of each municipalised service. Economic efficiency will thus no longer be subservient to the historical accident of municipal boundaries.

Industry will of course be "socialised." Socialisation will take a variety of forms, the common features of which will be production for use and not for profit, and the separation of control from actual administration. Nationalisation, municipalisation (of which a great expansion is anticipated), and organisation on the co-operative principle exhibited by the existing Consumers' Co-operative Movement will be the three great types. The nationalised industries will be administered by a hierarchy of national boards, regional councils, and works or pit committees, responsible to a Standing Committee of the Social Parliament, and goaded into efficiency by the supervision and control of an independent department. Bureaucracy is anathema. A limited share in administration will be accorded to the appropriate organisations of workers, although Mr. and Mrs. Webb believe in the conduct of industry by the community for the community, rather than by the workers for the workers. The charwomen who clean the schools are not to dictate what shall be taught there. Vocational organisations, of the form of our present trade unions and professional associations, will be concerned rather with the protection of the status of the several vocations, the promotion of all kinds of scientific research (on which the authors lay great stress), and the maintenance of professional honour. For a national body elected on a vocational basis, such as a regenerated Trade Union Congress, the authors

see little future in their commonwealth. It may be suggested that in taking this view they are rejecting a method of "functional devolution" likely to be more effective than the Parliamentary dualism which receives their blessing.

The book is interesting, but not light reading. Some of its proposals will no doubt appeal to all readers; all of its proposals to some readers. Universal acceptance *in toto* is, of course, not to be expected. But criticism is easy; construction as difficult as it is urgent. This constitution-making commands the respect of the critic for its concrete and practical character.

BARBARA WOOTTON.

Science for the Young Farmer.

The Chemistry of Crop Production. By Prof. T. B. Wood. Pp. vii+193. (London: W. B. Clive, 1920.) 5*s*. 6*d*.

PROBABLY no one in the country is better equipped for the task of writing an elementary book for the young farmer than Prof. Wood. He has had a long teaching experience at Cambridge, and has himself run a farm at a profit; in addition, he has carried out important scientific investigations in agriculture, and was responsible during the war for studying fully the national food supply.

With this equipment on the part of the author, it is not surprising that his little book itself is admirable. It is lucidly written, and gives the student the facts he wants, expressed in language which, if lacking the picturesqueness of the author's daily use, is nevertheless much more vivid than is customary in a student's text-book. At the outset the complexity of the problem is realised, and it is emphasised that soil fertility depends not on one, but on many independent factors, any of which may prove insufficient and set a limit to plant growth. These factors are then studied one by one. Considerable information is given about soil types and the method of characterisation by mechanical analysis; examples are drawn from the surveys of Norfolk by Newman, and of Kent, Surrey, and Sussex by Hall and Russell. Several maps show the distribution of crops in the eastern counties, and illustrate the intense localisation of potatoes and the much wider distribution of wheat. Water supply is discussed in relation to rainfall, and a section on weather and meteorology will give the student much information of interest to him.

The principles of manuring are clearly set forth with many examples which will prove of value to the student. Throughout, considerable stress is laid on the economic side, prices and probable returns being freely quoted. In future editions it will be well to substitute a paragraph on the basic open-hearth for the present one on the Bessemer process, which is now largely superseded. The catalytic process for preparing ammonia synthetically will also probably deserve mention along with the method for making calcium nitrate and cyanamide from the air.

The last chapter contains an interesting summary of the leading features of British agriculture, showing how greatly grass predominates. This is shown to be connected with the high rainfall and high altitude of much of the country, though it is also influenced by considerations of capital and labour. Of the other crops, most are grown for animals, 63,000,000 tons (including 50,000,000 of grass) being produced for them, as against 1,900,000 tons for human consumption, and 1,400,000 for industries, all reckoned as dry matter. The 63,000,000 tons become 54,000,000 when deduction is made for the horses, and it is shown that the whole of this 54,000,000 tons, *plus* another 8,000,000 tons of imported produce, is taken by animals which will be eaten by human beings; but it yields only 1½ million tons of human food, again expressed as dry matter. The animal as at present managed is not a very efficient converter.

E. J. R.

A Fabre Anthology.

Insect Adventures. By J. H. Fabre. Pp. xii+308. (London: Hodder and Stoughton, Ltd., n.d.) 8*s*. 6*d*. net.

IT was a happy thought to adapt for young people, as Miss Louise S. Hasbrouck has done, some of the translations made by Mr. Teixeira de Mattos from Fabre's "Souvenirs Entomologiques." Fabre's studies of animal behaviour appeal to children more organically than any premature analysis, and the great naturalist had a way with him that attracted young folks. Reproaching the anatomical zoologists, he wrote: "You pry into death, I pry into life . . . I write above all for the young. I want to make them love the natural history which you make them hate; and that is why, while keeping strictly to the domain of truth, I avoid your scientific prose, which too often, alas! seems borrowed from some Iroquois idiom." So we have these delightful stories of ants, bees, wasps, flies, beetles, moths, caterpillars, and spiders. There is poetry in the picture of his first pond, with its diamonds and gold dust and "heavenly" beetles, which had all to be cast on the rubbish heap when the boy got

home. "In later years I found out that the diamonds of the duck-pool were rock-crystal, the gold-dust, mica; but the fascination of the pond held good for all that. It was full of secrets that were worth more to me than diamonds and gold."

The autobiographical chapter, "The Boy who Loved Insects," is charming, and we are glad to see the inclusion for young geometricians of the discussion on the logarithmic spiral which Fabre appended to the story of the spider's web. We wish, however, that it had been possible to omit Fabre's unfortunate but characteristic taunting of the evolutionists. He asks where the snail with its spiral shell of lime and the spider with its spiral thread of silk "pick up this science." "We are told that the Mollusc is descended from the Worm. One day the Worm, rendered frisky by the sun, brandished its tail and twisted it into a corkscrew for sheer glee. There and then the plan of the future spiral shell was discovered. This is what is taught quite seriously, in these days, as the very last word in science. The Spider will have none of this theory, for she is not related to the Worm. Yet she is familiar with the logarithmic spiral and uses it in her web. . . . What guides her? Nothing but an inborn skill, whose effects the animal is no more able to control than the flower is able to control the arrangement of its petals and stamens. The spider practises higher geometry without knowing or caring. The thing works of itself, and takes its way from an instinct imposed upon Creation at the start." Now the great observer was within his rights in suggesting that instinct is unanalysable animal-genius, or any other theory of that elusive kind of behaviour, and he was within his rights in stating that in his opinion the widespread occurrence of the logarithmic spiral in Nature pointed to a "Universal Geometrician, whose divine compass has measured all things," but he was not within his rights in travestying the evolution theory.

This is a delightful book, and very pleasantly printed. Only a few blemishes have caught our eye, like Moquin-Tandom; and was not the adjective that Darwin applied to Fabre "inimitable"?

Our Bookshelf.

A Physician's Anthology of English and American Poetry. Selected and arranged by Dr. C. A. Wood and Dr. F. H. Garrison. Pp. xxiii+346. (London: Humphrey Milford, 1920.) 8*s.* 6*d.* net.

WE have got rid of the old convention that all flowers at a funeral must be white: we send them now in all the colours of the rainbow. So is this wreath, laid on Osler's grave by two men who loved him. They have done well. It is a delightful book: sincere, quiet, companionable, thoughtful, as good a friend as anyone could wish to have in his pocket. Note the place of the apostrophe: it is a book for a doctor, not only a book by two doctors. Here and there, of course, it challenges a reviewer, but that is the way of all anthologies. For instance, there is more of Clough than of Christina Rossetti: and the last poem of all, from Weir Mitchell, is inferior to a similar poem by Stevenson. There is rather too much of Lecky, and even of Matthew Arnold: and Siegfried Sassoon's poems of the War have that imperfection which is criticised in Mrs. de Selincourt's perfect story of "Autumn Crocuses." But these are mere little hole-pickings in a very beautiful and well-wrought fabric.

The preface is admirable: and all that the anthologists say of the influence of the doctor's experiences on the doctor's thoughts is true. But they do not make enough allowance, it may be, for the touch of antagonism between practice and poetry. It may come natural to a doctor to say with Weir of Hermiston, "I ha' no call to be bonny"—in part because he is a man of science, and there is a world of difference between science and poetry; in part because his day's work is essentially objective. He exalts it with his kindly feelings, but it remains an affair of signs and symptoms which do not lend themselves to poetical treatment; rather they cry aloud for medical or surgical treatment.

One more point: there have been, and are, men who are both doctors and poets; but we must not include in that list men who gave up practice for poetry: who "qualified," but did nothing much as practitioners, and later were poets. The medical profession cannot lay claim to Keats or Schiller. But this point lies outside the treasures of "A Physician's Anthology," and we congratulate the good physicians who made so good a selection.

Elements of Statistics. By Prof. Arthur L. Bowley. Fourth edition. Pp. xi+459. (London: P. S. King and Son, Ltd.; New York: Charles Scribner's Sons, 1920.) 24*s.* net.

ALTHOUGH Prof. Bowley's "Elements of Statistics" no longer holds the practically unique position as a text-book which it held on its first appearance twenty years ago, yet teachers and students alike will welcome this new and enlarged edition of a work the value of which has been proved by experience in the interval. The second part of the book, which deals with the higher mathematical treatment of statistical methods, has been entirely rewritten, and the author admits his indebtedness to the work on those lines done in recent years by Prof. Edgeworth, Mr. Udny Yule, and others. Prof. Bowley, however, while going beyond the limits set in earlier editions, by assuming now in the reader a knowledge of the

use of the calculus, has endeavoured with a fair amount of success to simplify the proofs of the algebraic formulæ used, so as to keep these within the scope of the average university graduate course in mathematics. More space is devoted to the coefficient of correlation, the too facile use of which by many writers is responsible to-day for much loose reasoning.

Part i. remains on the same lines as in the earlier editions; by reference to particular groups of English statistics it illustrates the general principles guiding the collection, tabulation, and utilisation of results of statistical inquiries, so far as these aims can be reached without the use of any but the most elementary mathematics. Some of the illustrations have been brought up to date, and in particular the chapter dealing with the important subject of index numbers of prices and cost of living has been rewritten, but, in spite of the fear expressed by the author that too much attention to such details might have upset the balance of the work, it seems a pity that he did not take this opportunity of revising thoroughly all the illustrations from official and other publications. This would have made the volume much more alive and attractive to the non-academic reader whose object it is to equip himself as a citizen to understand and criticise the increasing volume of figures with which statements of rival political and social policies are now supported.

The Sea-Shore. By W. P. Pycraft. (The Nature Lover's Series.) Pp. vi+156. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) 4*s.* 6*d.* net.

MANY books have been written about the sea-shore and its life, some very good, Miss Newbigin's by far the best; others good, like Lewes's and J. G. Wood's; others not good at all. Mr. Pycraft's book is very good, for he knows at first hand what he is talking about. He is an expert on sea-shore birds, and he has insight into the *magnalia naturae*. Moreover, the book has the smack of individuality—the first of a "Nature Lover's Series"—aiming at a synoptic view, not of the fauna merely or principally, but of the sea-shore as a region as full of intellectual as of æsthetic delights. Many of those who go to the shore for recreation miss half the fun because they are unaware of the intensely interesting problems all around them. They do not see the significance of things. But Mr. Pycraft's book gives them a jumping-off place. It tells of the gathering together of waters, of shallow seas and deep seas, of cliffs and caves, of pebbles and sand-beaches, of islands and their charm, and of the animal inhabitants of the varied haunts which the sea-shore includes. It is all luminous and illuminating, and, naturally, the treatment of the sea-shore birds is masterly. Mr. Pycraft strikes the genetic note in his physical chapters, and the bionomic note in his natural history. We are sorry that he has deliberately refrained from dealing with the sea-shore plants and with the Algæ, for that was needed to round off the survey. This defect notwithstanding, the book has a wider horizon than most sea-shore books, and many will be grateful to the author. Even in short books it is surprisingly difficult to avoid sheer casualties like Asterius and the four chisel-like teeth of the sea-urchin, a number immediately raised to five. It is not our experience that a guillemot's egg "rolls round in a circle" when jostled, but we bow to the authority of one of the most scientific of ornithologists. His book is pure gold.

The Encyclopaedia and Dictionary of Education. Part i. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* net.

THIS is part i. of an "Encyclopædia and Dictionary of Education" being issued under the general editorship of Prof. Foster Watson. The work when complete will comprise nearly 2000 large crown quarto pages. It will contain as many as 2250 separate articles contributed by more than 850 specialists representing most of the chief universities of the world in practically every branch and section of theoretical and practical education. Having regard to the fact of the rapid development of education in all branches, especially in this country, during the last two decades, and its close connection with social and national movements, it is believed that a work dealing systematically with its progress will meet with warm approval.

The subject-matter of education has grown so complex, including its psychological, medical, and other aspects, that it demands for the inquirer, the teacher, and the administrator some authoritative guidance such as this work is designed to give, including clear, accurate, and concise accounts of all types of teaching institutions in the British Isles and Dominions, not only in their historical aspect, but also in their present conditions. In addition, there is passed in review the educational systems of all the important foreign countries. Due prominence has also been given to the lives and teachings of great educationists, and the Board of Education's Regulations have been epitomised in a convenient and simple form.

Each part will be illustrated. A complete list of the contributors is supplied with part i., but we note the absence of the names of any contributors dealing with the important developments and position of education in Germany.

The Mechanical Production of Cold. By Sir J. A. Ewing. Second edition. Pp. x+204. (Cambridge: At the University Press, 1921.) 25*s.* net.

ALTHOUGH it is more than twelve years since the first edition of Sir J. A. Ewing's book was published, the author has not found it necessary to do more than correct some errors and to modify the text in places where the meaning was obscure. The book therefore is substantially the same as the first edition, a notice of which appeared in NATURE for February 25, 1909 (vol. lxxix., p. 484).

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.]*

Atomic Structure.

IN a letter to NATURE of November 25 last Dr. Norman Campbell discusses the problem of the possible consistency of the assumptions about the motion and arrangement of electrons in the atom underlying the interpretation of the series spectra of the elements based on the application of the quantum theory to the nuclear theory of atomic structure, and the apparently widely different assumptions which have been introduced in various recent attempts to develop a theory of atomic constitution capable of accounting for other physical and chemical properties of the elements. Dr. Campbell puts forward the interesting suggestion that the apparent inconsistency under consideration may not be real, but rather appear as a consequence of the formal character of the principles of the quantum theory, which might involve that the pictures of atomic constitution used in explanations of different phenomena may have a totally different aspect, and nevertheless refer to the same reality. In this connection he directs attention especially to the so-called "principle of correspondence," by the establishment of which it has been possible—notwithstanding the fundamental difference between the ordinary theory of electromagnetic radiation and the ideas of the quantum theory—to complete certain deductions based on the quantum theory by other deductions based on the classical theory of radiation.

In so far as it must be confessed that we do not possess a complete theory which enables us to describe in detail the mechanism of emission and absorption of radiation by atomic systems, I naturally agree that the principle of correspondence, like all other notions of the quantum theory, is of a somewhat formal character. But, on the other hand, the fact that it has been possible to establish an intimate connection between the spectrum emitted by an atomic system—deduced according to the quantum theory on the assumption of a certain type of motion of the particles of the atom—and the constitution of the radiation, which, according to the ordinary theory of electromagnetism, would result from the same type of motion, appears to me to afford an argument in favour of the reality of the assumptions of the spectral theory of a kind scarcely compatible with Dr. Campbell's suggestion. On the contrary, if we admit the soundness of the quantum theory of spectra, the principle of correspondence would seem to afford perhaps the strongest inducement to seek an interpretation of the other physical and chemical properties of the elements on the same lines as the interpretation of their series spectra; and in this letter I should like briefly to indicate how it seems possible by an extended use of this principle to overcome certain fundamental difficulties hitherto involved in the attempts to develop a general theory of atomic constitution based on the application of the quantum theory to the nucleus atom.

The common character of theories of atomic constitution has been the endeavour to find configurations and motions of the electrons which would seem to offer an interpretation of the variations of the chemical properties of the elements with the atomic number as they are so clearly exhibited in the well-known periodic law. A consideration of this law leads directly to the view that the electrons in the atom are arranged in distinctly separate groups, each containing a number of electrons equal to one of the periods in the sequence of the elements, arranged according to increasing atomic number. In the first attempts to obtain a definite picture of the configuration and motion of the electrons in these groups it was assumed that the electrons within each group at any moment were placed at equal angular intervals on a circular orbit with the nucleus at the centre, while in later theories this simple assumption has been replaced by the assumptions that the configurations of electrons within the various groups do not possess such simple axial symmetry, but exhibit a higher degree of symmetry in space, it being assumed, for instance, that the configuration of the electrons at any moment during their motions possesses polyhedral symmetry. All such theories involve, however, the fundamental difficulty that no interpretation is given why these configurations actually appear during the formation of the atom through a process of binding of the electrons by the nucleus, and why the constitution of the atom is essentially stable in the sense that the original configuration is reorganised if it be temporarily disturbed by external agencies. If we reckon with no other forces between the particles except the attraction and repulsion due to their electric charges, such an interpretation claims clearly that there must exist an intimate interaction or "coupling" between the various groups of electrons in the atom which is essentially different from that which might be expected if the electrons in different groups are assumed to move in orbits quite outside each other in such a way that each group may be said to form a "shell" of the atom, the effect of which on the constitution of the outer shells would arise mainly from the compensation of a part of the attraction from the nucleus due to the charge of the electrons.

