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Education for the Engineering Industry.*

THE triumphs of engineering science and technique are reflected by every development of modern civilisation, and further development will depend, to a large extent, upon the continued supply of qualified and capable engineers. Here, then, is constituted a need which must be provided by engineers and educationists of to-day. It depends on them whether the engineers of the next generation shall be trained and educated in a manner suited to the importance of their calling.

The import of this has been realised in some quarters for a considerable time. In 1928 the Engineering and Education Sections of the British Association held a joint discussion upon "School, University, and Practical Training in the Education of the Engineer". Later in the same year, the President of the Board of Education appointed a Committee to inquire into technical education for the engineering industry. The detailed and thorough nature of this investigation is shown by the Committee's report, which has been recently published by H.M. Stationery Office under the title "Education for the Engineering Industry".

In effect, this report is the expression of a general consensus of industrial opinion, and as such deserves careful consideration. The tendency to direct attention to the practical or works executive side, almost to the exclusion of the office or administrative side, should be noticed. Also, in accordance with the Committee's terms of reference, the report is, in the main, a review, interspersed with many valuable suggestions, but with no definite schemes for the amelioration of the evils noted. To those interested in the subject, this last fact must cause real disappointment, for one cannot but feel that, if the duty had fallen within the scope of such a strong committee, some decisive and practicable schemes would have resulted. Such recommendations would have received widespread and most careful attention.

Considerable emphasis is brought to bear upon the subject of recruitment, and it might be well to review the sources of supply as reported. About ninety per cent of the recruits come to the industry straight from the elementary school at the age of fourteen years; of the remainder, the majority probably come from junior technical schools at ages ranging from fifteen to sixteen years, while a smaller

* Education for the Engineering Industry. 1: Report of the Committee on Education for the Engineering Industry; 2: Comments on the Report by Education Bodies. Pp. vii+67. (London: H.M. Stationery Office, 1931.) 1*s.* 3*d.* net.

proportion are recruited from secondary schools at ages from sixteen to seventeen years. This neglects the comparatively small number received from universities and technical colleges.

From the report, it would appear that, in general, recruitment is still carried out in a fashion quite haphazard, with little or no discrimination between the various types cited. This alone renders the problem of subsequent training most difficult for all but very large industrial concerns, since no clearly defined regulations exist to guide individual firms. Surely, as was suggested at the British Association in 1928, a standard national scheme of apprenticeship could be set up—a scheme which would be readily adaptable to suit the distinguishing features of at least the three main grades of recruits. This is vitally an industrial concern; and that such an obvious opportunity should have passed unheeded forms a fit subject for regret.

Industrial opinions on the merits of the three types of recruit are interesting. The elementary school type is labelled satisfactory, with the caution that intelligent selection, preferably from central schools, is advisable; the junior technical school type would appear to have found unqualified approval; and recruitment from secondary schools is considered intrinsically sound. Regarded as types, the first evidently finds least favour, but as the other two sources of supply cannot hope to cope with the demand, the problem of improving the general personnel of the engineering industry must centre in the betterment of the elementary school type. This is in itself a task. At the outset it must be realised that the majority of this section are not likely to profit by any serious degree of technical education. Their subsequent learning, then, must consist almost entirely of purely descriptive work, with the aim of improving their ideas of the industry in particular and their outlook upon life in general. The progress made during this course of descriptive work would readily indicate the minority capable of further advancement. These remarks may, to a large extent, apply also to the junior technical school type of recruit. The explanation of the favour bestowed upon this class may well lie in the fact that, in effect, these boys are highly selected; the slight vocational bias in their training, even if it has no lasting effect, will certainly facilitate proper selection.

The secondary school boy falls into quite a different category. He is usually the pick of the elementary school type, advanced by a few years of higher education, and generally capable of assimilating a fair degree of technical instruction. Unfortunately, in the report, he is all but maligned for showing a distinct preference for so-called 'black-coated' positions. Assuming this to mean a preference for the office and, ultimately, the administrative side, is it not a quite natural tendency? Surely a certain incompatibility exists between higher education and manual labour. A good grounding on the practical side is undoubtedly necessary for those aspiring to administrative posts, and apprentices with this aim in view will not object to gain their experience in the workshops. On the other hand, perhaps the most progressive suggestion of all in this report concerns this class of recruit. It is proposed that the period spent at school between the normal age of entry to apprenticeship and actual entry should be treated as part of the apprenticeship period. It is also of interest to note that vocational training in secondary schools is not advocated; this conforms to general academic opinion.

Regret is expressed at the divorce of men with high technical qualifications from the practical side of the engineering industry. Such a situation is, however, not surprising if the note appended to the report by one of the members of the Committee is a true indication of the feelings of employers. He states that he does not think that the average employer in general engineering works of Great Britain would be likely to train university students and afterwards offer them positions in productive departments. No reasons are given. Is this further evidence of the persistence of that old reluctance of the industrialists to admit the need for technical training? It is surely fundamentally right that the higher posts in industry should be filled by well-trained men. How one can hope to become highly trained in these days without attending the university or technical college is difficult to understand.