These considerations are seen to refer to essential features of the nucleus atom, and so far to have no special relation to the character of the quantum theory, which was originally introduced in atomic problems in the hope of obtaining a rational interpretation of the stability of the atom. According to this theory an atomic system possesses a number of distinctive states, the so-called "stationary states," in which the motion can be described by ordinary mechanics, and in which the atom can exist, at any rate for a time, without emission of energy radiation. The characteristic radiation from the atom is emitted only during a transition between two such states, and this process of transition cannot be described by ordinary mechanics, any more than the character of the emitted radiation can be calculated from the motion by the ordinary theory of electro-magnetism, it being, in striking contrast to this theory, assumed that the transition is always followed by an emission of monochromatic radiation the frequency of which is determined simply from the difference of energy in the two states. The application of the quantum theory to atomic problems—which took its starting point from the interpretation of the simple spectrum of hydrogen, for which no *a priori* fixation of the stationary states of the atoms was needed—has in recent years been largely extended by the development of systematic methods for fixing the stationary states corresponding to certain general classes of mechanical motions. While in this way a detailed interpretation of spectroscopic results of a very different kind has been obtained, so far as phenomena which depend essentially on the motion of one electron in the atom were concerned, no definite elucidation has been obtained with regard to the constitution of

atoms containing several electrons, due to the circumstance that the methods of fixing stationary states were not able to remove the arbitrariness in the choice of the number and configurations of the electrons in the various groups, or shells, of the atom. In fact, the only immediate consequence to which they lead is that the motion of every electron in the atom will on a first approximation correspond to one of the stationary states of a system consisting of a particle moving in a central field of force, which in their limit are represented by the various circular or elliptical stationary orbits which appear in Sommerfeld's theory of the fine structure of the hydrogen lines. A way to remove the arbitrariness in question is opened, however, by the introduction of the correspondence principle, which gives expression to the tendency in the quantum theory to see not merely a set of formal rules for fixing the stationary states of atomic systems and the frequency of the radiation emitted by the transitions between these states, but rather an attempt to obtain a rational generalisation of the electromagnetic theory of radiation which exhibits the discontinuous character necessary to account for the essential stability of atoms.

Without entering here on a detailed formulation of the correspondence principle, it may be sufficient for the present purpose to say that it establishes an intimate connection between the character of the motion in the stationary states of an atomic system and the possibility of a transition between two of these states, and therefore offers a basis for a theoretical examination of the process which may be expected to take place during the formation and reorganisation of an atom. For instance, we are led by this principle directly to the conclusion that we cannot expect in actual atoms configurations of the type in which the electrons within each group are arranged in rings or configurations of polyhedral symmetry, because the formation of such configurations would claim that all the electrons within each group should be originally bound by the atom at the same time. On the contrary, it seems necessary to seek the configurations of the electrons in the atoms among such configurations as may be formed by the successive binding of the electrons one by one, a process the last stages of which we may assume to witness in the emission of the series spectra of the elements. Now on the correspondence principle we are actually led to a picture of such a process which not only affords a detailed insight into the structure of these spectra, but also suggests a definite arrangement of the electrons in the atom of a type which seems suitable to interpret the high-frequency spectra and the chemical properties of the elements. Thus from a consideration of the possible transitions between stationary states, corresponding to the various steps of the binding of each of the electrons, we are led in the first place to assume that only the two first electrons move in what may be called one-quantum orbits, which are analogous to that stationary state of a central system which corresponds to the normal state of a system consisting of one electron rotating round a nucleus. The electrons bound after the first two will not be able by a transition between two stationary states to procure a position in the atom equivalent to that of these two electrons, but will move in what may be called multiple-quanta orbits, which correspond to other stationary states of a central system.

The assumption of the presence in the normal state of the atom of such multiple-quanta orbits has already been introduced in various recent theories, as, for instance, in Sommerfeld's work on the high-frequency spectra and in that of Landé on atomic dimensions and crystal structure; but the application of the correspondence principle seems to offer for the first time a rational theoretical basis for these conclusions and for the discussion of the arrangement of the orbits of the electrons bound after the first two. Thus by means of a closer examination of the progress of the binding process this principle offers a simple argument for concluding that these electrons are arranged in groups in a way which reflects the periods exhibited by the chemical properties of the elements within the sequence of increasing atomic numbers. In fact, if we consider the binding of a large number of electrons by a nucleus of high positive charge, this argument suggests that after the first two electrons are bound in one-quantum orbits, the next eight electrons will be bound in two-quanta orbits, the next eighteen in three-quanta orbits, and the next thirty-two in four-quanta orbits.

Although the arrangements of the orbits of the electrons within these groups will exhibit a remarkable degree of spatial symmetry, the groups cannot be said to form simple shells in the sense in which this expression is generally used as regards atomic constitution. In the first place, the argument involves that the electrons within each group do not all play equivalent parts, but are divided into sub-groups corresponding to the different types of multiple-quanta orbits of the same total number of quanta, which represents the various stationary states of an electron moving in a central field. Thus, corresponding to the fact that in such a system there exist two types of two-quanta orbits, three types of three-quanta orbits, and so on, we are led to the view that the above-mentioned group of eight electrons consists of two sub-groups of four electrons each, the group of eighteen electrons of three sub-groups of six electrons each, and the group of thirty-two electrons of four sub-groups of eight electrons each.

Another essential feature of the constitution described lies in the configuration of the orbits of the electrons in the different groups relative to each other. Thus for each group the electrons within certain sub-groups will penetrate during their revolution into regions which are closer to the nucleus than the mean distances of the electrons belonging to groups of fewer-quanta orbits. This circumstance, which is intimately connected with the essential features of the processes of successive binding, gives just that expression for the "coupling" between the different groups which is a necessary condition for the stability of atomic configurations. In fact, this coupling is the predominant feature of the whole picture, and is to be taken as a guide for the interpretation of all details as regards the formation of the different groups and their various sub-groups. Further, the stability of the whole configuration is of such a character that if any one of the electrons is removed from the atom by external agencies not only may the previous configuration be reorganised by a successive displacement of the electrons within the sequence in which they were originally bound by the atom, but also the place of the removed electron may be taken by any one of the electrons belonging to more loosely bound groups or sub-groups through a process of direct transition between two stationary states, accompanied by an emission of a monochromatic radiation. This circumstance—which offers a basis for a detailed interpretation of the characteristic structure of the high-frequency spectra of the elements—is intimately connected with the fact that the electrons in the various sub-groups, although they may be said to play equivalent parts in the harmony of the interatomic motions, are not at every moment arranged in configurations of simple axial or polyhedral sym-

metry as in Sommerfeld's or Landé's work, but that their motions are, on the contrary, linked to each other in such a way that it is possible to remove any one of the electrons from the group by a process whereby the orbits of the remaining electrons are altered in a continuous manner.

These general remarks apply to the constitution and stability of all the groups of electrons in the atom. On the other hand, the simple variations indicated above of the number of electrons in the groups and sub-groups of successive shells hold only for that region in the atom where the attraction from the nucleus compared with the repulsion from the electrons possesses a preponderant influence on the motion of each electron. As regards the arrangements of the electrons bound by the atom at a moment when the charges of the previously bound electrons begin to compensate the greater part of the positive charge of the nucleus, we meet with new features, and a consideration of the conditions for the binding process forces us to assume that new, added electrons are bound in orbits of a number of quanta equal to, or fewer than, that of the electrons in groups previously bound, although during the greater part of their revolution they will move outside the electrons in these groups. Such a stop in the increase, or even decrease, in the number of quanta characterising the orbits corresponding to the motion of the electrons in successive shells takes place, in general, when somewhat more than half the total number of electrons is bound. During the progress of the binding process the electrons will at first still be arranged in groups of the indicated constitution, so that groups of three-quanta orbits will again contain eighteen electrons and those of two-quanta orbits eight electrons. In the neutral atom, however, the electrons bound last and most loosely will, in general, not be able to arrange themselves in such a regular way. In fact, on the surface of the atom we meet with groups of the described constitution only in the elements which belong to the family of inactive gases, the members of which from many points of view have also been acknowledged to be a sort of landmark within the natural system of the elements. For the atoms of these elements we must expect the constitutions indicated by the following symbols:

Helium	(2_1),	Krypton	$(2_1 8_2 18_3 8_2)$,
Neon	$(2_1 8_2)$,	Xenon	$(2_1 8_2 18_3 18_3 8_2)$,
Argon	$(2_1 8_2 8_2)$,	Niton	$(2_1 8_2 18_3 32_4 18_3 8_2)$,

where the large figures denote the number of electrons in the groups starting from the innermost one, and the small figures the total number of quanta characterising the orbits of electrons within each group.

These configurations are distinguished by an inherent stability in the sense that it is especially difficult to remove any of the electrons from such atoms so as to form positive ions, and that there will be no tendency for an electron to attach itself to the atom and to form a negative ion. The first effect is due to the large number of electrons in the outermost group; hence the attraction from the nucleus is not compensated to the same extent as in configurations where the outer group consists only of a few electrons, as is the case in those families of elements which in the periodic table follow immediately after the elements of the family of the inactive gases, and, as is well known, possess a distinct electro-positive character. The second effect is due to the regular constitution of the outermost group, which prevents a new electron from entering as a further member of this group. In the elements belonging to the families which in the periodic table precede the family of the inactive gases we meet in the neutral atom with configurations of the outermost group of electrons which, on the other hand, exhibit a great tendency to complete themselves by the binding of further electrons, resulting in the formation of negative ions.

The general lines of the latter considerations are known from various recent theories of atomic constitution, such as those of A. Kossel and G. Lewis, based on a systematic discussion of chemical evidence. In these theories the electro-positive and electro-negative characters of these families in the periodic table are interpreted by the assumption that the outer electrons in the atoms of the inactive gases are arranged in especially regular and stable configurations, without, however, any attempt to give a detailed picture of the constitution and formation of these groups. In this connection it may be of interest to direct attention to the fundamental difference between the picture of atomic constitution indicated in this letter and that developed by Langmuir on the basis of the assumption of stationary or oscillating electrons in the atom, referred to in Dr. Campbell's letter. Quite apart from the fact that in Langmuir's theory the stability of the configuration of the electrons is considered rather as a postulated property of the atom, for which no detailed *a priori* interpretation is offered, this difference discloses itself clearly by the fact that in Langmuir's theory a constitution of the atoms of the inactive gases is assumed in which the number of electrons is always largest in the outermost shell. Thus the sequence of the number of electrons within the groups of a niton atom is, instead of that indicated above, assumed to be 2, 8, 18, 18, 32, such as the appearance of the periods in the sequence of the elements might seem to claim at first sight.

The assumption of the presence of the larger groups in the interior of the atom, which is an immediate consequence of the argument underlying the present theory, appears, however, to offer not merely a more suitable basis for the interpretation of the general properties of the elements, but especially an immediate interpretation of the appearance of such families of elements within the periodic table, where the chemical properties of successive elements differ only very slightly from each other. The existence of such families appears, in fact, as a direct consequence of the formation of groups containing a larger number of electrons in the interior of the atom when proceeding through the sequence of the elements. Thus in the family of the rare earths we may be assumed to be witnessing the successive formation of an inner group of thirty-two electrons at that place in the atom where formerly the corresponding group possessed only eighteen electrons. In a similar way we may suppose the appearance of the iron, palladium, and platinum families to be witnessing stages of the formation of groups of eighteen electrons. Compared with the appearance of the family of the rare earths, however, the conditions are here somewhat more complicated, because we have to do with the formation of a group which lies closer to the surface of the atom, and where, therefore, the rapid increase in the compensation of the nuclear charge during the progress of the binding process plays a greater part. In fact, we have to do in the cases in question, not, as in the rare earths, with a transformation which in its effects keeps inside one and the same group, and where, therefore, the increase in the number in this group is simply reflected in the number of the elements within the family under consideration, but we are witnesses of a transformation which is accompanied by a confluence of several outer groups of electrons.

In a fuller account which will be published soon

the questions here discussed will be treated in greater detail. In this letter it is my intention only to direct attention to the possibilities which the elaboration of the principles underlying the spectral applications of the quantum theory seems to open for the interpretation of other properties of the elements. In this connection I should also like to mention that it seems possible, from the examination of the change of the spectra of the elements in the presence of magnetic fields, to develop an argument which promises to throw light on the difficulties which have hitherto been involved in the explanation of the characteristic magnetic properties of the elements, and have been discussed in various recent letters in NATURE.

N. BOHR.

Copenhagen, February 14.

The Dimensions of Atoms and Molecules.

CERTAIN relations which are to be traced between the distances separating atoms in a crystal make it possible to estimate the distance between their centres when linked together in chemical combination. On the Lewis-Langmuir theory of atomic constitution, two electro-negative elements when combined hold one or more pairs of electrons in common, so that the outer electron shell of one atom may be regarded as coincident with that of the other at the point where the atoms are linked together. From this point of view, estimates may be made (W. L. Bragg, *Phil. Mag.*, vol. xi., August, 1920) from crystal data of the diameters of these outer shells. The outer shell of neon, for example, was estimated from the apparent diameters of the carbon, nitrogen, oxygen, and fluorine atoms, which show a gradual approximation to a minimum value of $1{\cdot}30\times10^{-8}$ cm. The diameters of the inert gases as found in this way are given in the second column of the following table:

Gas	Diameter 2σ (Crystals)	Diameter $2\sigma'$ (Viscosity)	Difference $2\sigma'-2\sigma$
Helium ...	—	1·89	—
Neon ...	1·30	2·35	1·05
Argon ...	2·05	2·87	0·82
Krypton ...	2·35	3·19	0·84
Xenon ...	2·70	3·51	0·81

In the third column are given Rankine's values (A. O. Rankine, Proc. Roy. Soc., A, vol. xcviii., 693, pp. 360–74, February, 1921) for the diameters of the inert gases calculated from their viscosities by Chapman's formula (S. Chapman, Phil. Trans. Roy. Soc., A, vol. ccxvi., pp. 279–348, December, 1915). These are considerably greater than the diameters calculated from crystals, but this is not surprising in view of our ignorance both of the field of force surrounding the outer electron shells and of the nature of the electron-sharing which links the atoms together, for it is quite possible that their structures might coalesce to a considerable extent. The constancy of the differences between the two estimates given in the fourth column shows that the *increase* in the size of the atom as each successive electron shell is added is nearly the same (except in the case of neon), whether measured by viscosity or by the crystal data. Further, Rankine has shown that the molecule Cl_2 behaves as regards its viscosity like two argon atoms with a distance between their centres very closely equal to that calculated from crystals, and that the same is true for the pairs Br_2 and krypton, I_2 and xenon.

We see, therefore, that the evidence both of crystals and viscosity measurements indicates that (*a*) the elements at the end of any one period in the periodic table are very nearly identical as regards the diameters of their outer electron shells, and (*b*) in passing from one period to the next there is a definite increase in the dimensions of the outer electron shell, the absolute amount of this increase estimated by viscosity agreeing closely with that determined from crystal measurements.

A further check on these measurements is afforded by the infra-red absorption spectra of HF, HCl, and HBr. The wave-number difference $\delta\nu$ between successive absorption lines determines the moment of inertia I of the molecule in each case, the formula being

$$\delta\nu=\frac{h}{4\pi^2cI},$$

where h is Planck's constant and c the velocity of light.

It is therefore possible to calculate the distances between the centres of the nuclei in each molecule, for

$$s^2=\frac{m+m'}{mm'}\cdot\frac{h}{4\pi^2cm_H\delta\nu},$$

where m and m' are the atomic weights relative to hydrogen and m_H the mass of the hydrogen atom. The following table gives these distances (E. S. Imes, *Astroph. Journal*, vol. l., p. 251, 1919). It will be seen that there are again increases in passing from F to Cl and Cl to Br, which agree closely with the increases in the radii σ of the electron shells given by the crystal and viscosity data.

$s\times10^8$			$\sigma\times10^8$ (Crystals)		$\sigma'\times10^8$ (Viscosity)	
H F 0·93		Neon (= F) ...	0·65		1·17	
	0·35			*0·37*		*0·26*
H Cl 1·28		Argon (= Cl) ...	1·02		1·43	
	0·15			*0·15*		*0·15*
H Br 1·43		Krypton (= Br) ...	1·17		1·58	
				0·18		*0·17*
H I —		Xenon (= I) ...	1·35		1·75	

The increase from fluorine to chlorine of $0{\cdot}35\times10^{-8}$ cm. confirms the estimate given by crystals of $0{\cdot}37\times10^{-8}$ cm., as against the estimate $0{\cdot}26\times10^{-8}$ cm. given by viscosity data. It follows from the above that the distance between the hydrogen nucleus and the centre of an electro-negative atom to which it is attached is obtained by adding $0{\cdot}26\times10^{-8}$ cm. to the radius of the electro-negative atom as given by crystal structures. The radius of the inner electron orbit, according to Bohr's theory, is $0{\cdot}53\times10^{-8}$ cm., double this value. The crystal data, therefore, predict the value $\delta\nu=13{\cdot}0$ cm.$^{-1}$ for the HI molecule, corresponding to a distance $1{\cdot}61\times10^{-8}$ cm. between their atomic centres.

This evidence is interesting as indicating that the forces binding the atoms together are localised at that part of the electron shell where linking takes place.

W. L. BRAGG.
H. BELL.

Manchester University, March 16.

The International Research Council.

THE object of this council, says Sir Arthur Schuster in NATURE of March 17, is "to reorganise international work which had come to a standstill through the war, and to extend it where found desirable." It may be worth while to consider for a moment how the council has set to work to promote these innocent and laudable ends.

The statutes of the council exclude members of "enemy" countries from every "international" union formed under its auspices until 1931. After that date the statutes may be amended, but only by a two-thirds majority; and amendment is not within the competence of any particular union concerned. "Once an international union is established," says Sir Arthur Schuster, "it become autonomous" except "in a few matters in which a common policy is desirable." He might perhaps have added that these "few matters" include the one and only matter about which there is any difference of opinion; and that, so far as co-operation with "enemy" countries is concerned, any science which consents to form a union loses its autonomy completely. Einstein may attend a congress of physics after 1931 if more than two-thirds, not of the physicists of the world, but of the members of the council, consider it advisable to allow him.

I have some experience of the working of the statutes myself, for I was a member of the committee appointed to consider the formation of a Union of Mathematics. When this committee met I moved, on behalf of the society of which I was a representative, that it was desirable "that any union which should be formed should be thrown open to the mathematicians of all nations at the earliest practicable opportunity." This resolution was rejected, not on the ground that it did not represent the general opinion of mathematicians (as beyond doubt it did), but on the ground that it conflicted with the statutes of the council.

The object of this council is not to promote international co-operation, but to exclude the Germans from it. I do not know who wrote the article in the *Times* of which Sir Arthur Schuster complains, nor have I any direct information as to the decisions of English biologists; but if indeed they have refused to join on the ground that the formation of a union "would perpetuate differences which should be left to time to heal," then they deserve the thanks of every English man of science; and so, too, does the correspondent of the *Times*, who has blurted out what so many of us have been feeling and so few have had the courage or the energy to say. G. H. HARDY.

New College, Oxford, March 21.

Solar Radiation in Relation to Faculæ.

IN my letter published in NATURE of January 13, p. 630, it was suggested that the apparent relation between increased solar radiation and sun-spots was due to outbursts of heated gases accompanying the spots. This conclusion seems confirmed by later observations furnished from the Observatory of La Plata by Mr. Bernhard H. Dawson.

Since September there have been eleven cases in which outbursts of faculæ were observed on the east edge of the sun, and eight in which they were observed on the west edge. The accompanying table shows the mean values of solar radiation preceding and following the appearance of these faculæ. Zero day indicates the day of observation and the numbers are the amounts exceeding 1·900 calories per sq. cm. per minute.

Faculae on East Limb of Sun.

	Before									Days after					
	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Solar radiation	38	60	42	38	52	49	49	54	49	50	50	44	56	60	59	51

Faculae on West Limb of Sun.

	Days before													After	
	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2
Solar radiation	58	44	56	58	49	56	56	56	55	48	51	46	54	62	—	47

These results show a marked maximum of solar radiation on the day of observation whether the faculæ were on the east limb or the west limb. After their appearance on the east limb there was a second maximum twelve days later, and there was also a maximum ten to eleven days preceding the observation of faculæ on the west limb.

The results are plotted in the accompanying diagram (Fig. 1). It would seem from these results

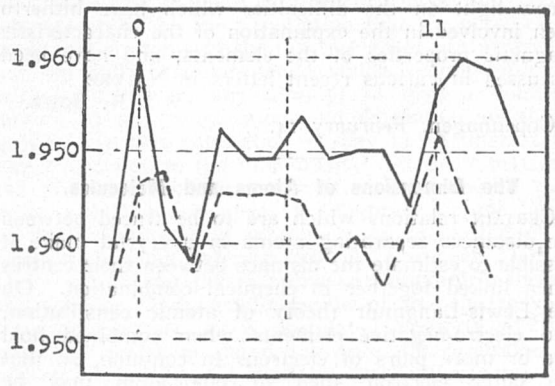

FIG. 1.

that outbreaks of heated gases on the edge of the sun result in increasing the effective radiative surface of the sun, and thus intensify the solar radiation.

H. H. CLAYTON.

Buenos Aires, February 19.

The Sound of Distant Gun-fire.

FATHER SCHAFFERS's letter in NATURE of March 10 on the audibility of gun-fire sounds when travelling through air prompts me to ask if observations have ever been made upon such sound-waves when passing through the earth's crust. In 1917 I commenced to dig gravel in my garden here. The pit finally reached a depth of 12 ft., and was about 7 ft. long by 6 ft. wide. When I had reached a depth of about 6 ft., and from that point downwards, I constantly heard the sounds of gun-fire, while at the surface they were quite inaudible. The digging out of gravel was carried on at intervals during a period of many months, and I must have heard the sounds dozens of times. C. CARUS-WILSON.

Strawberry Hill.

MANY observations similar to the interesting one recorded by Mr. Carus-Wilson were made during the war. The sounds of gun-fire were heard plainly in excavations, though they were inaudible on the ground above. They were even heard by persons lying with their heads on the ground, but not when sitting up. Mallet remarks that the noise of the firing at the Battle of Jena in 1806 was heard as a low murmur in the fields about Dresden, at a distance of 92 miles, but he adds that "it is almost certain that in this case the noise was transmitted through the earth" (Brit. Assoc. Rep., 1851, p. 283). Grouchy and his officers at Sart-les-Walhain are said to have heard the firing at Waterloo. They "placed their ears to the ground and thus detected plainly the muffled boom of distant guns."

CHARLES DAVISON.

"Dunster," Cavendish Avenue, Cambridge.

Electrons.[1]

By SIR WILLIAM BRAGG, K.B.E., F.R.S.

II.

KEEPING in mind the results already described, we can now appreciate a very remarkable development of electron theory which has been made in the last few years. Spectrum analysis has long been occupied with the extraordinary complications of the light radiation emitted by the various atoms. As a result it appears that the frequencies of the lines in a spectrum often display curious and exact numerical relations, in the form generally involving differences of frequencies of similar lines or groups of lines. For instance, the famous Balmer equation :—

$$\text{Frequency} = \nu = N(1/n_1^2 - 1/n_2^2),$$

where $N = 3{\cdot}290 \times 10^{15}$, gives the frequencies of series of lines in the hydrogen spectrum. When n_1 is put equal to 2, and n_2 to 3, 4, 5 in succession, the series of values for ν represent the frequencies of the lines in the visible spectrum. If

$$n_1 = 3 \text{ and } n_2 = 4,\ 5,\ 6,\ \ldots,$$

in succession, we have the frequencies of lines in the infra-red (Paschen); and if

$$n_1 = 1,\ n_2 = 2,\ 3,\ 4,\ \ldots,$$

we have the frequencies recently shown by Lyman to exist in the ultra-violet.

Now there is nothing in our older conception of the origin of radiation within the atom to give us a clue as to why differences of frequencies should come into these empirical, though most useful, formulæ. We have pictured to ourselves vibrating systems, mechanical or electric, and waves arising therefrom. But what connection between masses or electricities gives us in any simple way equations involving the addition or subtraction of frequencies? We are in a blind alley. Let us, therefore, abandon our preconceptions as to the origin of those lines which we find in the light spectrum and suppose that here also they arise in the same fashion as we actually know that they arise in the cases we have considered above. Suppose that the energy of an emission of radiation is derived from the energy of an electron. It may be the only way in which radiation ever does arise, but it is not necessary to suppose so much at present. It is enough that we carry into the atom the whole process which in X-rays and the photo-electric effect we have observed to take place in part outside. Suppose that within the atom there are certain positions or conditions in which electrons *may* be, each postulating a certain energy associated with the electron; and suppose that sometimes an electron slips from one position to another of lower energy, and that the difference in energies is transformed into wave radiation according to the same law as before, *i.e.* energy transferred $= h \times$ frequency. Let the energy in these states be $Nh/1^2$; $Nh/2^2$; $Nh/3^2$; etc., and so on. Then all the series yielded by the Balmer formula are accounted for at the same time.

What may these states be? Why not, as Bohr suggests, so many different orbits in which electrons can move round the central positive nucleus in the atom, the nucleus the sure existence of which Rutherford has established? At one time, if we had presumed the existence of these orbits, we should have been inclined to connect them with the direct emission of radiation, and the frequency of that radiation would be the number of revolutions in a second. But now we assume these orbits to persist without radiation, and that radiation arises where the electron steps from one orbit to another; moreover, the frequency of the issuing radiation is determined by the simple rule: Frequency is equal to change of electron energy divided by h. We are not picturing any new process here, or evolving new ideas to fit awkward facts; we are supposing a process to exist in one place which we already know to exist in another.

It is a very remarkable fact that the number N is equal to $2\pi^2me^4/h^3$ within small errors of experiment. Spectrum measurements show that N is equal to $3{\cdot}29033 \times 10^{15}$; and $2\pi^2me^4/h^3$ is equal, taking the most recent determinations of m, e, and h, to $3{\cdot}289 \times 10^{15}$. Imagine an electron revolving in a circle about the positive nucleus of the hydrogen atom according to the orthodox laws of dynamics with kinetic energy $2\pi^2me^4/n^2h^2 = Nh/n^2$. Its velocity, v, is $2\pi e^2/hn$; the radius, r, of the circular orbit is found by putting $mv^2/r = e^2/r^2$, and is equal to $n^2h^2/4\pi^2e^2m$. The angular momentum is $mvr = nh/2\pi$. If the electron changes its orbit from $n = n_2$ to $n = n_1$, where n_2 is greater than n_1, its kinetic energy in the new orbit is *greater* than in the old by $Nh(1/n_1^2 - 1/n_2^2)$. But an amount of potential energy has been set free equal to $e^2(1/r_1 - 1/r_2)$, and this is equal to twice the change in kinetic energy, as is easily seen by substituting for the r's their values as found above. Consequently, the right amount of energy is available for radiation. We can, therefore, following Bohr, define the necessary separate states as those of motion in circular orbits in which the angular momentum is an integral multiple of $h/2\pi$. The simplicity of these expressions is very attractive. But the matter is far from ending here. During the last few years Bohr and Sommerfeld have led an inquiry into the possibilities of this theory which has produced very remarkable results. These are due to a slight modification in the original conception. The different circular orbits which Bohr first pictured have become groups of orbits fixed by laws which are somewhat arbitrary, but not without foundation. A group contains a limited number of orbits

[1] The Twelfth Kelvin Lecture delivered before the Institution of Electrical Engineers on January 13. Continued from p. 82.

in which the electrons may move, and each group corresponds to one of the original circular orbits. Some of the orbits in each group are elliptical. It appears that the energy of the electron would be the same in all the orbits of any one group were it not that when an electron moves in an ellipse its velocity is not always the same. Now a fast-moving electron shows a variation in mass when its speed alters, and this does affect slightly the energy of the orbit. Consequently, the electron that steps from an orbit belonging to one group to an orbit belonging to another group may part with an amount of energy which is not always exactly the same. The frequency of the consequent radiation may, therefore, have two or more values differing slightly from each other: the single spectrum line is doubled or trebled. This is what Sommerfeld calls the "fine structure" of the lines.

Now there is far more than mere speculation in this. The formula which Sommerfeld gives as

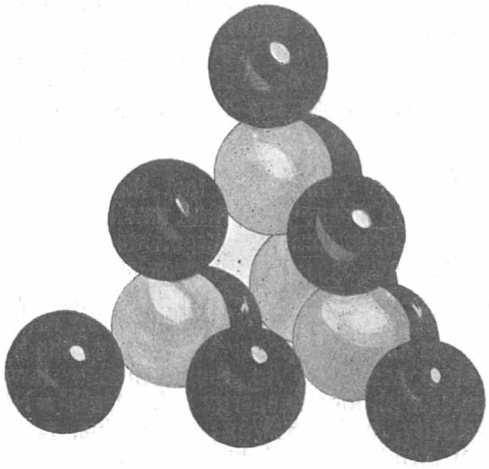

FIG. 2.—Model of the arrangement of carbon atoms in the diamond. All the atoms are alike, but those represented by light spheres differ in orientation from those represented by dark spheres.

the result of an analysis which is as reasonable as can be expected does more than account for known effects; it has predicted the existence of numerous lines, and even their intensities, and the predictions have been verified by experiment in the most remarkable way. The story is told in Sommerfeld's work on "Atom-building": a story of the work of himself, Bohr, and others during the last six years or so.

We see that in this fundamental inquiry into the nature and properties of radiation the electron plays a very direct and important part. Our eyes are designed to detect waves, not electrons, and so our first attention is directed to radiation in wave form. But we now find that radiation energy may alternatively be carried by electrons, and that many things become clearer when we appreciate this fact. We can make further progress in our understanding of radiation, and indeed in our understanding of the electron, only by getting to know more about the reciprocal conversion of one form of energy into the other, since evidently it is one of the most frequent and most fundamental operations in Nature.

So far our conception of the structure of an atom would consist of a positive nucleus and of electrons attached thereto in some way, with the further idea that the energy attached to these electrons can have only certain definite values. Bohr assumes that they have these values because they can move round the core in certain orbits only, and Sommerfeld enlarges this idea, as already explained. But, of course, this can be no more than a partial picture of the whole atomic structure. The atom so conceived cannot fill the part required of it in the building of molecules and crystals.

When we come to examine these structures we find atoms attaching themselves to each other through the action of forces which cannot always be considered as acting from centre to centre. For instance, the arrangement of the carbon atoms

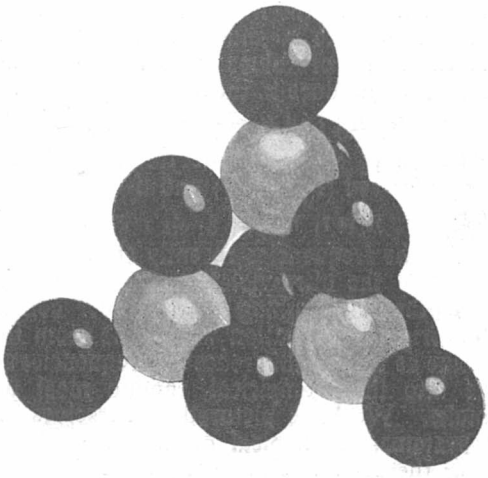

FIG. 3.—An extra ball can be inserted in the model without disturbing other balls.

in a diamond, as recently determined by X-ray methods, is such that every atom is at the centre of gravity of four others, arranged round it in tetrahedral fashion, as shown in the model. The representation of an atom by a smooth sphere and nothing more would be in agreement with the idea that the properties of the atom in any one radial direction are exactly the same as in any other radial direction, and that any forces between two atoms are between centre and centre. But if that were the case, the carbon atoms would pack themselves together more closely than they do. As a matter of fact, if the top of this model is lifted, another carbon atom can be inserted and the top replaced exactly as it was. If a more extensive model were employed, it would be seen that just twice as many atoms could be packed into any volume as are already there. We must conclude that there are definite subcentres of force on the outskirts of the atom, and that in the carbon atoms of which the dia-

mond is composed there are four such sub-centres arranged symmetrically—that is to say, in tetrahedral fashion round the core.

Must not these sub-centres be electrons? And if so, must we not take them to be circulating in small orbits about a local centre? Or, perhaps, as Parson has suggested, the electron is ring-shaped, the electricity revolving round the axis of the ring. In this way we should have electromagnetic forces to link the atoms together.

It is very interesting to observe that, in any case, the carbon atoms in the diamond are not all oriented in exactly the same way. Taking a cleavage or tetrahedral plane as that of reference, half the atoms will be pointing towards the plane and the other half pointing away. This ought to make a difference to the X-ray spectra, and it has been looked for at various times, but without success. Lately, however, the improvement in the X-ray spectrometer has been considerable, and I now have no difficulty in finding the expected effect.[2] It is clear, I think, that the carbon atom in the diamond is to be represented as to its properties by a tetrahedron, and that the atom has different properties in different directions, or, as the chemist would say, has directed valencies. There can be little doubt that this is so in all atoms. The suggestion is that some of the electrons in an atom forming part of a crystal are tied down to certain regions on the surface, and that not all, if indeed any, of them are at all times revolving round the central core.

When atom joins up to atom it is these sub-centres that are at work; and since atom to atom and again atom to atom make in the end the crystal, and since the crystalline structure is the basis of all solid structure, and is fundamentally concerned with the strength of materials and their temper and all their physical properties, it is easy to see how great is this minute study of the electron.

If this conception of fixed electrons seems to clash with the orbital motions of Bohr and Sommerfeld, we must remember that the clash is between two pictures both of which are, we know, imperfect. We may expect that on the next occasion when a lecturer tries to tell you what advance has been made in the study of electrons some of these contradictions will have disappeared. Whether it will so turn out or not, I am sure of this, that in the attempt to realise the properties of Nature's unit, the electron, we are working in the true direction towards an understanding of the great problems of radiation and of material structure.

[2] There is, in fact, a small second-order spectrum in the reflection of X-rays by the tetrahedral plane.

Reformed Cannibals.[1]

NEW GUINEA, despite the considerable amount of attention that has been paid to it, has still large areas unexplored, and many peoples about whom nothing is known. Extremely little, even in the "Annual Reports of New Guinea," has been written about the natives of the D'Entrecasteaux group, the large mountainous islands which lie off the north coast of the south-eastern end of New Guinea, although a good deal of information has been collected about some of the peoples on the adjacent mainland and about the Trobriand Islanders farther east. An ideal opportunity was thus open to Mr. Jenness, a distinguished classical student of Balliol, who was one of the first to obtain the Oxford diploma in anthropology. A further advantage he had was in the collaboration with his brother-in-law, the Rev. A. Ballantyne, who for nine years had been a missionary on Goodenough Island.

The result of this partnership is a pleasantly written, sympathetic account of the Goodenough Islanders, which fills up one of the many gaps in our knowledge of the ethnology of New Guinea. The authors have given a succinct account of native life from the economic, social, and psychical points of view, and it is a comfort to students at home to feel that they have here something on which they can rely implicitly. Specialists will naturally turn to particular chapters, but all should read the book through in order to get a complete view of the mode of life, actions, ideas, and ideals of the people; these are all interdependent and cannot satisfactorily be studied apart.

We may perhaps attribute the conciseness of the book to the present cost of book-production, but a little more detail in various sections would have added to its value. We are, however, given the hope that other matter may be published later; we trust that this will be the case, and that the material culture will receive fuller treatment, for we learn that the collections have now reached the Pitt-Rivers Museum. We should also like to hear more about the stone sitting-places and their connection with cannibalism, and about the use of memorial- and grave-stones, as these are doubtless connected with one of the great culture migrations into Oceania. Evidently it was not the intention of the authors to enter into the thorny paths of racial or cultural migrations, or even to give parallels among neighbouring people; so they have rigidly confined themselves to what they have themselves noted, and this is all that we can demand of them. A field-observer who is alive to the wider problems will usually be able to appreciate the value of small details which might otherwise be overlooked or considered as too trivial to mention; but in any case generalisation should not be mixed up with description, and our authors have not fallen into this common practice.