Finally, the admirable part of the report is that in which concerted action between industry and college, extension of part-time education, active encouragement for the boy with ability, and rational methods of promotion are all enthusiastically recommended. Here we have evidence that these subjects are at last receiving sincere attention. It is, however, unfortunate that no schemes are drawn up to show how these desirable objectives may be reached. It can only be hoped that these recommendations will receive the immediate attention of all to whom they are directed. Here the valuable suggestions appended to the report by Mr. A. E. Berriman might well serve as guidance for a definite line of attack.

Mathematics and the French Mind.

(1) *Cours de mécanique : mécanique des solides indéformables, mécanique des milieux continus déformables, théorie sommaire des machines et de l'aviation, les mécaniques de Newton et d'Einstein.* Par Prof. Paul Painlevé et Prof. Charles Platrier. (Cours de l'École polytechnique.) Pp. viii + 644. (Paris : Gauthier-Villars et Cie, 1929.) 150 francs.

(2) *Cours de géométrie.* Par M. d'Ocagne. Première partie : *Géométrie pure* ; Deuxième partie : *Géométrie appliquée.* Pp. xi + 429. (Paris : Gauthier-Villars et Cie, 1930.) 120 francs.

(3) *Cours d'analyse professé à l'École polytechnique.* Par Prof. J. Hadamard. Tome 2 : *Potentiel, calcul des variations, fonctions analytiques, équations différentielles et aux dérivées partielles, calcul des probabilités.* Pp. vi + 721. (Paris : Hermann et Cie, 1930.) 140 francs.

(4) *Cours de mathématiques générales (analyse et géométrie).* Par René Garnier. (Cours de la Faculté des Sciences de Paris.) Tome 1 : *Calcul différentiel, géométrie.* Pp. xi + 463. (Paris : Gauthier-Villars et Cie, 1930.) 80 francs.

(5) *Erreurs et moindres carrés.* Par Prof. R. Deltheil. (*Traité du calcul des probabilités et de ses applications*, par Émile Borel. Tome 1 : *Les principes de la théorie des probabilités*, fascicule 2.) Pp. vi + 161. (Paris : Gauthier-Villars et Cie, 1930.) 30 francs.

(6) *Principes géométriques d'analyse.* Par Prof. Gaston Julia. Première partie : *Leçons faites à la Sorbonne.* Recueillies et redigées par Marcel Brelot et René de Possel. (Cahiers scientifiques, Fascicule 6.) Pp. vi + 116. (Paris : Gauthier-Villars et Cie, 1930.) 25 francs.

(7) *Leçons sur les ensembles analytiques et leurs applications.* Par Prof. Nicolas Lusin. (Collection de Monographies sur la Théorie des Fonctions.) Pp. xv + 328. (Paris : Gauthier-Villars et Cie, 1930.) 60 francs.

MANY consider mathematics to be the most abstract and inhuman of the sciences, but to the connoisseur a mathematical treatise is a work of art, revealing by its style the temperament, aspirations, and even the human weaknesses of its author. When we consider a collection of French books on pure and applied mathematics, we are reminded of the great differences between French and English ideals. The clarity of the French style is well known and "what is not clear is not French". It was also a Frenchman who said that "language was given to us in order that we might conceal our thoughts", but this maxim appears to have influenced German and, to a lesser degree, English writers more than his own countrymen.

Closely allied to clarity is the importance attached to logical precision. In the training of French engineers at l'École polytechnique, for example, the course in elasticity will be a closely reasoned mathematical investigation, in which a logical flaw would be regarded as a scandal. When their studies are complete, the young engineers will go out into the world and discover with amazement that the problems of actual machines are not always amenable to such refined methods. In some cases they will adapt themselves to practical requirements, but in others they may feel a lasting prejudice against practical work and never really settle down to the real requirements of their profession. In England, on the other hand, the tendency is to emphasise the practical aspect at the expense of the underlying theory. This has the disadvantage that persons so trained may not have sufficient grasp of fundamental principles, in spite of their knowledge of current routine, to be able to cope with new conditions that may arise. In both nations the really capable men will ultimately become masters of their subject, but the Frenchmen will tend to approach the particular through the general, the concrete through the abstract, while the Englishmen tend to reverse the process.

French mathematical books give a lucid account of general theories, but too often leave them in the air, without investigating their detailed application. French mathematical students, if we may judge from their text-books, work very few examples. M. le Chatelier has deplored the fact that too many students confine themselves to learning their lecture notes by heart. He considers that they should work out examples for themselves, but regrets that this ideal seems impossible of attainment. In England, on the other hand, the working of problems is firmly established as the essential feature of mathematical study. Unfortunately, this feature, so good in moderation, is apt to be carried to extremes, as in the old Mathematical Tripos, which was considered to be largely responsible for the sterility of many who should have contributed to the advancement of their subject.