The curious custom of chopping off a finger-

[1] "The Northern D'Entrecasteaux. By D. Jenness and the late Rev. A. Ballantyne. With a preface by R. R. Marett. Pp. 219. (Oxford: At the Clarendon Press, 1920.) 12s. 6d. net.

joint on the death of a relative seems to have been peculiar to Goodenough. It was first noted by M. H. Moreton, R.M., in his report, Appendix N to the "Annual Report on British New Guinea," 1897–98. He describes which joints are cut off for special relatives, and adds: "They do not, as a rule, disjoint the fingers of the right hand, but, on the occasion of a man distinguishing himself in fighting, the first joint of the third finger of the right hand is lopped off. This custom is falling into disuse. . . . I do not know that the custom of disjointing is practised in a single other district. . . . I have noticed many natives with mutilated left hands." Our authors do not refer to Moreton's statement, nor do they confirm or deny any association between the particular joint and a definite relationship. They describe the method, and say that "in Mud Bay adults shrank from the pain this mutilation caused, so little children were made the victims. . . . Men seldom lose more than two or three finger-joints [never of the thumb or of the right-hand little finger], but it is not at all unusual for a woman to have all the fingers (not the thumbs) of one or even of both hands maimed," but only the terminal phalanges are removed. One lore-learned native said that "all the dead go to Wafolo [an uninhabited district on the north-west side of Fergusson Island] except those with unchopped fingers; these are killed and eaten by some dogs that bar their path."

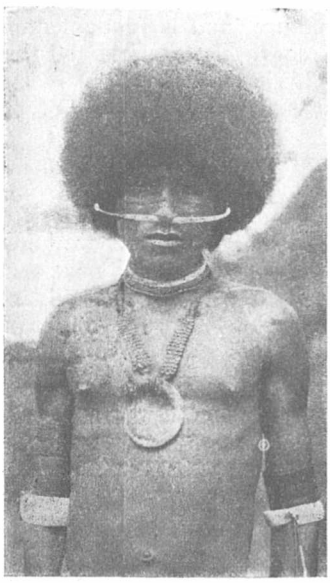

FIG. 1.—A Kabuna youth, Mud Bay, Goodenough Island. From "The Northern D'Entrecasteaux."

FIG. 2.—Fishing with traps and hauling up a square fish-net, *lata*, Mud Bay, Goodenough Island. From "The Northern D'Entrecasteaux."

Mr. Ballantyne's long and intimate knowledge of the natives gives especial authority to the estimate of the psychology of the natives and of their magico-religious beliefs and customs, and it is in this section that the partnership of a missionary and a trained ethnologist is particularly valuable. Thirty-seven excellent photographs add to the interest of this instructive book. A. C. H.

Obituary.

PROF. A. G. NATHORST.

ALFRED GABRIEL NATHORST, who for the greater part of his life was Director of the Palæobotanical Museum of the Swedish Academy, died at Stockholm on January 20 at seventy years of age. In many respects Nathorst was a remarkable man; precluded by deafness from the ordinary means of communicating with his fellows, he had an almost uncanny power of divining the point of a remark before it was fully expressed in writing on the tablet which he always carried with him: a keen sense of humour, a boyish love of the ridiculous, and a lovable personality made him a delightful companion. Some chance word or incident would lead him to quote verbatim passages from Dickens, especially "The Pickwick Papers," Kipling, or other favourite author; he wrote and spoke English and German with apparent ease, and some of his papers are written in French. In him, as in comparatively few men, were combined the naturalist's love of the open air and the lust of travel with the patience of the laboratory student.

Nathorst paid his first visit to England in 1872, when he met Sir Charles Lyell, whose "Principles of Geology," as he stated in acknowledging the award of the Lyell medal from the Geological Society in 1904, first attracted him to the study of geology. In 1870 he went to Spitsbergen, where he became familiar with recent Arctic plants, and on his return he investigated fresh-water Pleistocene beds in Denmark, Germany, Switzerland, and England, utilising his knowledge of existing species in tracing the distribution of Arctic plants in Europe during the Glacial period. A series of travel-notes published in 1880 contains many valuable opinions on fossil plants from Meso-

zoic and Tertiary localities in English collections. In 1879 he collected specimens of the dwarf birch at Bridlington, and on later visits he always divided his time between conferences or excursions with Mr. Clement Reid and collecting plants from the Jurassic rocks of Yorkshire. A summary of his work on the distribution of Arctic plants during the Glacial epoch was contributed by him to NATURE for January 21, 1892.

In 1907 Nathorst attended the centenary of the Geological Society as a delegate of the Swedish Academy, and received the Sc.D. degree from the University of Cambridge. In 1909 he returned to Cambridge as a delegate to the Darwin celebrations. In 1917, at the age of sixty-seven, in accordance with Swedish custom, he retired from the museum directorship. After his retirement his researches were frequently interrupted by heart trouble, but he had the satisfaction of completing an important memoir, published last year, in continuation of his well-known investigations of the Lower Carboniferous flora of Spitsbergen. Nathorst's contributions to knowledge cover a very wide field—Arctic exploration, stratigraphical and tectonic geology, palæontology in the broadest sense, and recent botany. In 1882 he again visited Spitsbergen, and in 1898 he was the scientific leader of an expedition, primarily in search of Andrée, to Bear Island, King Charles Land, and other regions; it was in the course of this expedition that he circumnavigated Spitsbergen. He described his experiences of two summers in polar seas in an attractive two-volume book written in Swedish and published in 1900, and the scientific results of the voyage, both geological and palæobotanical, have appeared in a succession of valuable papers.

Nathorst's first paper, in 1869, was on Cambrian rocks of Scania, and this was followed by a series of botanical and geological papers. In 1875 he published the first of a long series of contributions to our knowledge of the rich Rhætic floras of Scania, which have thrown a flood of light upon many extinct types, and incidentally have illustrated in a most striking manner the possibilities of the intensive study of the fossil plants of a single region. Though he became more and more absorbed in palæobotanical researches, he always retained an active interest in both geology and botany; the range of his work was exceptionally wide. He had few equals in the extent of his knowledge and in breadth of view.

It is to Nathorst more than to any other man that we owe our knowledge of Arctic floras extending from the Devonian to the Late Tertiary period. His work is characterised by meticulous accuracy, lucidity of presentation, originality, and philosophical treatment. In 1904 he contributed to the French Academy a preliminary account of a remarkable collection of Jurassic plants from Graham Land, on the borders of Antarctica, which demonstrated the almost world-wide distribution of certain ferns and cycadean plants. His palæobotanical papers deal with floras from Japan, the New Siberian Islands, the Arctic regions generally, Scandinavia, and other parts of the world. By his researches into the Jurassic plants of Yorkshire, Nathorst not only added greatly to knowledge, but also stimulated other workers in the same field, and his friendly invasion of the East Coast increased the activity of some English palæobotanists. His discovery of male flowers of Williamsonia and of several new types of the genus is of special interest to English students. An improved method, which he invented, of treating the carbonised or mummified impressions of plants led to fruitful results both from his own researches and from those of others. His demonstration of the true nature of many supposed Palæozoic Algæ marked an important advance in accurate knowledge and in experimental methods of research.

Of special interest from the point of view of evolution are Nathorst's discoveries of many new generic types, such as Pseudobornia, a primitive Devonian plant combining characters of the Equisetales and the extinct group Sphenophyllales; Lycostrobus, a Rhætic lycopodiaceous cone comparable to the large Palæozoic Lepidostrobi; Cephalotheca, a new Devonian fern with peculiar fertile pinnæ; several new seeds from Lower Carboniferous rocks of Spitsbergen; Wielandiella, a remarkable cycadean genus bearing bi-sporangiate flowers and in habit entirely different from that of recent cycads; Cycadocephalus, a Rhætic cycadean micro-strobilus; and Camptopteris, one of several Rhætic ferns which he described in detail. He also made numerous important additions to our more accurate knowledge of cycadean fronds included in the group Cycadophyta (a name instituted by Nathorst), and investigated the past history of the Ginkgoales, a group with one existing representative, the maiden-hair tree.

The Palæobotanical Museum of Stockholm, which was worthily housed in a new building, erected by the Government at a cost of 140,000*l*., a few years before his death, is an epitome of his achievements and a monument of which his native country may be justly proud. In no other country has palæobotanical research received a more generous recognition; it is usually relegated to a position of secondary importance.

It would be difficult to exaggerate the value of Nathorst's contributions to natural knowledge; he devoted his life to research, and it was always a joy to him to give all the assistance he could to other workers who appealed to him for guidance. As a critic he would take infinite pains, and it was never a trouble to him promptly to answer in a letter of almost perfect English the most trivial questions. Those who were among his regular correspondents have lost a true friend, the value and stimulating effect of whose wise counsel and frank but kindly criticism cannot at once be thoroughly appreciated.

Nathorst was fortunately able to retire with the knowledge that his successor and pupil, Dr. Halle, would fully maintain the high standard of palæobotanical work which has long been associated with the Stockholm Museum. A. C. SEWARD.

ADOLF APPELLÖF, who died at Upsala on January 5, was born on the island of Gottland on November 2, 1857. In 1889 he became a conservator of the zoological collections in Bergens Museum, and succeeded to the keepership of the whole department in 1907, being at the same time made professor at the newly established university there. In 1910 he was appointed professor of comparative anatomy at Upsala, which post he held until the end. In his early writings on Cephalopoda, Appellöf showed that similarly hectocotylised arms arose in diverse groups; he threw light on the homologies of the shell in Sepia, Spirula, and Nautilus, and proved the occurrence of a shell in the octopods. Among many works on actinians, that on their development (1900) won for him the Nansen prize. Later he studied the Crustacea, wrote an important work on the decapods of Norway, and won the Joachim Friele gold medal with a memoir on the lobster. Two papers on Pycnogonids of the Arctic should not be forgotten. Such were Appellöf's chief publications; but he did a large amount of investigation into fishery and other zoological problems in expeditions along the Norwegian coast and, on the *Michael Sars*, to the North Sea and North Atlantic. His chief work, however, was the inspiring instruction of youth in the laboratory at Bergen, and later at Upsala and in the biological station of "The Club," which he founded five years ago on Gullmar Fjord. There, among the living sea-creatures and the merry students, Appellöf's cheerful enthusiasm found its untrammelled exercise. F. A. B.

THE death of MR. HERBERT BYROM RANSOM is announced in *Engineering* for March 11. Mr. Ransom was born in 1867, and was educated at Cheltenham College, and passed through the engineering course at University College, London. He received his practical training with Messrs. Manlove, Alliott, and Co., Ltd., Nottingham, and became a director of the company in 1902. In 1908 he retired to take up private practice. He was a member of the Institutions of Civil and Mechanical Engineers, and his papers to the former institution were awarded a Miller prize and scholarship, a Watt medal, and a Telford premium.

THE death is reported, in his eighty-third year, of DR. CHARLES H. FERNALD, professor of natural history at the Maine State College (now the University of Maine) from 1871 to 1886, and of zoology and entomology at the Massachusetts Agricultural College from 1886 to 1910. When the Hatch experiment station was established at the latter institution Dr. Fernald became the entomologist of the station. He had contributed largely to scientific journals, and in collaboration with Mr. E. H. Forbush prepared a large work on "The Gypsy Moth," which was published by the State. He was the father of Dr. H. T. Fernald, the present head of the entomological department at the Massachusetts Agricultural College.

THE death of SIR ARTHUR LEWIS WEBB on March 15 is announced in the *Engineer* for March 18. Sir Arthur was born in 1860, and entered the irrigation branch of the Public Works Department of India in 1881, after having passed through the Royal Engineering College at Coopers Hill. He was transferred to the Egyptian Irrigation Department in 1894, and rose to be Under-Secretary for Irrigation and Adviser to the Public Works Ministry. He was created K.C.M.G. in 1912.

Notes.

FOR the meeting of the British Association which will be held at Edinburgh on September 7–14 next the following presidents of Sections have been appointed:—Section A (Mathematics and Physics), Prof. O. W. Richardson; B (Chemistry), Dr. M. O. Forster; C (Geology), Dr. J. S. Flett; D (Zoology), Mr. E. S Goodrich; E (Geography), Dr. D. G. Hogarth; F (Economics), Mr. W. L. Hichens; G (Engineering), Prof. A. H. Gibson; H (Anthropology), Sir J. Frazer; I (Physiology), Sir W. Morley Fletcher; J (Psychology), Prof. C. Lloyd Morgan; K (Botany), Dr. D. H. Scott; L (Education), Sir W. H. Hadow; and M (Agriculture), Mr. C. S. Orwin. Sir Richard Gregory has been appointed president of the Conference of Delegates of Corresponding Societies. Among the subjects of general interest which are being arranged for discussion at joint sectional meetings are:—The Age of the Earth, Biochemistry, Vocational Training and Tests, The Relation of Genetics to Agriculture, The Proposed Mid-Scotland Canal, and The Origin of the Scottish People. The president of the association, Sir Edward Thorpe, will deliver his address at the inaugural meeting on Wednesday evening, September 7, and discourses will be given at general evening meetings by Prof. C. E. Inglis on The Evolution of Cantilever Bridge Construction, involving a comparison between the Forth and Quebec bridges, and by Prof. W. A. Herdman, the present president, on Edinburgh and Oceanography. Measures are being taken towards a more effective co-ordination of the daily programmes in order to avoid the clashing of subjects of kindred interest.

THE SECRETARY FOR MINES has appointed Dr. F. H. Hatch to be Technical Adviser to the Mines Department on questions relating to the metalliferous mining industry.

SIR EDWARD THORPE (Great Britain), Prof. Le Chatelier (France), Prof. Ciamician (Italy), and Dr. Ernest Solvay (Belgium) have been elected honorary foreign members of the Chemists' Club, New York.

THE annual Wilbur Wright lecture of the Royal Aeronautical Society for this year is to be delivered by Major G. I. Taylor at the Royal Society of Arts on Tuesday, April 12, at 8 o'clock.

IT is announced in *Science* for March 4 that the Bruce gold medal for the year 1921 of the Astronomical Society of the Pacific has been awarded to Dr. H. A. Deslandres, director of the Astrophysical Observatory of Meudon, near Paris, for his "distinguished services to astronomy."

THE International Institute of Anthropology, which has been founded at Paris, will hold a congress at Liège on July 25–August 1. The provisional programme appears in the current issue of the *Revue Anthropologique*, which has been adopted as the organ of the institute and of the Schools of Anthropology of Paris and of Liège. The central office of the institute is at 15 rue de l'Ecole de Médecine, Paris VI.

AT the anniversary meeting of the Royal Irish Academy on March 16 Prof. Sydney Young was elected president in succession to the Most Rev. Dr. Bernard, Provost of Trinity College, Dublin, whose period of office has just expired. Prof. C. S. Sherrington, president of the Royal Society, was declared an honorary member in the section of science under the statute by which presidents of the Royal Society are honorary members of the academy.

THE summer meeting of the Institution of Electrical Engineers is to be held in Scotland on June 7–10, and a provisional programme for it has just been issued. Besides a number of visits to places of interest, the reading of the two following papers has been arranged for:—"The Dalmarnock Generating Station," R. B. Mitchell (at the Royal Technical College, Glasgow, on June 7), and "The Hydro-electric Resources of the Scottish Highlands," Prof. Magnus Maclean (in Glasgow University on June 8).

AT the meeting of the Royal Geographical Society on Monday, March 21, the president announced that the King has sent a donation of 100*l.* towards the funds of the Mount Everest Expedition. The president added:—"Both his Majesty and her Majesty the Queen take the greatest interest in the expedition, and have questioned me closely as to our plans, the prospects of success, and the composition of the party; and they have assured me of the keen interest with which they will follow the progress of the expedition."

THE election to a Sorby research fellowship at the University of Sheffield will take place in June next. The appointment, subject to regulations, will be for five years, and the emoluments approximately 500*l.* per annum. The object of the fellowship is not the training of men for original research, but to obtain advances in natural knowledge by enabling men of proved ability to devote themselves to research. Applications for the fellowship should be made to the Secretaries of the Royal Society, Burlington House, W.1, by May 31, and such applications should give particulars of the candidate's scientific career and state the nature of the work he proposes to follow if elected.

AT the annual general meeting of the Ray Society on March 10 the following officers were re-elected:—*President:* Prof. W. C. McIntosh *Treasurer:* Sir Sidney F. Harmer. *Secretary:* Dr. W. T. Calman. The Right Hon. Lord Rothschild was elected a vice-president, and Mr. E. E. Green, Mr. Chas. Oldham, and Sir David Prain were elected new members of council. The report of the council directed attention to the urgent need for a large increase in the number of subscribers if the society is to avoid the alternatives of raising the rate of subscription or restricting the annual output of publications. It was announced that the first part of the fourth volume of Prof. McIntosh's "British Marine Annelids" was in the press, and would form the issue to subscribers for 1920. Substantial grants towards the cost of publication of this work have been made by the Carnegie Trust for the Universities of Scotland and by the Royal Society.

A SECOND International Congress of Eugenics is to be held in New York City on September 22–28, under the honorary presidency of Dr. Alexander Graham Bell. The president of the congress is Prof. Henry Fairfield Osborn, its treasurer Mr. Madison Grant, hon. secretary Mrs. C. Neville Rolfe (of London), and general secretary Dr. C. C. Little. The papers to be read before the congress fall into four sections:—(1) Studies in human heredity, including the results of research in pure genetics which may be applicable to man. (2) The human family, including the factors that influence the fecundity of different strains and the differential mortality of the eugenically superior and inferior stocks; mate selection to be considered in this section. (3) Human racial differences; in this section will be considered the facts of migrations and the influences of racial characteristics on human history and miscegenation. (4) Applied eugenics; here will be discussed eugenics in relation to the State, to society, and to education. It is desired that all papers from Europe should be in the hands of the general secretary, Dr. C. C. Little, American Museum of Natural History, by May 1, and those from Canada and the United States not later than June 15. Persons having material for exhibition are requested to write at once to Dr. Little, stating its nature and size.