In France there is no lack of research in pure mathematics, and here the instinct of generalisation finds a legitimate and fruitful opportunity. Until the present century, British mathematicians have done best in applied mathematics, where the somewhat incoherent and not fully logical work of men like Maxwell has proved to be of more permanent value than the more closely knit and elaborate

efforts of French writers which have now fallen into the background. However, in recent years a change has taken place. At least two English pure mathematicians have a world-wide reputation, while the new syllabus for French schools and colleges is much less abstract than the old. Perhaps at last the two nations are learning from each other.

We shall now deal briefly with the special features of the books under review.

(1) Profs. Painlevé and Platrier cover a much wider range than any English course of mechanics, for in addition to the usual rigid dynamics, hydrostatics, and hydrodynamics, there is a thorough treatment of elasticity; a little about steam engines, gas engines, and turbines; three short chapters on aviation, and finally both the special and general theory of relativity. Until 1929 the course was lithographed, but the excess of material caused this arrangement to break down. It is to be hoped that the effect upon the students will not be similar. But if it is really necessary that they should have to be taught such an enormous range of subjects, they certainly have it presented to them in the best possible manner. The section on gyroscopic motion is particularly notable.

(2) and (3). The second and third books on the list are, like (1), part of the course at l'École Polytechnique, the students of which, it must be remembered, are selected by severe competitive examination. (2) M. d'Ocagne begins with homographic and other transformations, and then goes on to the differential geometry of plane and skew curves and of surfaces, and to line geometry. The later parts of the book deal with applied geometry, including mechanism, graphical statics, graphical integration, and finally nomography. (3) Prof. Hadamard includes potential, calculus of variations, analytic functions, elliptic functions, differential equations (ordinary and partial), and probability. The book differs from the well-known courses of analysis by Goursat or Picard in that it contains many references to problems in mathematical physics, which add considerably to its interest. It is pleasing to notice that the French, sometimes said to be the most insular of nations, have discovered the merits of the numerical method of solving differential equations given by the Englishman, John Couch Adams; the account given here is taken from a Russian contribution, written in French, to a French journal.

(4) M. Garnier has written out the elementary course in analysis and geometry, taken in the first six months at the University of Paris, by those who are preparing for a study of the physical sciences. The first part deals with calculus, infinite series, and complex numbers, and authors of English elementary works could consult it with advantage for elegant methods of treating bookwork. The second part has a very brief treatment (43 pages) of curves and surfaces of the second degree (quite inadequate from an English point of view), and then more than a hundred pages of differential geometry.

(5) Prof. Deltheil has prepared a part for the extensive treatise on probability edited by Borel. It deals with the theory of errors and least squares on classical lines. It is, from its own point of view, quite good; but we regret that the opening chapter is devoted to inverse probability without any mention of the condemnation of this theory by Dr. R. A. Fisher, whose work on small samples, treated by the 'method of likelihood', seems of fundamental importance.

(6) Prof. Julia's book is an attempt to link up geometry and the theory of functions. A study is made of certain transformations, in particular of a circle into itself. These lead to some of the fundamental inequalities of analysis. A sequel to this volume will deal with the researches of Lindelöf and Littlewood.

(7) The last book on our list is by a Russian, but it owes a good deal to French influence, and the author's originality in arriving at mathematical results by way of philosophy is eulogised in a preface by Lebesgue. It deals with the difficult questions of the theory of aggregates, which are on the border line between mathematics and philosophy. In this subject it seems difficult to arrive at the truth, and the author considers that some work hitherto generally accepted is fallacious. "Philosophers", said Einstein, "are children who play with words"; and M. Lusin concludes by warning us that philosophic considerations are always vague, and that we must rely on what may be called observed mathematical facts.

H. T. H. PIAGGIO.

The Great Zimbabwe Problem.

The Zimbabwe Culture: Ruins and Reactions. By G. Caton-Thompson. Pp. xxiv + 299 + 74 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 25*s.* net.

IT is believed that Miss Caton-Thompson's admirable survey of this problem will finally lay to rest a controversy which has now continued for more than thirty years; in fact, it may be flippantly described as 'the great Zimbabwe myth', and few

in England will credit the heat which this discussion engendered. An idea sprang up, soon after the discovery of the ruins by the Rhodesian pioneers, that they were of immense age, and the opinion grew that Rhodesia was the great source of the alleged wealth of the Sabæans, the ruins being the remains of a fortress designed to protect the gold trade; others, for some reason, claimed that they were built by Phœnician traders. These theories were encouraged by Bent, who explored the ruins about 1891, and to some extent by Hall and Neal, who did further work there about 1901. The pronouncements of these investigators appealed to a public in South Africa who revelled in the romantic atmosphere, which was fully exploited by journalistic pens. In fact, the fervour evoked was so great that anyone who was bold enough to express doubt was looked upon as a terrible iconoclast, if not worse.

Randall MacIver in 1905 carried out some careful excavation work at Zimbabwe and other places, and he was the first person to place the solution of the problem on a scientific stratigraphical basis. As is well known, he reported that nothing could be found which could be dated as being earlier than medieval times, and as regards the architecture, it exhibited no trace of Oriental or European origin.

These conclusions produced an angry storm of criticism and did little to dissipate the cloud of misconception. A local worker in Rhodesia, Mr. J. F. Schofield, however, reopened the discussion in 1925 and produced some pertinent evidence. Most professional archæologists were all along satisfied of the soundness of MacIver's conclusions, but the technique of archæological research has progressed in the last twenty-five years and therefore the British Association decided that, as it was visiting South Africa in 1929, it would be a fitting occasion for an effort to settle a number of points which it was felt had been incompletely dealt with by the MacIver Expedition. Miss Caton-Thompson was entrusted with the mission and, accompanied by Miss Norie and Miss Kenyon, spent some five months on her task.

The results are set forth in the volume now before us, and they provide an example of the best systematic archæological work of to-day, and it is believed that the logic of the deductions cannot fail to disperse the misconceptions which have for so long persisted. It is difficult to understand that any modification of current ideas regarding the origin of the ruins should be considered to damage their interest; a little reflection will show that this is not the case, and it is to be hoped that Miss Caton-Thompson's investigations will prove a basis for, and also a stimulus to, further archæological research in South Africa and Rhodesia, for they afford a pattern as regards method and the various unanswered questions are clearly specified.

Miss Caton-Thompson, upon arrival at the site, was faced with the problem which all archæologists have to decide, namely, "Where shall I, in the time at my disposal, with the means at my command, be likely to obtain definite results?" The main enclosure at Zimbabwe had been dug over in every direction for years past by prospectors and archæologists, thus being ruined by disturbance. She therefore decided to explore fully, in the first place, the Maund ruins near by, for there is reason to believe that they are coeval with the main buildings, and, further, the cement floor which is such a persistent feature in these ruins was more or less intact. This floor, of course, seals off everything prior to its formation and it therefore is of definite stratigraphic value, as constituting a datum level, and in a research, the particular object of which was to discover datable articles in undisturbed layers of deposits, it is thus of great importance, providing the evidence is carefully interpreted.

Two distinct periods of occupation were proved, one marked by the stone walls and the cement floors and a later one characterised by mud mounds, the degraded relics of buildings, the work of successors to these sites. It is of great importance to note that practically everything found was, beyond doubt, of African origin. As on previous occasions a few exotic sherds of pottery and some foreign beads were found. In some cases the beads were in association with skeletal remains of Africans. These objects were evidently traded from either Sofala or Tete, and the wonder is that there are not more.

The next site to be examined was the elliptical structure containing the conical tower which is the best known feature of these ruins. As the author states: "Around the famous tower have rallied all the theories of the exotic origin of the Rhodesian ruins and it was fitting therefore that it should submit to a final test".

With the permission of the Rhodesian Government, a tunnel was driven under the tower and a small collection of objects was obtained therefrom, but nothing to which any great age can be attributed and nothing of foreign origin. After this a considerable amount of work was done at the so-called "Acropolis", and to avoid confusion due to previous excavation and refilling on the top of the hill, attention was wisely confined to dissection of the old rubbish-heaps which here and there are to

be found on the flanks. Here again practically every object was of African origin.

Miss Caton-Thompson cast her net widely, however, and ignored no site which might be productive of useful evidence. She therefore explored a number of ruins to the north-east of Zimbabwe—Chiwona, Matendere, Mshosho, and Hubvumi, also Dhlo-Dhlo, some fifty miles to the west. In none of these did she discover anything to conflict with the sequence found at and near Zimbabwe.

Now with regard to general conclusions, MacIver's dictum that the ruins were medieval and post-medieval appears to be generally correct. But Miss Caton-Thompson concedes that the commencement date of the buildings may go back as far as the ninth century A.D., this conclusion being based on the age-determination of imported beads found here and there; but the earliest date from other evidence seems to be not earlier than the thirteenth century, and, curiously enough, the soapstone objects, upon the exotic origin of which so much argument has been based, appear, so far as can be determined, to come rather late in the sequence.

It is, however, impossible and even inadvisable in the limits of a review to attempt to give a complete résumé of the methodical steps by which all these conclusions have been reached. One thing becomes clear: that it is mainly by the aid of meticulous research of this character that concrete evidence will be obtained regarding the various waves of people which have swept into South Africa from the north during the last two thousand years, and which are loosely termed the Bantu invasions.