THE annual general meeting of the Chemical Society was held at Burlington House on March 17, when Sir James J. Dobbie, the retiring president, delivered his address. The following new officers and members of council were declared elected:—*President:* Sir James Walker. *Vice-Presidents who have filled the office of President:* Prof. H. E. Armstrong, Sir James J. Dobbie, Prof. W. H. Perkin, Sir William J. Pope, Dr. Alexander Scott, and Sir William A. Tilden. *Other Vice-Presidents:* Prof. F. G. Hopkins, Prof. F. S. Kipping, and Prof. J. F. Thorpe. *Ordinary Members of Council:* Prof. J. S. S. Brame, Dr. C. H. Desch, Mr. E. V. Evans, Mr. H. B. Hartley, Dr. T. S. Patterson, Dr. T. Slater Price, Mr. W. Rintoul, Dr. R. Robinson, and Dr. N. V. Sidgwick. In presenting the Longstaff medal to Prof. J. F. Thorpe the president referred to the importance of the researches on organic chemistry on which Prof. Thorpe and his colleagues had been engaged for many years. The

anniversary dinner was held at the Hotel Cecil the same evening, and was attended by more than two hundred fellows and guests. Sir James J. Dobbie was in the chair. Of the five jubilee past-presidents whom the council desired to entertain as guests of honour only Sir James Dewar and Sir William Tilden were able to be present. After the loyal toasts had been honoured Sir Alfred Mond gave the toast of "The Chemical Society," to which the president replied. The toast of "The Past-Presidents" was proposed by Prof. Harold B. Dixon, and response made by Sir James Dewar and Sir William A. Tilden; whilst Prof. C. Moureu (vice-president of the French Chemical Society), the Hon. Mr. Justice Sargant, and Prof. C. S. Sherrington (president of the Royal Society) replied to the toast of "The Guests," proposed by Prof. F. G. Donnan.

AN Appointments Committee for Russian Scientific and Literary Men has been formed under the chairmanship of Sir Arthur Schuster, among other members being Lord Bryce, Sir Frederic Kenyon, and Prof. Sherrington, president of the Royal Society. Numbers of distinguished Russian scholars, many of whom are destitute, while others are engaged in work for which they are unfitted, are scattered over European countries. It is the object of the committee to bring the names and qualifications of these men to the notice of universities and other institutions which may be able to offer them suitable employment. A list of names of those at present known to the committee has been received, and in it we notice the following:—Assistant-Prof. Vladimir Issaieff, technical chemistry (sugar and fermentation industries); Prof. Anatole Poppen, ophthalmology (specialist in trachoma); Prof. Lazar Rosenthal, bacteriology; Prof. Vadim Yurevich, bacteriology and infectious diseases; Assistant-Prof. Jacob Khlitchieff, naval engineering and shipbuilding; Assistant-Prof. Nicholas Znamensky, applied mechanics; Dr. Leonid Dubitzky, hygiene; Dr. Nicholas Hans, philosophy and psychology; Dr. Boris Perrot, hygiene and tuberculosis; Dr. Serge Chakhotin, zoology and physiology; Dr. Ernest Ferman, hygiene; and Dr. Boris Sokoloff, protozoology. The hon. secretary to the committee is Dr. C. J. Martin, Director, Lister Institute, London, S.W.1, and he will be glad to forward particulars of the careers of the men whose names are given above, or copies of the circular letter inviting anyone who knows of spheres of work in which they could be engaged to communicate with him. Opportunities for providing these stranded scientific workers with positions where their knowledge and experience could be usefully employed must arise from time to time in university and other institutions, and any assistance in bringing information of such possible openings to the notice of the committee would be gratefully welcomed.

AMONG many savage or barbaric races the belief in the dangers which occur in the course of house-building is widely felt. A good account of this is given in a paper by Dr. G. Landtman in *Acta Academiae Aboensis*, part i., in relation to the Papuan Kiwai tribe, inhabiting the district at the mouth of the Fly River in British New Guinea. At present the people can give no exact explanation of the Darimo, or protective figures of the house. They do not seem to represent any definite being or beings. "The gloomy aspect of the figures and the uncanny, if indistinct, ideas associated with them exercise in themselves a powerful effect upon the native mind without any exact interpretation being required. It is enough for the people that the weird forms are possessed of mysterious properties, partly their own and partly those of the medicines applied to them."

THE study of the aborigines of Tasmania will be much advanced by the publication of a descriptive catalogue, prepared by Messrs. W. L. Crowther and C. E. Lord, of the osteological specimens contained in the Tasmanian Museum. The list forms a record of the largest single collection extant of osteological remains of the extinct Tasmanian aboriginal race. It embraces also specimens concerning which data are being gathered for publication, while additional particulars have been added to specimens already in part described. With the exception of the researches of Harper and Clarke, and later of Berry and Robertson, on certain of the crania contained in this list, none of the specimens have been described. Even the complete skeleton of Trucanini, the last of his race, remains to be measured and the indices to be tabulated. Some further specimens in private hands have been traced, and anthropologists will await with interest the completed results of the investigation.

IN an interesting review (*Journal of Genetics*, vol. x., No. 4) of the sex-ratios and the various ways in which they have been modified in animals and plants, Mr. Julian S. Huxley discusses the relations of modified sex-ratios to the sex-chromosomes, and adopts the probable hypothesis that in many such cases the normal effect of the presence of one or two X-chromosomes has been overridden by a metabolic effect of some environmental factor. This factor may be delayed fertilisation (producing in frogs chiefly males, and also altering the sex-ratio in cattle), attack of the anthers by a smut in the plant *Lychnis dioica* causing the partial transformation of male plants into hermaphrodites, development of females from male crabs by parasitic castration, and in cattle the partial alteration of a female into a male when twinned with a male owing to the circulation in the blood of substances derived from the male embryo (Lillie). In all such cases the normal effect of the chromosome complex in development has been modified probably by the metabolic influence of substances not present in normal conditions. A similar interpretation is applied to the experiments of Goldschmidt and of Harrison with moths and of Riddle with pigeons. It is pointed out that aberrant sex-ratios may result from differential fertilisation, differential mortality of gametes or zygotes, or the overriding of the chromosome constitution by such external factors as those mentioned. This view is applied to an explanation of a case in the "millions fish" (*Girardinus poeciloides*), where there was first a great preponderance of males, then a lesser preponderance of females, and finally equality in the numbers of the sexes.

THE Scaphopoda (tusk shells) of the eastern coast of America have received careful systematic treatment by Mr. J. B. Henderson, whose account (U.S. Nat. Mus., Bull. 111, 1920) is based on the extensive collection in the United States National Museum and in other museums, and on several hundred lots from his own dredgings in the Florida Keys. The species appear to fall into two well-marked groups—a northern cold-water group extending from New England to Cape Hatteras, and having affinities with the species of northern Europe, and an Antillean assemblage.

MAJOR W. S. PATTON contributes to the *Indian Journal of Medical Research* (vol. vii., No. 4, 1920) an account of the Mesopotamian house-flies and their allies, and describes the measures against them which he adopted in the camp at Nasiriyeh, on the Euphrates. The principal means were :—(1) Incineration of manure and excrement to destroy the eggs and larvæ of flies; (2) the burying of fresh manure in the centre of a mound of manure previously accumulated and in which the temperature, owing to fermentation, was already high enough to kill eggs and larvæ—a method originally employed in France by Roubaud and now "thoroughly recommended" for a tropical climate by Major Patton after his experience of its usefulness in Mesopotamia; (3) the drowning of larvæ and pupæ; (4) the use of baited traps to catch adult flies; and (5) the burning at dusk of large numbers of flies which had congregated in the interior of huts erected at suitable points to serve as resting-places for the flies. Kerosene torches were passed rapidly over the walls and roofs of these huts for this purpose.

A LECTURE by Mr. W. B. Brierley on "Personal Impressions of American Biological Research" was given on Tuesday, March 15, at a meeting held at the Imperial College, South Kensington, by the National Union of Scientific Workers. Sir Daniel Hall occupied the chair. Mr. Brierley said that the most striking feature of American agriculture was the almost complete concentration in wide areas of a single crop, so that there were 500 miles together of maize, cotton, or rice, and not much smaller areas of fruit or vegetables for preserving. One consequence of this was that a plant disease ran riot through a whole area, and the field problems confronting the American agricultural biologist were so vast and menacing as almost to destroy the possibility of academic research except in the eastern industrial regions. In the industrial area, containing the older universities, the biological work approximated closely to that done in this country in subject and mode of attack, but in the State universities in the newer agricultural regions—each with its own single crop presenting urgent problems for solution—certain features were noticeable :—(1) An early and extreme specialisation, subjects which were here studied after a degree course in botany (such as plant pathology) being themselves degree courses, and the graduates immediately devoting themselves exclusively to the study of a single type of disease. (2) There was almost no gradation between the academic biologist of real eminence and the ordinary worker dealing with a limited field of applied science.

THE United States Geological Survey has just issued a monograph (Professional Paper 96) on "The Geology and Ore Deposits of Ely, Nevada," by Mr. Arthur C. Spencer. This work is notable as giving a very complete account of the occurrences of disseminated copper ore usually spoken of as the porphyry copper deposits. Their importance may be gauged from the fact that, although work upon them only commenced in 1908, in the period between then and 1915 nearly 20,000,000 tons of this ore had been treated, producing nearly 200,000 tons of copper, whilst some 95,000,000 tons of ore have been developed. The ore consists for the most part of monzonite porphyry of various types; true monzonite is a plutonic rock containing about equal amounts of orthoclase and plagioclase, together with hornblende, augite, or mica. The greater part of the monzonite in the Ely district is of the variety known as quartz monzonite, intermediate between granite and granodiorite. This rock appears to carry a certain quantity of primary copper minerals, chiefly chalcopyrite, in quantities sufficient to give about 0·5 per cent. of copper in the unaltered rock. The portions worked as ore have later undergone secondary enrichment; the copper has been leached out from the overlying parts until these contain only about 0·2 per cent. of copper, the leached zone extending to a depth varying between 20 ft. and 200 ft. The cupriferous solutions descending from these upper portions were decomposed lower down, depositing chalcocite and some additional chalcopyrite, thus bringing the copper contents of the workable portion up to 1·5 or 2 per cent.; the thickness of the zone thus enriched appears to be about 300 ft. in most parts. The mode in which these changes have probably been brought about has been carefully studied, and is described in full detail, and the work forms a valuable contribution to our knowledge of ore deposition.

MESSRS. NEGRETTI AND ZAMBRA have designed and produced an instrument called a rainfall rate recorder which registers on a revolving drum a graph of the actual rate of rainfall at any moment in inches per hour. The principle involves weighing the water as it passes down an inclined surface. The inclined surface is a tube in the shape of a spiral, and is suspended at one end of a balanced lever, the other end of which carries the pen. The spacing of the recording scale is more open for the lower than for the higher intensities. The instrument is capable of being made of great use, especially for engineers concerned with main drainage and similar works. An examination of the records obtained suggests that the initial record of a rainfall is fallacious, drops accumulating in the tube and starting with a record much higher than is true, whilst the curve at the end of a rainfall is similarly fallacious owing to drops remaining in the tube. These objections are far from trifling, and require to be got rid of before the instrument is really trustworthy, though when rain is falling heavily the changes in the rate of fall are

very clearly shown. The price of the instrument, with the necessary charts and plant, is 55*l*.

THE *Meteorological Magazine* for January contains a communication from Sir Napier Shaw concerning the possibility of dissipating fog by artificial heating, the subject having been suggested to him by an inquirer who alleged that he "had seen fog disperse over a football ground as the game proceeded." Sir Napier Shaw is clearly very dubious of the possibility of dissipating fog artificially, especially as in a fog the air is in motion and not absolutely still, as is generally supposed. A preliminary survey of the rainfall of 1920 is given; it is said to be divided into two well-marked periods, the first seven months being generally wet and the five later months generally dry. The total for the year was above the average in the west, but there was a deficiency along the east coast of Great Britain. The greatest excess was in Wales, where in places the total was 30 per cent. above the average. For the British Isles as a whole the rainfall in 1920 is estimated as 109 per cent. of the average. The Thames Valley rainfall map for December shows the greatest rainfall during that month to have occurred in the southern areas, in parts of Hampshire and Sussex, where it exceeded 4 in., whilst in the north, around Cambridge, the rainfall was 1·5 in. or less.

A PAPER by Prof. Gabriel Petit published in *La Nature* of October 16, 1920, gives an interesting account of the effect of radio-activity on the fertility of the soil. From the results of experiments on geraniums, chrysanthemums, etc., the author concludes that there is no doubt that radio-active substances exert a very favourable influence on the growth of plants. The experiments show that the treatment is harmful if the radio-active substance is present in too great quantity. Researches are therefore being continued in different parts of the country to decide on the optimum dose and on the best method of application; to discover which of the three kinds of rays—the α, β, or γ—are the most valuable, and whether the rays act on the plant directly or indirectly *via* the soil or *via* the micro-organisms in the soil; and, finally, to decide whether radio-activity has any influence on nitrogen fixation. It is clear that there is an almost unlimited field for experiments, and, in the author's opinion, there will undoubtedly be a great gain for agriculture from the scientific application of radio-active substances.

AT the meeting of the Illuminating Engineering Society on March 17 Major A. Garrard read a paper entitled "Motor-car Headlights: Ideal Requirements and Practical Solutions." It was pointed out that the problem involves a compromise between two almost irreconcilable points of view, that of the driver of a car who requires a powerful beam impinging on distant persons and vehicles and that of approaching persons or drivers of other vehicles who are apt to be dazzled by the intense light of such a beam. On the whole, the best practical solution appears to lie in keeping all light below the eye-level, at the same time giving maximum intensity just below the boundary. Several headlights in which an attempt was made to realise this condition were shown at the meeting. The lecturer suggested that the ideal beam should consist of (1) a bright, penetrating part, very shallow and relatively wide, projected along the road surface below eye-level; (2) a much wider beam, not so bright, illuminating hedges, etc., also all below eye-level; and (3) a generally diffused beam of very low intensity close to the car. He contended that these requirements cannot be met by any simple device or attachment to the ordinary parabolic headlamp, but only by some form of optical projecting apparatus employing at least one lens, which should not be materially more complex or expensive than the headlight of the present day.

THE *Bulletin de la Société d'encouragement pour l'Industrie nationale* for January contains the complete text of the public lecture given by Lt.-Col. Renard in February, 1920, on "The Evolution of Aeronautics during the War." Col. Renard points out that while in the war of 1870–71 the ordinary balloon played an important part, in the recent war its utility was insignificant. On the other hand, the captive balloon, which had been scrapped as out of date by the French military authorities in 1911, was used by the Germans from the very beginning of the war as a means of observation. Before the end of the war captive balloons of 800 to 1000 cubic metres capacity were in constant use. In the same way the development of the dirigible had only reached the stage represented by a volume of 8000 cubic metres in France in 1914, while in Germany Zeppelins of three times that volume had been constructed. The aeroplane had, on the contrary, been developed in France with enthusiasm, and speeds of 120 km. per hour attained. During the war this speed was doubled. Col. Renard urges on his country the importance of developing civil aviation as the best preparation for the next war, which he believes will open by the aerial bombardment of all the principal cities of one of the belligerents.

THE March issue of the *Philosophical Magazine* contains an article by Sir J. J. Thomson on the structure of the molecule and chemical combination, which collects together and amplifies the statements the author has made in his Royal Institution lectures during the past few years. He points out that the nuclear atom with revolving electrons is unstable, and replaces it by a positive nucleus with electrons in equilibrium around it, the equilibrium being secured by the law of action of nucleus and electron being taken as an attraction according to the inverse square of the distance at considerable distances, but as a repulsion at small distances. In these circumstances it is shown that one electron arranges itself at the distance from the nucleus at which attraction changes to repulsion, two arrange themselves on opposite sides of the nucleus, three at the corners of an equilateral triangle, four at the corners of a tetrahedron, and so on up to eight electrons, which arrange themselves in regular order on the surface of a sphere with the nucleus at the centre. When there are more than eight electrons, the first eight form an inner, and the rest an outer, layer, the number of the latter determining the valency of the atom. The properties of the atoms and molecules which are accounted for on this theory are numerous, and the theory seems most fertile.

AN important paper on the "corona voltmeter" was read to the American Institute of Electrical Engineers last July by Prof. J. B. Whitehead, of Johns Hopkins University. The principle on which the voltmeter is founded is that a corona forms on a clean, round wire in air at a sharply marked definite value of the voltage dependent only on the pressure and temperature of the air. The voltage at which the corona forms can be observed directly by the eye or by the deflection of a galvanometer in the high-tension circuit, or best by the sound made in a telephone. The wire on which the corona forms is in a chamber the pressure of the air in which can be varied. This instrument gives a higher accuracy than that obtainable by a sphere-gap voltmeter, and the presence of neighbouring conductors does not affect its readings. An instrument on this principle to read 100,000 volts can easily be constructed in any electrical laboratory. The author is making one to read 400,000 volts. In experimenting with these voltmeters on alternating pressures a curious physical law was discovered. If R denotes the maximum potential gradient in kilovolts per cm., and r the radius of the wire in cm., then at 25° C. and 76 cm. pressure the value of R at which the corona appears is given by $R=29{\cdot}84+9{\cdot}938/\sqrt{r}$, provided that $1/\sqrt{r}$ is less than 2·26; but if the value of $1/\sqrt{r}$ is greater than 2·26, $R=32{\cdot}96+8{\cdot}559/\sqrt{r}$. The reason given as an explanation of this sudden change in the law is that the laws governing the formation of the positive and negative coronas found with direct voltages are slightly different.

IN addition to a large amount of useful statistical information in a paper on fuel oil read by Mr. W. A. White before the North-East Coast Institution of Engineers and Shipbuilders on January 28, there is a section in which the advantages of fuel oil over coal are enumerated for power purposes at sea. Fuel oil lends itself more easily to complete combustion than any solid fuel; owing to the higher heating value there is a saving in dead-weight, and increased space may be devoted to cargo; the conditions governing the speed of the ship are better, and there is economy regarding the necessary crew. In relation to the last-mentioned point, the *Aquitania* while burning coal had a staff of 350 men in connection with the stokeholds, and now on fuel oil this vessel requires some 84 men only. For bunkering the *Aquitania* has four fuel-receiving lines, and 480 tons per hour have been pumped into her bunkers from one barge through one pipe-line; the total quantity of fuel required for her round trip could easily be delivered into the bunkers in six hours. Before conversion to oil-burning the *Aquitania* and the *Olympic* each took about 108 hours at each end for coal-bunkering, and employed 50 to 60 men; oil-bunkering employs 3 men only.