The work is well produced and profusely illustrated. C. W. H.

Flora of Central Asia.

(1) *The Plant Introductions of Reginald Farrer.* Edited by E. H. M. Cox. Pp. xi + 113 + 12 plates. (London: New Flora and Silva, Ltd., 1930.) 50*s*.

(2) *Plant Hunting on the Edge of the World.* By F. Kingdon Ward. Pp. 383 + 16 plates. (London: Victor Gollancz, Ltd., 1930.) 21*s*. net.

(3) *Wild Flowers of Kashmir.* (Series 3.) By B. O. Coventry. Pp. xix + 100 + xxi-xxix + 51 plates. (London and Leicester: Raithby, Lawrence and Co., Ltd., 1930.) 16*s*.

(1) TO those who knew Farrer personally and to the many who have enjoyed his writings, this book will make instant appeal. Farrer left his mark on English horticulture, and it is only fitting that there should be an account of his work, and especially of his venturesome last years in western China and Burma. The main part of the book is devoted to an annotated list of the plants secured in Farrer's journeys in Kansu in 1914–15 and to his explorations on the Burmese frontier in 1919–20. The introduction is adequate and eminently readable. The writer of the book has had no light task, for the written records of these expeditions are imperfect, Farrer's plants and seeds from Kansu received but scant attention during the War, and his untimely death on the Burmese frontier left his last notes and collections in some confusion. Fortunately, Mr. E. H. M. Cox had the opportunity of accompanying Farrer for part of his Burmese expedition and can therefore write with first-hand knowledge. He has supplemented this by visits to most of the gardens where Farrer's plants are likely to be found. His has been a careful analysis. The results are satisfactory, and Farrer has been fortunate in his biographer.

The book is well printed on excellent paper. The illustrations are attractive, and among them are twelve coloured reproductions of paintings by Farrer in the field. These illustrations, representing plants of the Burmese frontier, are of high merit and add much to the value of the book. A few errors in the botanical names and terms have survived the proof-reading, but these are few.

Apart from those who will read the book from interest in Farrer, the record of plants found by him in Kansu and Burma, with his annotations and descriptions, is such as must be recognised by botanical institutions and by those horticulturists (and they are many) who are keen on the floral treasures of these regions.

(2) Those acquainted with Mr. Kingdon Ward's previous books of venturesome travel in central Asia, such as "The Land of the Blue Poppy", will welcome this noteworthy record of botanical exploration in one of the least-known corners of the world. The first half gives an account of the author's journey in 1926 through that part of extreme north-west Burma bordering on Tibet and China, and the rest of the book is devoted to a subsequent journey in 1928 through the hinterland of the Assam Himalaya, again leading to Tibet and China. It is an uninviting region to the traveller—with uncouth and unfriendly natives, dense jungles, and heavy rainfall. To travellers of Mr. Kingdon Ward's type it is redeemed by the interest of its flora, especially as regards its alpine plants.

Little is known of the fauna and flora of this

region—a vast tangle of mountains between the Himalaya and the Chinese Alps. The author has, in these and previous expeditions, made valuable contributions, both biological and geographical. Many of the plants referred to in the text bear unfamiliar names, but that is simply because the plants were unknown previously and have but recently been described. Even for the non-botanical reader the book well repays perusal. It is written in an easy style and well illustrated.

(3) Mr. Coventry's book on the wild flowers of Kashmir is the third of the series, and is on the same lines as the previous two. Fifty additional Kashmir plants are annotated and figured. Every visitor to the delectable land of Kashmir who is interested in its flora, should take these three handy volumes as his companions. The only alternatives are the bulky seven tomes of the "Flora of British India" and certain published lists of the plants of the north-west Himalaya. These lack illustrations and otherwise do not appeal to the traveller who is not a professed botanist. The figures in the series under review are coloured and are reproduced from the direct colour photographs of the author. They are of very high merit, not only in the reproduction, but also in the choice of the material. The botanist may miss the dissections which are the normal accompaniment of botanical illustrations; but the author has caught the *facies* of each plant so well that they need not be regretted. With the adequate and clearly expressed text, the results are very satisfactory, and lovers of Kashmir will welcome additions to the series.

Our Bookshelf.

The Animal Mind. By C. Lloyd Morgan. Pp. xii + 275. (London: Edward Arnold and Co., 1930.) 12*s*. 6*d*. net.