Our Astronomical Column.

NEW COMET 1921*a*.—A comet of the 9th magnitude was discovered by Mr. Reid at the Cape Observatory on March 13. The following observations have been received:

G.M.T.	R.A.	S. Decl.	Place
d. h. m.	h. m. s.	° ′ ″	
March 14 14 51·0	20 14 35·0	18 28 48	Johannesburg
,, 18 16 49·7	20 16 56·7	16 20 40	Algiers

Deduced daily motion +35s., N. 31½′. Predicted place March 25d. 16h., R.A. 20h. 21m., S. declination 12° 41′. The comet will rise on that day about 2¾h. before sunrise. It cannot be identical with comet Pons-Winnecke, for the latter passes its ascending node near aphelion, whereas the new comet passed its ascending node about noon on March 12.

Careful search has been made for Pons-Winnecke by several observers without success. Either the comet is unexpectedly faint or it is a long way from the predicted place.

RE-APPEARANCE OF SATURN'S RING.—The *Comptes rendus* of the Paris Academy of Sciences for February 28 contains the observations of this phenomenon made at Strasbourg by MM. A. Danjon and G. Rougier. The smaller equatorial (aperture 16 cm.) was employed. From February 11 to 21 no trace of the ring was visible outside the disc; its shadow on the disc appeared as a black line 0·2″ broad.

On February 22, at 9h. G.M.T., the ring was seen as a very narrow bright line with condensations distant 18·2″ and 13·8″ from the centre of the disc, being strongest on the eastern side. These measures, and the others in the article, are reduced to the mean distance of Saturn from the sun. The visibility of the ring increased perceptibly during the four hours of observation, and on the following night it was quite an easy object. Making use of Barnard's measures of the ring system, the authors show that the condensations measured by them were respectively a little inside the middle of ring A, and about one-fourth of the width of ring B outside its inner edge. They are not the same as those measured by Barnard in 1907, which were on the outer part of ring B and on the crêpe ring.

The position angle of the ring was measured on February 22; the value found was 85° 14′, which is 7′ less than the Nautical Almanac value. Measures of Saturn's disc gave for the equatorial diameter 17·65″, and for the polar one 15·75″; compression, 1/9·3. It is interesting to note that the equatorial horizontal parallaxes of the sun from the earth and Saturn are practically identical.

The ring will be edgewise to the sun on April 10; after that its dark side will again be turned towards the earth until August 3, when the third passage through the ring plane will take place.

BRAZILIAN NATIONAL OBSERVATORY ANNUAL.—The Annuario pelo Observatorio Nacional do Rio de Janeiro for 1921 contains the usual astronomical data, together with expanded refraction tables and a very extensive list of useful constants. There are a full description, with diagrams, of the various wireless time signals, and an essay on the calendar, describing the various suggestions that have lately been put forward for eliminating the inconveniences of the present system.

The magnetic elements for a large number of Brazilian stations are given. Those for Rio de Janeiro are tabulated at twenty-year intervals from 1660 onwards and compared with various formulæ. The latest formula for magnetic declination is that due to Dr. Morize, the present National Astronomer, viz. $5{\cdot}6°+0{\cdot}08°\,t+8{\cdot}0°\sin(0{\cdot}63°\,t-44{\cdot}1)$, t being reckoned in years from 1850. The largest residual of this formula is 0·44° in 1760. The sine-term has a period of 571 years.

Tide tables for nine Brazilian ports complete the volume.

The Royal Anthropological Institute.

THE anniversary meeting of the Royal Anthropological Institute, which was held on January 25, marks the completion of the fiftieth year of the institute's existence. The institute was founded in 1871 as the result of the amalgamation of two pre-existing societies, the Ethnological Society and the Anthropological Society. The history of these two societies throws a very interesting light on the development of anthropological science in this country. The Ethnological Society was founded in 1843 by Dr. Thomas Hodgkin, of Guy's Hospital, Dr. Richard King, and Dr. Thomas Cowell Prichard. Hodgkin, a prominent member of his profession and a Quaker, had been in 1837 one of the founders of the Aborigines Protection Society; but with others, who, like himself, were more interested in the scientific aspect of the problems with which this society dealt, finding little scope for their interests, he decided to found a society which should deal only with the scientific side. In 1859 Dr. James Hunt became secretary of this society. A man of intensely active mind and tremendous energy, Dr. Hunt was strongly of opinion that the society was too narrow in its aims and lacking in energy. As a result he, with others, seceded, and the Anthropological Society was founded in January, 1863, at a meeting at which Sir Richard Burton took the chair.

An ambitious programme was immediately drawn up, including the popularisation of the subject by means of lectures, the discussion of political and social problems of the day, and the publication of translations of works by prominent Continental anthropologists. Another of Hunt's projects was the foundation of an anthropological college with full teaching staff, subsidised by the Government. Anthropological questions were much in the air at this time, as the result of the publication of "The Origin of Species" and the archæological discoveries of Boucher de Perthes and Christy and Lartet in France. The Neanderthal skull had been discovered in 1857. The Ethnological Society still confined itself in the main to the backward races, and was urging upon the public the advantage of such studies to the nation in its dealings with its Dependencies. But the Anthropological Society was speculating on the innumerable questions which were then troubling the political world, as well as on the wider pseudo-scientific problems of the day. It not only dealt with such topics as the Aryan question, but also discussed race, nationality, and character as exhibited in the "negro mind," the "Irish mind," and the like.

The two societies, however, at the end of the 'sixties, found themselves in difficulties. The Anthropological Society, notwithstanding its popularity and its very considerable membership, had become heavily indebted through its ambitious policy and lavish expenditure on publications; while the Ethnological Society also found its income inadequate to meet its expenses. The death of Hunt in 1869 paved the way for an amalgamation. Negotiations were brought to a successful termination by the two presidents, Huxley on behalf of the Ethnological Society and Beddoe on behalf of the Anthropological Society. At a meeting held on February 4, 1871, a resolution was passed founding the Anthropological Institute of Great Britain and Ireland, and Lubbock was elected the first president.

The amalgamation was not, however, a final reconciliation, and in 1873 a number of members, who held that the interests of the Anthropological Society were not sufficiently considered, seceded, and formed the Anthropological Society of London. This society, however, lived for three years only, and in 1876 the majority of the members returned to the institute.

The history of the institute falls into three periods. For the first ten or eleven years after its foundation it was engaged in consolidating its position and in defining its aims. The heavy debt of 1200*l.* which it had inherited from the parent societies was cleared off, largely by private subscription. Notwithstanding a declining membership and a diminishing income, a quarterly Journal was published, which maintained a high standard in quality of material and illustration.

A clearer and more definite conception of the function of such a body as the institute in its relation to the needs of anthropological science was now in process of formulation. The broad generalisations based upon what we should now consider totally inadequate evidence, which had been characteristic of one, if not of both, of the earlier societies, become fewer and tend to disappear. Their place is taken by communications which record the detailed results of careful observation. Such generalisation as there is is becoming cautious, tentative, and more strictly conditioned by the character of the evidence. This line of development was, no doubt, very considerably influenced by the epoch-making work of two distinguished fellows of the institute; in 1872 Evans published his "Ancient Stone Implements," and in the same year Tylor published the second edition of his "Primitive Culture." But the guiding influence of such men as Huxley, Galton, Flower, Busk, Pitt-Rivers, Francks, and Lubbock (the first Lord Avebury), to name a few only of those who were prominent in the counsels of the institute in its early years, could not fail to leave an indelible mark on its character and history.

It is interesting to glance through the volumes of the Journal at this period and to note the names both of fellows and of contributors. Darwin, Romanes, Bagehot, Sir H. S. Maine, Sir J. G. Wilkinson, Sir A. H. Layard, as well as two reigning monarchs, the Emperor of Brazil and the King of Siam, appear in the lists of fellows; while among those contributing to the Journal were Bishop Callaway, Sir R. F. Burton, Owen, Barnard Davis, Herbert Spencer, Col. H. Yule, Vambéry, Sir H. Bartle Frere, and Lieut. D. J. Cameron, the African traveller who was the first to give an account of the natives between 4° and 12° lat.

The second period in the history of the institute may be said to begin about 1880 and to extend to 1898. In the early 'eighties interest in anthropology was growing rapidly. The foundation of the Folk-lore Society in 1877 may possibly have been the earliest manifestation of this movement. In 1883 the number of fellows of the institute ceased to decline, and an upward movement began, which has continued steadily, if slowly, ever since. In 1883 the University of Oxford founded a readership in anthropology, to which Tylor was appointed. This was the beginning of the systematic teaching of the subject in our universities. In the same year the Pitt-Rivers Museum was founded at Oxford, and the formation of the Archæological and Ethnological Museum was begun at Cambridge, Baron A. von Hügel being the curator. Human crania had been admitted to the British Museum zoological collections, and in the new building at South Kensington 407 skulls and 10 complete skeletons were on exhibition. It is interesting to note that at this date the collection of the Royal College of Surgeons, which in 1853 had consisted of 18 skeletons and 242 crania, had grown to 89 com-

plete skeletons and 1380 crania, irrespective of the Barnard Davis collection consisting of 24 skeletons and 1539 crania, which had been acquired in 1880.

Shortly afterwards Macalister introduced anthropological work in his lectures at Cambridge. In 1884 Galton instituted an anthropometric laboratory at the Health Exhibition, in which 10,000 individuals were measured, and afterwards installed the laboratory at South Kensington, where it continued to exist for some years. A similar laboratory was established in Cambridge, and another in Dublin in 1891. In these activities the institute was interested either directly or through its fellows. In 1884 it organised a conference in connection with the Indian and Colonial Exhibition, at which a large number of papers dealing with the native races of the Empire was read. As a direct outcome of the conference a movement was set on foot which led to the foundation of the Imperial Institute as a memorial of the jubilee of Queen Victoria in 1887. The institute also took an active part in fostering the many movements with which Galton was connected, including the study of the physical and mental characteristics of our own population, the use of statistical methods in anthropology, and the introduction into this country of the system of identifying criminals both by anthropometric measurements and by the classification of finger-prints. In 1894 the position of Adviser to the Home Office on Criminal Identification was established, and continued to be held by a fellow of the institute for some years.

The second period comes to an end in 1898. The enthusiasm which characterised the 'eighties and the early 'nineties had begun to wane, but with the introduction of new blood the institute made a vigorous step in a forward direction. The Journal was enlarged, the illustrations in particular being increased in number and improved in quality, and the monthly periodical *Man* was instituted, the first number being published in January, 1901. A broader view was taken of the institute's functions, and it entered upon a period of activity which was continued without interruption until the outbreak of war in 1914.

The institute now began to urge with insistence the practical bearing of anthropology and anthropological data on administrative and legislative problems. The native question in South Africa, physical deterioration, anthropometrics in schools and the medical inspection of school-children, and the necessity for a knowledge of native customs and modes of thought in the government of backward races and as an essential part in the education of administrators of our Dependencies are some only of the numerous questions in connection with which the institute has urged its views upon the public and the Government. These activities were necessarily interrupted by the war. Setting aside this gap of six years, the last period still stands too close for us to gauge the direction of the institute's future development. Though the work of collecting material still goes on apace, and will continue so to do for some time, it may be permissible to hazard a guess that the future line of development must lie in the direction of the comparison and co-ordination of facts in order that these may be presented as an organised body of knowledge, and thus made available for the educationist, the administrator, and the legislator. E. N. F.

Publications of the U.S. National Research Council.

By J. W. WILLIAMSON.

THE National Research Council of Washington, U.S.A., is the American counterpart of the Department of Scientific and Industrial Research in this country. It was organised in 1916 at the request of the president of the National Academy of Sciences, under its Congressional charter, as a measure of national preparedness; and President Wilson in 1918, by executive order, requested the National Academy of Sciences to perpetuate the National Research Council, and assigned to it definite duties. We have before us a number of publications issued by the National Research Council. It is explained that the Proceedings of the National Academy of Sciences has been designated as the official organ of the National Research Council for the publication of accounts of research, committee and other reports, and minutes. But the Council publishes also at irregular intervals the Bulletin of the National Research Council for the presentation of contributions other than proceedings; and it issues from time to time, under the general title of "The Reprint and Circular Series of the National Research Council," papers published or printed by or for the Council and relating to matters in its designated field of action. Some of these papers have already appeared in scientific and technical journals.

The first four numbers of the Bulletin already issued deal with "The National Importance of Scientific and Industrial Research," "Research Laboratories in Industrial Establishments of the U.S.A.," "Periodical Bibliographies and Abstracts for the Scientific and Technological Journals of the World," and "North American Forest Research." Of the Reprint and Circular Series the first nine numbers cover a wide and diversified area, including reports of the Patent and Psychology Committees of the National Research Council; papers on problems of refractory materials, solar and terrestrial radiation, sidereal astronomy, and industrial research; and, finally, a "reading list on scientific and industrial research and the service of the chemist to industry."

Some of these publications can, perhaps, better be dealt with by way of separate review, but it may be useful here to direct attention to certain points raised that bear on the general question of scientific research, particularly in its application to industry. The "reading list" referred to above shows the extent of this field, for it contains something like 1100 references to books, pamphlets, and articles under the popular classification of (1) scientific research and (2) industrial research, and the flood continues. As one writer says: "Newspapers, magazines, and periodicals are continually publishing articles on industrial research; vast numbers of people are talking, more or less knowingly, about it; and industries and Governmental Departments, which up to a few years ago had hardly heard of industrial research, are embarking or endeavouring to embark upon the most elaborate research projects."

In all this restless stirring amongst the dry bones there is a great need to keep constantly in mind a few paramount and fundamental principles. The first is that the main instrument of research is man, and not machinery, instruments, or buildings. Mr. Frank B. Jewett, chief engineer of the Western Electric Co., in a paper on "Industrial Research," well says: "The matter of an adequate supply of properly equipped and trained investigators and directors of research is absolutely vital to the growth of industrial research, and I am as sure as one can be of anything

in the world that all of our visions of the benefits to be derived from a large expansion of industrial research will come to naught if we fail to realise or neglect the fact that in the last analysis we are dependent absolutely upon the mental productivity of men, and men alone, and that we must, in consequence, provide adequately for a continuous supply of well-trained workers." It is, and must be, the function of the universities and higher educational institutions to pour out the steady stream of well-equipped and trained investigators that is the first and vital need of the industrial research movement.

Another essential condition for the successful development of industrial research is that there must be concurrently a corresponding growth and development in the domain of fundamental scientific research —what is, perhaps somewhat loosely, called "pure science"—for from the fountains of pure science come the waters that freshen and replenish the streams of applied research. It is worthy of note, and should be reassuring even to those who look with distrust on the more recent developments of industrial research, that in the various papers published by the National Research Council dealing with the application of science to industry there is abundant testimony from men whose main interests are industrial to the truth of this principle. Mr. J. J. Carty, vice-president of the American Telephone and Telegraph Co., for example, in an address on "Science and the Industries," says: "The pure scientists are the advance guard of civilisation. By their discoveries they furnish to the engineer and industrial chemist and other applied scientists the raw material to be elaborated into manifold agencies for the amelioration of the condition of mankind. Unless the work of the pure scientist is continued and pushed forward with ever-increasing energy, the achievements of the industrial scientist will diminish and degenerate." It is, again, to the universities mainly, if not almost wholly, that we must look for this fundamental, purely scientific research. The publications under review perform not the least useful of their functions in emphasising the basic importance of the universities in all schemes for the national development of industrial research.

The last point with which in our limited space we can deal is the fundamental question of the organisation of research. Dr. James Rowland Angell, in an address on "The Development of Research in the United States," says: "Scientific men have as yet only achieved the most elementary beginnings of the organisation of scientific interests. Indeed, it has been something of a fetish among scientists that we must rely upon individual inspiration and initiative, and that the individual worker must be safeguarded in every possible way from the corroding influence of administrative organisation." This complaint is not baseless. There are still people who regard the mere suggestion of organising research as a profanation of genius not less desecrating than a proposal to have poetry written by committees; and yet scientific principles and methods are no more out of place in the organisation of research than they are in research itself. It may be long before we reach common agreement as to the main plan, but the science of the organisation of research is as worthy a study as—shall we say?—the science of education or of economics. Dr. Angell, in the address referred to above, observes: "As a matter of fact, large areas of the most needed research lie in territory where properly trained men of talent, given proper conditions of work, may produce constantly and in increasing measure results of the utmost consequence. But one of the conditions of maximal efficiency is that they shall work inside the framework of a general programme in which there is intelligent co-operation in the allocation of the field and in the constant communication of results achieved. Such distribution of responsibility and effort is entirely consonant with the fullest actual initiative which any scientist can desire."

The publications of the National Research Council are a solid contribution to the elucidation of many problems in this new and promising field of national development.

Psychotherapy and War Experience.

INABILITY to see the wood for the trees is not uncommon in writers on most scientific subjects, but the characteristic of many medical exponents of psychotherapy seems rather that to them the wood is invisible because of their proximity to one very large and important tree. Dr. William A. Brend, who contributes a notable article entitled "Psychotherapy and War Experience" to the January issue of the *Edinburgh Review,* is emphatically not one of these. His essay attracts one, apart from the obvious interest and importance of its subject, on account of the balance, the perspective, the background, and the sympathetic appreciation of delicate nuances which the picture displays. It is a lucid and judicious account of the substance of eight publications—not all of them recent—by Freud, Ferenczi, Ernest Jones, Lay, and McCurdy; but it is much more than this, for it gives the general reader some idea of the changes which the psycho-analytic movement has brought about in the outlook of modern psychotherapy. Yet Dr. Brend obviously holds no brief for this school of thought alone. He describes, too, the parts which suggestion (including hypnotism), persuasion, re-education, and modified psycho-analysis have played in alleviating the mental sufferings caused by the war, the unwisdom of encouraging the patient merely to "distract his mind," whether by play or by work, the inadvisability of allowing important lost memories to remain lost, the uses of hypnosis in recovering repressed experiences, the indispensability of thorough-going psycho-analysis in some cases and its undesirability in others.