IN the preface to "The Animal Mind", Prof. Lloyd Morgan quotes the words of Don Quixote to the Duchess: "God only knows whether there be any Dulcinea or not in the world. . . ." Let us be quixotic enough, adds the author, "and some behaviourists say that it is sheer quixotry—to believe that our Dulcinea does exist. . . ." This sentence sums up the difficulties of a biologist who is asked to review "The Animal Mind", if he does not agree with the *Weltanschauung* of the author. Either you agree with Prof. Lloyd Morgan's views about scientific method and regard the views he expresses about animals as a contribution to scientific knowledge; or you do not agree with Prof. Lloyd Morgan's views about scientific method and are therefore compelled to say courteously but unequivocally that science is not advanced by speculations about what goes on in the mind as opposed to the central nervous system of an animal, and that the attempt to "put yourself in his place" is the very antithesis of the procedure which the scientific worker adopts in studying the characteristics of living matter.

The method of extensive introspection or, as the author himself calls it, "putting yourself in its place", is set forth in the following passage, which refers to the author's observations on his dog Tony: "Let me try to illustrate what I mean from what I may call the ball-situation and the stream-situation, putting myself in Tony's place. I, Tony, have learned to swim across a still pond and fetch things out of it. Meanwhile I have been learning quite a lot in ball situations. Among other things I have learned this: that if I follow a swift running ball up to a wall, and from the wall as it rebounds at an angle . . ." Those to whom this method of investigation appeals may refer to the text for the remainder of a soliloquy in which Prof. Lloyd Morgan, alias Tony, tortures his motives like the heroine of a Russian novel.

To those who place confidence in the method of Sherrington and Pavlov, the relevant issue is not whether Dulcinea exists, but whether Dulcinea belongs to fiction or to science. They will not wish to rob Prof. Lloyd Morgan of what comfort his Dulcinea can give him. They will merely insist that her place is the library. In the laboratory her charms will distract them from the serious business of the scientific worker.

Untersuchungen an Luftwurzeln. Von K. Goebel und W. Sandt. (Botanische Abhandlungen, herausgegeben von Prof. K. Goebel, Heft 17.) Pp. 124 + 6 Tafeln. (Jena: Gustav Fischer, 1930.) 12 gold marks.

THE senior author of the monograph, Prof. Karl von Goebel, during his journeys in the tropics made numerous observations upon the aerial roots of epiphytes, interesting and characteristic features of tropical vegetation; but he was not able to give them the systematic attention he desired. Dr. W. Sandt has therefore continued to study them, under Prof. von Goebel's direction, using the very fine collection of epiphytes growing in the glass-houses in the Munich Botanic Gardens, where anatomical and physiological studies were also possible. The main point under examination was the growth habit of these roots before and after entering the soil. Dr. Sandt confirms the earlier observations of Sachs and others, that in these aerial roots the growing region may be extraordinarily long and that this adequately accounts for the remarkable daily increment of growth of some of these aerial roots.

These roots, which grow obliquely, not vertically, downwards, are usually quite unbranched unless the apex is damaged. Branch root primordia may be formed, but do not grow out so long as this vigorous growth of the main root continues. When the root enters the soil, however, the zone of growth very rapidly becomes of the normal, comparatively narrow dimensions, and then the branch roots may

grow out; the main root apex also grows very slowly or not at all in water, whilst branch roots develop freely. Numerous measurements on the growth of marked roots and some observations and experiments upon absorption by them are described, and the regions of the roots, growing in air and soil, are briefly compared in their anatomy.

Experimental Mechanical Engineering: for Engineers and for Students in Engineering Laboratories. By Prof. Herman Diederichs and Prof. William C. Andrae. Vol. 1: *Engineering Instruments.* Pp. viii+1082. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 40*s.* net.

THE precise methods of the physical laboratory have long since been applied in the realm of engineering practice. In workshops, factories, engine-rooms, and steel-works, scientific apparatus is found in ever-increasing quantity. Specifications are drawn up with scientific accuracy and contracts have to be carried out within fine limits. Not only during tests, but also as a matter of daily routine, records of pressure, temperatures, velocities, volumes, and analyses have to be taken at frequent intervals, and every engineer must be something of a physicist. Of the scientific apparatus in use, there is an endless variety constantly being added to, and the need of an authoritative text-book on the subject is apparent.

To meet this need, the authors of "Experimental Mechanical Engineering" have compiled this work on engineering instruments, their construction, use, and calibration. Chapters deal in turn with the measurement of length, area, time, speed, pressure, temperature, work and power, liquids, gas, vapours, and fuel analysis, exhaust and flue gas analysis, and lubrication. They are well illustrated by diagrams, and references are given to the sources of information. This is a book which should be in the library of every technical college, every drawing office, and of every engineer who is concerned with the testing and running of plant. A second volume is to be published to cover the testing of power plant apparatus as laid down in the codes of the American Society of Mechanical Engineers.

Plants of the Gold Coast. By Dr. F. R. Irvine. Pp. lxxix + 52 + 32 plates. (London: Oxford University Press, 1930.) 5*s.* net.