"Some knowledge of the principles of the new psychology is desirable for everyone, but that is not to say that a person of normal mentality should, without good reason, allow all his natural repressions to be brought to the surface by anyone who claims to be an analyst."

It is hoped that many will read of the extensive provision of psychotherapy made by the Army since 1916, and at present by the Ministry of Pensions under Sir Lisle Webb, and that they will then inquire what is being done for the civilian. The answer is:

"As far as the ordinary civilian population is concerned, very few facilities for this treatment are available for those who are unable to pay the fees of consultants. One or two clinics have been started on a small scale, but it is now recognised that to cover the ground adequately very large provision of this nature will require to be made, and it is to be hoped that such clinics will eventually be established under the Ministry of Health."

Those of us who almost daily have sadly to tell sufferers that "very few facilities for this treatment are available for those who are unable to pay the fees of consultants" very earnestly share the hope of Dr. Brend.

T. H. PEAR.

University and Educational Intelligence.

CAMBRIDGE.—The election of the first professor to the Sir William Dunn chair of biochemistry will take place on April 19.

Mr. L. J. Comrie and Mr. W. M. H. Greaves, both of St. John's College, have been elected to Isaac Newton studentships in astronomy.

It is proposed to appoint a University lecturer in medical radiology.

The annual report of the General Board of Studies on various University departments refers to the overcrowded state of the laboratories, with the consequent burden on the teaching staff. Cambridge has suffered along with other anatomical schools from a scarcity of subjects for dissection, and, partly as a consequence of overcrowding, other departments also have suffered from difficulties in the supply of material. Various new buildings and extensions of existing buildings are proceeding in the chemical, physical, engineering, biochemical, and parasitological schools.

It is proposed to discontinue the Higher Local Examination, which has been gradually displaced by the Higher School Certificate Examination.

LEEDS.—Her Highness Princess Helena Victoria paid an informal visit to the University on March 15. She was received by the Vice-Chancellor (Sir Michael Sadler) and by the Pro-Vice-Chancellor (Prof. Smithells). Her Highness then inspected several of the departments of the University. In the large physics laboratory was an exhibit consisting in the main of experiments which had been carried out in the department in the preceding year. Among the items shown were the "ultra-micrometer," an instrument described to the British Association at the 1920 meeting, by which distances as small as 10^{-8} cm. could be detected; and a new system of *both way* wireless telephony by which conversation may be carried on in precisely the same manner as in an ordinary telephone. In the department of textile industries the Princess was shown in process of manufacture Herdwick wool (the roughest type of the British wools), Suffolk Down wool (one of the finest of British wools), the finest Australian wool, llama from 14,000 ft. up the Andes, and the under-fibre of the musk-ox (forwarded to the department by Mr. Stefansson, the Canadian explorer). British and Continental methods of manufacture and wool-combing were also shown. In the museum the collection of old fabrics—possibly the finest in the provinces—was supplemented by Indian shawls lent by Sir Michael Sadler.

Mr. R. J. Stewart McDowall, lecturer in the physiology department of the University of Edinburgh, has been appointed to the post of lecturer in experimental physiology and experimental pharmacology.

LONDON.—At a meeting held on March 16 the Senate adopted a resolution for the continuance of the physiological laboratory at the University headquarters at South Kensington until the end of the session 1922–23.

The following doctorates have been conferred by the Senate:—*D.Sc. in Mathematics:* Miss D. M. Wrinch, an internal student of University and King's Colleges, for a thesis entitled "An Asymptotic Formula for the Hypergeometric Function ${}_0\Delta_4(z)$." *Ph.D. (Science):* Miss D. M. Adkins, an internal student of Royal Holloway College, for a thesis entitled "(i) The Economic Value of the Soya Bean" and "(ii) The Digestibility of Germinated Beans." *D.Sc. in Agricultural Chemistry:* Mr. H. E. Annett, an external student, for a thesis entitled "Biological Chemistry."

THE University Extension Board of the University of London arranged during the present session a sessional course of lectures on "The Bases and Frontiers of Physical Science" by Prof. John Cox at Gresham College. The last four lectures of this course, beginning on Friday, April 8, will deal with "The Principle of Relativity."

TWO scholarships, each of the yearly value of 300*l.*, are being offered by the Grocers' Company for the encouragement of original research in sanitary science. The scholarships are tenable for one year, but may be renewed for a second or a third year under certain conditions. The election will take place in June next, and applications must be made before May 2, on the prescribed form, to the Clerk of the Grocers' Company, Grocers' Hall, E.C.2.

THE Imperial College of Science and Technology announces a further generous donation by a leader in industry, who desires to remain anonymous, to the fund for the provision of scholarships to enable students of the college to spend a year in post-graduate study at American universities or in works. At present four such students are in America. The present donation will enable four more to be sent for 1921–22.

THE report for 1920 of the Association of Science Teachers, which has just been received, refers to the revised edition of the association's "Book List," which now includes books on zoology, natural history, and astronomy. The list can be obtained from the hon. secretary or from Miss Storr, 12 Angell Park Gardens, S.W.9, price 1*s.* 6*d.* It is intended to publish a supplement at the end of the year. Notice is given of a course of lectures on biological science which the executive hopes to be able to arrange at Oxford during the summer vacation; the probable date for the course is July 29 to August 9, and the fee will be 30*s.* The afternoon session of the general meeting held on January 4 at University College was devoted to a lecture by Dr. J. C. Drummond on vitamines, in which a brief summary was given of our knowledge of these important constituents of food. Representatives of the association have attended meetings of the Consultative Council of University and School Science Teachers, and the subjects discussed are mentioned. Reference is also made to the death of Mr. D. H. Nagel, an appreciation of whom appeared in NATURE for October 7 last. Mr. Nagel's place as chairman of the council has been taken by Prof. Weiss, of Manchester.

THE report of the Carnegie Trust for the Universities of Scotland for the year 1919–20 contains a complete financial statement of the work of the executive committee of this foundation during the past year. Grants are made quinquennially in ordinary circumstances, but the difficulties arising out of war conditions made the distribution of interim grants for the years 1918–19 and 1919–20 desirable. A return to the old system was made with the opening of the academic year 1920–21, and details of the grants allocated are given in the appendices. The estimated available income for the five years is 225,000*l.*, and it has been decided that 200,000*l.* shall be distributed among the universities, the remaining 25,000*l.* being set aside to meet extra-mural expenses. The former sum will be divided in the following way:—To St. Andrews, 18·5 per cent.; to Glasgow, 29 per cent.; to Aberdeen, 19·5 per cent.; and to Edinburgh, 33 per cent. More than two-thirds of the sum (144,580*l.*) is earmarked for buildings and permanent equipment, while 32,920*l.* goes for the endowment of professorial chairs and lectureships. In view of the difficult circumstances in which the universities find themselves, a further sum of 49,000*l.* from the reserve

fund has been allotted, which is to be expended mainly on purposes immediately connected with students. The values of research scholarships and fellowships have been raised from 150*l*. and 200*l*. to 200*l*. and 250*l*. per annum respectively. Grants have been made to assist 4912 students in the payment of fees involving an expenditure of 68,591*l*.

AT a meeting of the Royal Anthropological Institute held on February 22 Sir Alfred T. Davies, of the Welsh Department of the Board of Education, gave an account of the scheme for the collection of rural lore in Wales by school-children which had been instituted by that Department. The educational object of the scheme had been to quicken the interest of the children in their immediate surroundings and to stimulate their desire for acquiring knowledge through their own efforts. In its original form the object of the scheme was to secure on Ordnance maps, which had been provided out of funds supplied from private sources, the records of traditional names of fields and a record of the state of the land in relation to cultivation at the beginning and the end of the Great War. This record would prove in days to come a valuable source of information as to the economic and social state of Wales at this date. The whole scheme was voluntary so far as teachers were concerned, and those who were interested were invited to secure and record supplementary information such as local folk-lore, local industries, ancient monuments and buildings of note, the names and birthplaces of men who had been born in the district and had afterwards become famous, and other data of the kind. The chief item in the cost was the supply of sheets of the Ordnance map, which had amounted to just over 5*s*. per school. The president, Dr. W. H. R. Rivers, in opening the discussion, said that the point in the scheme which most impressed an anthropologist was the great enthusiasm which it showed for the preservation of the past.

A POWERFUL plea for the organisation of science in Australia has been made by Prof. T. H. Laby, of the University of Melbourne. Prof. Laby points out that while in both Great Britain and America the war period was a time when important changes were made in the organisation of science, no corresponding change occurred in Australia. Science in that continent is organised on a State basis; each of the five States has its Royal Society together with a number of minor scientific societies, but the only society in which the whole Commonwealth is represented is the Australasian Association for the Advancement of Science. This body meets normally once in two years, but, owing to force of circumstances, no meeting has been held during the last seven years. Prof. Laby argues that such a body is unable to take continuous care of Australian science. The world-wide need for the re-organisation of science was expressed in Great Britain by the formation of the Conjoint Board of Scientific Societies, the National Union of Scientific Workers, and the establishment of State-aided research associations; in America a similar movement led to the formation of the National Research Council to "mobilise" the scientific *personnel* and resources of the country. In Prof. Laby's opinion, none of these bodies would meet the whole of Australia's requirements. He advocates rather the formation of a national scientific society or national academy composed of those who are contributing to both pure and applied science which shall have sufficient resources to promote and direct scientific research; further, it should be recognised by the Government as an advisory body, and be capable of safeguarding the professional interests of men of science.

Calendar of Scientific Pioneers.

March 24, 1712. Nehemiah Grew died.—Like Malpighi, Grew is regarded as one of the founders of vegetable anatomy. He practised medicine in Coventry and London, and was secretary of the Royal Society in 1677. In 1682 he published his "Anatomy of Plants." Grew was probably the first to distinguish sexuality in plants.

March 24, 1776. John Harrison died.—A native of Yorkshire, Harrison made several improvements in clocks and watches, and, having settled in London, during the years 1735–59 he produced the first four chronometers. Though when tested at sea for determining the longitude they proved successful, it was only after long delay that Harrison was granted the full award of 20,000*l*. offered by the Act of Parliament of 1713.

March 24, 1849. Johann Wolfgang Döbereiner died.—For some years professor of chemistry at Jena, Döbereiner's chief work was on platinum in a minute state of division and the oxidation products of alcohol. He was the inventor of the Döbereiner lamp.

March 24, 1881. Achille Ernest Oscar Joseph Delesse died.—An Inspector-General of Mines and a president of the Geological Society of France, Delesse paid special attention to the deposits beneath the sea.

March 24, 1905. Pietro Tacchini died.—Distinguished for his investigation of the physics of the sun, Tacchini was the founder of the Società degli Spettroscopisti and the Società Sismologica of Italy, and also of the Mount Etna Observatory. In 1879 he succeeded Secchi as director of the observatory of the Collegio Romano.

March 25, 1915. Karol Stanislav Olszewski died.—After studying under Bunsen, Olszewski became professor of chemistry at Cracow. Like his countryman Wroblewski, he was a pioneer worker on the liquefaction of gases, and was the first to study argon at very low temperatures.

March 26, 1797. James Hutton died.—The founder of physical and dynamical geology, Hutton gave his views to the world in his paper, "Theory of the Earth," of 1785, and in the book bearing the same title published ten years later.

March 26, 1877. Karl Bremiker died.—While holding a post in the Prussian Board of Trade, Bremiker in his leisure revised some of the star charts of the Berlin Academy. It was with the aid of these charts that Galle first observed Neptune. In later life Bremiker was a director of the Prussian Geodetical Institute.

March 28, 1874. Peter Andreas Hansen died.—Of Danish parentage, Hansen in 1825 succeeded Encke at the Gotha Observatory. His principal researches related to lunar theory and the orbits of comets and planets. His "Tables of the Moon" were published by the British Government, which granted him 1000*l*.

March 30, 1832. Stephen Groombridge died.—A London merchant and a keen astronomer, Groombridge produced an important catalogue of stars.

March 30, 1914. John Henry Poynting died.—Professor of physics in Mason's College and its successor, the University of Birmingham, for thirty-four years, Poynting's original researches referred mainly to the constant of gravity and to the theories of electrodynamics and the pressure of light. E. C. S.

Societies and Academies.

LONDON.

Royal Society, March 10.—Prof. C. S. Sherrington, president, in the chair.—Sir Joseph **Larmor**: Electro-crystalline properties as conditioned by atomic lattices. The view that the crystal lattice is usually composed of atoms is considered in relation to their ionic charges. Compensating surface charges on certain types of faces of a crystal are required; and inference is drawn with regard to the texture of crystal faces. The alternative view that a bipolar molecule is the crystal-unit would seem to encounter difficulties also as regards pyroelectric effects. Dielectric excitation can be represented as *relative* displacement of the positive and negative component lattices under the influence of an electric field. If the compound lattice has spiral features, so that the relative shifts of its various components with positive and negative charges are of screw type, chiral optical quality will be involved; a coarse numerical estimate indicates that in quartz and active liquids the twisting relative displacement of the ionic configurations is comparable in amount with their relative elongation. The chiral quality may reside wholly in the crystalline structure, disappearing on fusion or solution; or else the process of dielectric displacements of the positive and negative groups of ions in the crystal-unit may be also itself chiral. In either case, induced static polarity could not be chiral as regards waves so long as those of light; but this process of screw displacement is operative kinetically in the optical rotation by involving a magnetic moment of changing ionic twist induced by the alternating electric field of the radiation. A face of a crystal of cubic type containing both types of ions equally should acquire no true pyroelectric charge. Double refraction induced by strain must be ascribed to bending of ionic lattice structures, or in glass to fragments of such structure.—Prof. A. S. **Eddington**: A generalisation of Weyl's theory of the electromagnetic and gravitational fields. From the notion of "parallel displacement" used by Weyl in his theory, it is shown that a tensor $*B^{\rho}_{\mu\nu\sigma}$ exists giving a measure of the world-structure at each point. The contracted tensor $*G_{\mu\nu}$, formed by setting $\rho=\sigma$, breaks up into two parts: (1) a symmetrical part which is the gravitational potential $g_{\mu\nu}$ of Einstein's theory, and (2) an antisymmetrical part $F_{\mu\nu}$ (proved to be the curl of a vector) which is identified with the electromagnetic force. The theory explains how, notwithstanding the non-integrability of length in Weyl's geometry, there is a natural gauge; and Einstein's *interval* is an absolute invariant independent of gauge, and directly comparable with other intervals at a distance. The law of gravitation for empty space in the form finally adopted by Einstein, viz. $G_{\mu\nu}=\lambda g_{\mu\nu}$, follows at once on this theory. All the other recognised field-laws are found by identifying the physical measures with geometrical tensors which satisfy these laws identically. None of these impose any constraint on the possible varieties of world-structure; and there is no reason to introduce a physical principle of stationary action, at least so long as we do not deal with problems of electron structure. Explicit expressions for $*B^{\rho}_{\mu\nu\sigma}$ and $*G_{\mu\nu}$ are found in terms of Einstein's gravitational tensors and a tensor $K_{\mu\nu,\sigma}$ which represents electric and electronic forces. Weyl's theory corresponds to the particular case when $K_{\mu\nu,\sigma}$ is of the form $g_{\mu\nu}\phi_{\sigma}$.—Prof. T. R. **Merton**: Spectrophotometry in the visible and ultra-violet spectrum. The application of the neutral wedge to spectrophotometric measurements is extended. The method involves the "crossing" of the prismatic spectrum with a diffraction spectrum, the relative intensities of the different orders in the diffraction spectrum having been experimentally determined. The method of preparing and calibrating gratings for this purpose is described. The method is applicable to the determination of the relative intensities of lines in discontinuous spectra, but is specially adapted to the study of continuous spectra, absorption spectra, and the study of broadened lines. The method may have a special application in celestial spectroscopy.—Prof. W. A. **Bone**: Researches upon brown coals and lignites. Part i.: Heat treatment at temperatures below 400° C. as a possible method for enhancing their fuel values. A classification of lignites is made according to their external appearance: (*a*) Woody or fibrous brown coals. (*b*) Amorphous or earthy brown coals. (*c*) Common or brown lignites. (*d*) Black lignites. Lignites have a moisture content varying between 10 and 50 per cent.; on air-drying they usually disintegrate or crumble to powder. They are devoid of any coking properties, and in the "dry ashless" state usually contain less than 70 per cent. of carbon and more than 20 per cent. of oxygen. Experiments were conducted on the various types of lignites, which were heated in a special form of apparatus that allowed accurate measurement of temperature and amounts of liquid and gaseous products. Chemical change takes place, beginning at a low temperature of about 130° C. and progressing to a temperature at which no condensable hydrocarbons were eliminated from the fuel, termed the "practicable up-grading limit." Steam and carbon dioxide, with a small amount of carbonic oxide and a negligible amount of hydrocarbons, were eliminated. Practically the whole of the potential energy of the lignite is concentrated in the residue obtained by this "up-grading" treatment.—Prof. H. N. **Russell**: A superior limit to the age of the earth's crust. The method of determining the age of a mineral from the ratio of lead to uranium in its composition may be extended to the earth's crust as a whole. Accepting a radium content of $2{\cdot}5\times10^{-12}$ (Joly), corresponding to a uranium content of 7×10^{-6}, and a content of lead of 22×10^{-6} (F. W. Clarke), it follows that the age of the crust does not exceed 11×10^{9} years, which is reduced to 8×10^{9} years, if allowance is made for thorium.—H. **Ohshima**: Reversal of asymmetry in the plutei of *Echinus miliaris*. In the normal Echinoderm larva the hydrocœle and its associated structures develop on the left side of the larval body. Rarely the reversal of this asymmetry occurs. This abnormality was found in more than 10 per cent. of the artificially reared larvæ of *Echinus miliaris*. It may be a result of (1) change of polarity in the egg, or (2) twin-formation, or, most probably, (3) "compensatory hypertypy," owing to the arrest in development and later atrophy of the normal left hydrocœle. The right anterior cœlom is known to have latent potentialities for producing a hydrocœle, which can probably be activated by the stimulus due to the arrest in development of the left hydrocœle. The arrest is probably associated with the obliteration of the pore-canal, through which the hydrocœle has been communicating with the exterior. The occurrence in much lower percentage of the double-hydrocœle larvæ and of those devoid of the hydrocœle within the same culture jars can be similarly explained. If the left hydrocœle regains its communication with the exterior, it will continue to develop with the abnormal right hydrocœle, giving rise to the double-hydrocœle larva. If the right hydrocœle fails to appear while the left hydrocœle is still deprived of its communication with the exterior, a larva devoid of hydrocœle will result.

Physical Society, February 25.—Sir W. H. Bragg, president, in the chair.—R. H. **Humphry**: A note on the hot-wire inclinometer. Two fine platinum wires were stretched parallel to each other in a hole in a copper block and were heated electrically. The changes caused by rotation were investigated with hydrogen, air, and carbon dioxide surrounding the wires. The inclinometer filled with carbon dioxide was much more sensitive than one filled with air. The shape of the curves obtained suggests that the temperature gradient in the region traversed by the wires is nearly uniform.—Prof. E. F. **Herroun** and Prof. E. **Wilson**: The magnetic susceptibility of certain natural and artificial oxides. The susceptibility of ferric oxide as occurring in Nature varies through a wide range, but in the case of artificial preparations the range of variation may be much greater. The passage through the stage of magnetic oxide impresses more pronounced magnetic properties upon the resulting ferric oxide. Heating feebly magnetic ferric oxide with a basic oxide, *e.g.* lime or magnesia, increases susceptibility (confirming List and others). When higher susceptibility has been produced by heating ferric oxide, removal of the metal leaves the ferric oxide in a magnetic condition. The aluminates formed when ferric oxide is replaced by aluminic oxide show no definite increase in susceptibility.—J. **Guild**: The refractometry of prisms. A generalised formula for the refraction of light through a prism is obtained, and the particular cases pertaining to practical methods of refractometry are deduced from it. The sensitivity of various methods for various prism angles and refractive indices is shown in a series of curves, as is also the liability to error due to errors in auxiliary constants.—T. **Smith**: Tracing rays through an optical system. A further development of the system described by the author in the previous papers of the same title presented to the society; formulæ for skew rays are put into a shape so far as possible similar to those applying to rays in one plane.

Aristotelian Society, March 7.—Prof. A. N. Whitehead in the chair.—Prof. J. E. **Boodin**: Cosmic evolution. Modern science and modern philosophy agree in treating the evolution of our earth as an independent drama. The later levels of evolution are supposed by some magic to emerge from the earlier—life from matter, thought from reflex action. Some have attempted to introduce a *plus* principle, such as an *élan vital* or entelechy. But such a principle would have to be present from the beginning, thus antedating life. It would have to account for the reversed or alternating directions of evolutionary series, and sometimes it would have to lie dormant for long periods of time. It is at best an abstraction of the fact that certain processes have direction. It does not explain the fact. For this we need a cosmic dynamics, and this is found in interaction. Interaction is not merely a speculative principle. No reasonable man could hold that our complicated organs of sight and hearing are developed by chance in the organism without reference to the cosmic environment. It is safe to say that if there were no light patterns there would be no eyes; if there were no sound patterns there would be no ears. Through a long trial and error process and under the control of cosmic patterns the organism develops the appropriate instruments to respond in specific and differential ways to the cosmos. And what shall we say of the various levels of control within the organism? Can we account for the unique type of pattern of creative thought and its control of the lower levels by a chance combination of reflex arcs? Here, too, we must invoke the principle of cosmic interaction. The development of the organism to think is due as truly to thought patterns communicated through the cosmic continuum as the development of seeing is due to the light patterns acting upon organic matter. And thought patterns, like light patterns, must be communicated from other worlds that are of a level to emit such patterns. We know no other way. In neither case is it the act of thinking or seeing which is communicated. This is due to the interaction of the respective patterns with matter and its properties.

CAMBRIDGE.

Philosophical Society, February 28.—Sir Ernest Rutherford, vice-president, in the chair.—Sir Joseph **Larmor**: The nature of the crystal-reflection of X-rays. The analysis of X-radiation by a crystal suggests the general problem of selective reflection from a medium the properties of which vary periodically with depth according to any assigned law. The equations of this problem reduce to the well-known differential equation discussed by Hill in connection with the lunar theory. The conditions for selective reflection reveal immediately the main characteristics of the solutions of Hill's equation; while the expansions in series which have been worked out for various cases can be applied in numerical illustration of the action of the crystal grating. The laws of reflection from a single sheet of ions are also considered.—Dr. G. F. C. **Searle**: An experiment on focal lines formed by a zone plate. When the axis ON of a zone plate passes through a luminous point P, the zone plate acts as a lens. When ON makes an angle θ with OP, two sets of focal lines take the place of the single set of images. For lines in the plane PON the focal length is independent of θ. The theory is extended to the case in which a wave-front of any form falls at any angle on the zone plate—a case realised by placing between P and O a lens having one face cylindrical.—R. H. **Fowler** and C. N. H. **Lock**: The origin of the disturbances in the initial motion of a shell. The principal part of the disturbance is orientated similarly from round to round, and it is therefore argued that the cause is to be looked for in vibrations of the barrel.—E. K. **Rideal**: The latent heats of vaporisation. The latent heats of evaporation can be derived by calculation with the aid of the quantum theory. Regarding the process of evaporation as a monomolecular chemical reaction, it is possible by means of the effusion formula of Herz and Langmuir, and the equation for monomolecular chemical reaction of Dushman and Rideal, to evaluate the Nernst chemical constants. The expression derived for the chemical constant agrees dimensionally with a modified expression of Lindemann's which was obtained from dimensional considerations.

PARIS.

Academy of Sciences, February 28.—M. Georges Lemoine in the chair.—G. **Humbert**: The ternary forms of Hermite in an imaginary quadratic body (fields $\sqrt{-1}$ and $\sqrt{-2}$).—C. **Richet**, E. **Bachrach**, and H. **Cardot**: The phenomena of anaphylaxy in micro-organisms. Studies on the growth of the lactic bacillus in presence of thallium salts. Strains of this organism grown in presence of a small proportion of the poison for several generations become indifferent to it; but if now transferred to a culture medium containing a higher proportion of the thallium salt, growth is much less vigorous than with a lactic strain not accustomed to thallium salts. This may be considered as an anaphylactic phenomenon.—P. **Vuillemin**:

Exogenous xygomorphosis in flowers normally actinomorphs.—G. **Cerf**: Certain systems of Pfaff equations and the transformations of partial differential equations.—D. **Riabouchinski**: The initial movement of a liquid in contact with an obstacle with sharp edges.—A. **Danjon** and G. **Rougier**: The re-appearance of Saturn's ring, observed at the Observatory of Strasbourg, February 22, 1921 (see p. 119).—F. M. **de Laroquette** and S. **Millot**: Experimental data and balance for the estimation of X-rays in radiography and radiotherapy.—M. **de Broglie**: The corpuscular spectra of the elements.—M. **Pariselle**: An achromatic triplet with a large field.—C. **Matignon**: The action of iodine on different metals in the cold. A method for detecting the presence of chlorine in the atmosphere. Metals in thin foil are converted into iodides by contact with iodine. A piece of silver foil coated with potassium iodide forms a delicate test for the presence of chlorine in air; the foil forms part of an electric circuit, chlorine sets free iodine, and the silver iodide immediately formed is a non-conductor.—A. C. **Vournazos**: The bismuthobromocyanides.—M. **Chapas**: The solubility of the isomeric nitroanilines in metaxylene. These isomers differ greatly in solubility, at 15° C. the proportions being 11·6, 1·74, and 0·28 per cent. for the ortho-, meta-, and para-compounds respectively.—O. **Mengel**: Relations between earthquake phenomena and the structure of the Pyrenees.—G. **Guilbert**: A case of destruction by a gale. Various applications of meteorological rules published by the author in earlier communications. Several examples are given in which predictions based on these rules have been justified in detail.—A. **Lumière**: Surface tension and anaphylactic shock. Criticism of a recent paper by W. Kopaczewski. Measurements by the author of the relative surface tensions of water, 5 per cent. solution of sodium hyposulphite, blood serum, and the last diluted with an equal volume of sodium hyposulphite solution, do not agree with the corresponding measurements made by W. Kopaczewski, and hence the hypothesis of the latter as to the intervention of surface tension in the production of the anaphylactic shock is not confirmed.—A. **Paillot**: Contribution to the study of humoral immunity in insects.—G. **Bertrand** and A. **Compton**: The influence of heat on the activity of salicinase. It is known that the activity of a diastase increases with the temperature, passes through a maximum, and finally decreases to nothing. The most favourable temperature and the temperature at which activity ceases have been frequently treated as physical constants of a ferment, analogous with the melting point and boiling point of a definite substance. It is shown, however, that these two temperatures cannot be considered as constant, since they can be made to vary with the experimental conditions, the most important being the time during which the diastase is allowed to act. The results of a series of experiments on salicinase are given graphically in two curves, the ordinates being temperatures and the abscissæ duration of the action. With salicinase the two curves meet at 70° C.; this is the temperature of maximum activity, and also the highest temperature at which diastase can exist.—A. **Desgrez** and R. **Moog**: The influence of some organic bases and of their chlorohydrates on the activity of pancreatic amylase. The bases triethylamine and trimethylamine reduce the diastatic activity, but the chlorohydrates of these and of methylamine exert a contrary action and increase the activity of pancreatic amylase.—H. **Grenet**, H. **Drouin**, and M. **Caillard**: The study of some leucocytic reactions following on intravenous injections.—H. **Frossard**: The detection of thoracic vibrations in women and children in pleurisy.

ROME.

Reale Accademia nazionale dei Lincei, November 21.—F. D'Ovidio, president, in the chair.—B. **Grassi**: Life of Anopheles, i.—A. **Comessatti**: Geometric theory of binary forms, i. This part deals with directive ideas and their first consequences.—A. **Denjoy**: "Sur les ensembles parfaits présentant le caractère (A)."—E. **Clerici**: New mineral deposit near Rome. The author records the presence of fluorite and barytes in calcareous deposits near the Villa Farnesina and the tomb of the Nasoni.—A. **Contardi**: Transformations of trioxymethylene.—B. **Peyronel**: Ascophorous form of *Rhacodiella castaneae*, the cause of smut in the chestnut. The author has succeeded in cultivating the perfect stage of this fungus, which he refers to the genus Sclerotinia.—A. **Clementi**: Relation between the peptidolitic activity of intestinal erepsin and the chemical constitution of the substratum.—U. **Soli**: Bactericidal power of intestinal mucus.

December 5.—V. Volterra, vice-president, in the chair.—O. M. **Corbino**: Thermal analogue of Oersted-Ampère effect and electronic theory of metals.—B. **Grassi**: Life of Anopheles, ii. A number of specimens were dyed and set free, and from their disappearance it was inferred that the summer broods live only about ten days to a fortnight. The author now discusses the question as to whether the insects tend to return to the localities where they have already bitten. The results are sufficiently definite to explain why malaria does not spread more frequently to non-infected districts, and to show that it is more important to kill the mosquitoes in houses, particularly those containing malarial cases, than in such localities as pigsties.—A. **Comessatti**: Geometric theory of binary forms, ii. This part deals with the theorem of Bruno and conic co-variants.—E. **Del Vecchio**: Theorems of uniqueness for parabolic linear differential equations of third order, i.—A. **Denjoy**: "Les rapports des ensembles parfaits présentant le caractère (A) et des fonctions admettant une dérivée seconde généralisée."—M. **Pascal**: Superficial circulation, i. The ordinary conception of circulation round a closed curve is generalised, leading to a measure of circulation in the form of a surface integral over a closed surface. This is a vector which satisfies the usual laws of composition and resolution. The extension of problems from two to three dimensions is contemplated, with especial reference to Joukowski's theorem, according to which cyclic motion in a perfect fluid surrounding a moving body gives sustentation without resistance.—A. **Terracini**: A surface of the sixth order and class the asymptotics of which are skew cubics.—R. **Perotti**: Radical bacilli of *Diplotaxis erucoides*. Three forms of bacilli found on the Diplotaxis roots are described which possess the property of attacking and transforming insoluble carbohydrates such as starch. Their action is not pathogenic, and whether they belong to three species or one is left open.—G. **Cusmano**: Intermolecular condensations produced by oxynitric groups. The author discusses the actions of concentrated sulphuric acid on *o*-aminonitroxybenzol and the action of alkali on *o*-hydroxylaminonitroxybenzol.—The Academy has elected Drs. Pirotta and Lanciani to the offices of administrator and assistant administrator respectively.

December 19.—F. D'Ovidio, president, in the chair.—G. A. **Maggi**: Propagation of waves of arbitrary form in isotropic media. A mathematical investigation dealing with objections to Prof. Somigliana's proof, according to which only plane, cylindrical, or spherical waves can be propagated in an isotropic medium subject to the usual conditions.—

C. **De Stefani**: Ligurian fossil sponges, iii. The remains now described were from a calcareous deposit at San Martino, near the Polcevera, and include *Dictyonina lychniscosa*.—E. **Del Vecchio**: Uniqueness in parabolic equations of the third order, ii.—A. **Campetti**: Potential of excitement of electrons in mixture of potassium and sodium vapours.—G. **Armellini**: Secular perturbations in the inclination of the minor planet Hungaria.—D. **Maestrini**: Action of enzymes, v.: The resistance of phthalein to the action of hydrochloric acid in presence of starch.—S. **Sergi**: Vertebro-medullary topography of chimpanzee (*Anthropopithecus troglodytes*, female). The methods adopted are, in the main, those of Pfitzner, and the diagram and tables of measurements are applicable to the study of the comparative anatomy of the chimpanzee and of man in regard to the spinal medulla.—A. **Comessatti**: Geometric theory of binary forms, iii.: System of co-variants of given degree and Sylvester's theorem.

Books Received.

Practical Dairying. By Dora G. Saker. Pp. viii+123. (London: Methuen and Co., Ltd.) 6*s*. net.

History and Bibliography of Anatomic Illustration in its Relation to Anatomic Science and the Graphic Arts. By Ludwig Choulant. Translated and edited by Dr. Mortimer Frank. Pp. xxvii+435. (Chicago: University of Chicago Press; London: Cambridge University Press.) 10 dollars net.

Journal of the Scottish Meteorological Society. Vol. xviii. Third Series, No. xxxvii. (Edinburgh and London: W. Blackwood and Sons.) 12*s*. 6*d*.

Spot and Arc Welding. By H. A. Hornor. (Technological Hand-books.) Pp. vii+296. (London: C. Griffin and Co., Ltd.) 15*s*.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland. Thirty-seventh Annual Issue. Pp. vii+354. (London: C. Griffin and Co., Ltd.) 15*s*.

Pope's Manual of Nursing Procedure. By Amy E. Pope. Pp. xi+596. (New York and London: G. P. Putnam's Sons.) 15*s*.

The Chemistry of Synthetic Drugs. By Dr. Percy May. Third edition, revised. Pp. xv+248. (London: Longmans, Green and Co.) 12*s*. 6*d*. net.

The Journal of the Institution of Electrical Engineers. Vol. lix., No. 297, January. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Metabolism and Growth from Birth to Puberty. By Francis G. Benedict and Fritz B. Talbot. (Publication No. 302.) Pp. vi+213. (Washington: Carnegie Institution.)

The Qualitative Analysis of Medicinal Preparations. By H. C. Fuller. Second edition, rewritten. Pp. viii+191. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

Red Lead and How to Use it in Paint. By Dr. Alvah H. Sabin. Third edition, rewritten and enlarged. Pp. xi+139. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 11*s*. 6*d*. net.

A Text-Book of Geology. By Louis V. Pirrson. Part i.: Physical Geology. Part ii.: Historical Geology. Part i., second edition, revised. Pp. vii+470. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17*s*. 6*d*. net.

Chemistry of Pulp and Paper Making. By Edwin Sutermeister. Pp. vii+479+31 plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 36*s*. net.

Œdema and Nephritis: A Critical, Experimental, and Clinical Study of the Physiology and Pathology of Water Absorption in the Living Organism. By Prof. Martin H. Fischer. Third and enlarged edition. Pp. xvi+922. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 55*s*. net.

The Chemistry and Analysis of Drugs and Medicines. By Henry C. Fuller. Pp. ix+1072. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 55*s*. net.

A Textbook of Oceanography. By Dr. J. T. Jenkins. Pp. x+206. (London: Constable and Co., Ltd.) 15*s*.

A Manual of the Birds of Australia. By Gregory M. Mathews and Tom Iredale. Vol. i.: Orders Casuarii to Columbæ. Pp. xxiv+279+plates. (London: H. F. and G. Witherby.) 3 guineas net.

Das Physikalische Praktikum des Nichtphysikers. By Dr. F. Grunbaum and Dr. R. Lindt. Dritte auflage, by Dr. R. Lindt and Dr. W. Molius. Pp. xvi+414. (Leipzig: G. Thieme.) 72 marks.

Imperial Institute. Monographs on Mineral Resources, with Special Reference to the British Empire. Lead Ores. By T. C. F. Hall. Pp. ix+127. (London: J. Murray.) 6*s*. net.

The Quarterly Journal of the Geological Society. Vol. lxxvi. Part 4, No. 304, March. Pp. 325-412+xiv+plates. (London: Longmans, Green and Co.) 7*s*. 6*d*.

Diary of Societies.

THURSDAY, MARCH 31.

INSTITUTE OF METALS (at Shaftesbury Hotel, Great St. Andrew Street), at 8.—S. L. Archbutt: Aluminium Alloys.

FRIDAY, APRIL 1.

ROYAL SOCIETY OF MEDICINE (Laryngology), at 4.45.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. R. L. M. Wallis and Dr. C. L. Hewer: A New General Anæsthetic: Its Theory and Practice.

CONTENTS.