THE author of this work, who is master of agriculture and biology at Achimota College, is anxious to commit to print the vernacular names of plants of the Gold Coast and their relevant proverbs, with interpretations, before they are forgotten in the changed conditions of modern life. The work has been undertaken mainly to help African teachers and other Africans who are willing to take an interest in their flora.

The introduction contains much of interest, amongst which the author summarises his investigations into plant lore, herbalism, and the economic uses of local plants. A list of economic plants shows the species grouped according to their value for oils, fibres, timber, drugs, etc. The lists of native names are a valuable record. They are written in the new and unfamiliar script recommended by Dr. Westermann and the International Institute of African Languages and Cultures. The greater part of the book consists of an enumeration of the plants, with brief descriptions and notes on plant lore, in English. The arrangement is alphabetical, under the botanical names. The author welcomes suggestions for a future edition. The experience he will gain in the meantime will undoubtedly lead him to reconsider the scope of the work.

There are some good representative photographs of the vegetation and a few line drawings. The low price of 5*s.* is due to the financial assistance given by the Gold Coast Government to enable the author to achieve his object and place his book before the Gold Coast people.

A New Algebra for Schools. By Clement V. Durell. Parts 1 and 2. Pp. ix+328+xxiv+xxiii+xv. (London: G. Bell and Sons, Ltd., 1930.) Without Appendix: with Answers, 3*s.* 6*d.*; without Answers, 3*s.* With Appendix: with Answers, 4*s.* 6*d.*; without Answers, 4*s.*

THIS book has been written for the ordinary pupil, and an excellent course has been devised whereby the initial difficulties in algebra, due largely to the symbolic notation, may be overcome. In the early stages, the student is trained to think in numbers when using letters. Simple practical formulæ are then developed in such a way as to exhibit the utility of the notation. The volume, embracing parts 1 and 2, each corresponding to a normal year's work, carries the subject up to quadratic equations, and a characteristic feature lies in the numerous illustrations drawn from geometry, physics, and mechanics. At the present time, when progressive teachers are strongly advocating a greater degree of unification in school mathematical subjects, such a book as this is very welcome. There is an abundance of exercises to meet the needs of both ordinary pupils and those of special ability.

An Index to the Chemical Action of Micro-organisms on the Non-Nitrogenous Organic Compounds. By Prof. Ellis I. Fulmer and Prof. C. H. Werkman, assisted by Anella Wieben and Calvin R. Breden. Pp. xiii+198. (London: Baillière, Tindall and Cox, 1930.) 20*s.* net.

THIS book is a useful aid to biochemists wishing to know where to obtain information about the chemical action of micro-organisms. The contents are tabulated to show the action of each organism on all the substrates which have been examined and in each case the products found, the authority, and the reference to the literature. Each item is cross-referenced under "Substrate" and again under "Products". So far as the writer has been able to test it, the information is fairly complete. The present instalment deals only with organic, non-nitrogenous substances, and it is to be hoped that a further section dealing with other substrates will soon appear.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Pliny's Water-Mill.

A PHOTOGRAPH of a water-mill which recently reached me from Kashgar in Turkestan is reproduced in Fig. 1. It has taken me two years to secure this photograph; and, so far as I can trace, no illustration of a mill of this peculiar type has hitherto appeared in any British or American publication: though references to such

Copyright] [*H. P. Vowles.*

FIG. 1.

mills will be found in the works of a number of explorers in the Far East.

The interest of this particular mill lies in the fact that Pliny appears to have referred to water-mills of a similar type in his "Natural History" (xviii. 23). It will be noted that the water-wheel, which is undershot, does not drive mill-stones through gearing, but operates pestles by a 'trip-hammer' action. Pegs on the horizontal axle come in contact with the short ends of two pivoted levers as the axle rotates. The short ends are depressed alternately, the other ends of the levers—which carry pestles—then rising; further rotation of the axle releasing the levers so that the pestles fall by their own weight into mortars containing grain or rice.

After discussing hand-operated pestles for crushing grain, Pliny remarks: "Maior pars Italiae ruido utitur pilo: rotis etiam quas aqua verset obiter, et molat". This has been variously translated, but I think the following gives the sense of the words correctly: "In the greater part of Italy is used a roughened pestle, with wheels which the water turns in passing, and so it grinds". The passage is admittedly obscure, but with the knowledge that the pestle-and-mortar water-mill actually exists, I think we may reasonably infer that Pliny refers to this type.

Further evidence, albeit indirect, is afforded by the fact that mechanism precisely similar in principle, though differing in application, is described and illustrated by Heron of Alexandria in his "Pneumatics". The difference lies in the fact that Heron substitutes a wind-wheel for a water-wheel, and a piston falling by its own weight in a cylinder for the pestle falling by its own weight into a mortar.

It is not improbable that this type of water-mill was invented before the geared mill described by Vitruvius, and developed out of the (I think) still earlier water-raising wheel used for irrigation purposes, a vague reference to which occurs so far back as Sumerian times ("Cambridge Ancient History", vol. 1, p. 461). There are two other types of water-mill without gearing, but I have been unable to find any evidence for either in the literature of antiquity. Certainly no evidence is given by Bennett and Elton, in their "History of Cornmilling", in support of their view that the horizontal water-wheel on a vertical spindle was known in Græco-Roman times; though one may reasonably suspect, from its primitive design and construction, that it was originally invented at an early stage of civilisation. I hope to give fuller details in a paper to be read before Section H of the British Association in September.

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Classification for Bibliography of Science—A Problem.

THE relations of bibliography to science with especial regard to classification, as brought forward in Dr. S. C. Bradford's recent articles in NATURE,[1] have for many years been my purposive study. I welcome the renewed and increasing interest in the problems involved. It is very regrettable, however, that these matters were not considered more wisely a quarter of a century ago. What can best be done now should indeed become a question of major importance to scientific workers, to bibliographers, and to librarians.

Classification, affirmed to be fundamental to scientific method, has not yet been applied to scientific literature methodically and in a scientifically organised system. This should now become a first concern of the national and international organisations. The reasons for this, so well stated by Dr. Bradford, have been urged by me elsewhere on broad grounds.

The International Catalogue of Scientific Literature rejected in 1896 the classifications then proposed; and the study of the question was remitted to the Committee on organisation.[2] In the face of this negation on the part of the scientific workers, the International Institute of Bibliography soon after adopted an arbitrary classification devised by an American undergraduate in 1875 for the college library he was then serving. This was the famous Decimal Classification of Melvil Dewey. Its undeniable disqualification is that it is illogical and unscientific.

This system separates Science in Class 5 from Philosophy in Class 1 and places it subsequent to Social Science in Class 3, which is remote from History in Class 9. Then Philology in Class 4 it dissevers from Literature in Class 8; so all the literatures are severed from their languages. Biology and psychology, so far from being treated as distinct, fundamental sciences, are misrelated and dispersed. Biochemistry is given place neither under biology nor under chemistry, nor even in the index. These few examples of the disorder and inadequacy that pervade

the system justify my criticism [3] that it is disqualified and inadaptable for scientific development.

The doctrine that such disorder matters little, that specific subjects, however misrelated, can be brought together by the index and by cross-references, I have termed "the subject-index illusion". Without subordination of the specific to the generic, division produces dispersion of subjects that an alphabetic index does *not* countervail.

The International Institute, conceding to the proprietor's conservative regard for American public libraries, has engaged to maintain the basic order of the thousand subjects unchanged, except for a few alterations in headings; but has been free to elaborate specific subdivision and to develop a complementary mnemonic notation. This, however, is too lengthy and complicated for bibliographic uses; for example, experimental psychology of children is marked 612.821.3.031, where three letters would suffice: *I* for psychology, *IB* for physiological and experimental, and *IBF* for that of children. The complexity is exemplified by such combinations as 9(44)"17" = 2 for history of France in the eighteenth century, written in English, which an economical notation would mark simply with four letters, *MSLE*: for the periods of the history of France *MS*, for the eighteenth century *L*, and for English *E*.

Dr. Bradford has applied to the Decimal Classification the term "Universal". It may be regarded as international in some respects, but indeed not universal; it is not even internationally dominant. In America since 1900 it has been adopted by very few scientific and university libraries, the classification of the Library of Congress having been preferred. But there are strong objections to this system too, not only on scientific grounds but also because of its cumbersome complexity. Moreover, such a classification is not available for standardisation, because it is not typical.

In systems of selection, of cataloguing, and of classification, co-operation and economy depend on standardisation; but we should consider how and in what measure. Would it pay to standardise an arbitrary classification for scientific bibliography? Does co-operation require that? I think not; and I proffer a constructive solution to the problem. The whole ground is treated comprehensively in my book on "The Organization of Knowledge and the System of the Sciences", reviewed in NATURE of Aug. 9, 1930, p. 199. That book is fundamental to a second volume, offering a comprehensive study of the problem of bibliographic classification, which will probably be published this year by the American Library Association. It advocates co-operative development and standardisation of a basic classification and notation consistent with accepted principles and with the organisation of science, and adaptable to national, special, and typical conditions and requirements. A definite plan for co-operation in selection, cataloguing, and classification was outlined by me at the Conference of the American Library Association at Toronto in 1927.

International co-operation is of so great importance to us now that we should avoid detraction save for social economy. But the problem of bibliographic classification is as yet unsolved. It is involved in library economies; it is immersed in a historical situation. We cannot avail ourselves of standardisation while bibliographers advocate one system and librarians adopt another, though scientific workers find both very unsatisfactory. It behoves scientific workers, therefore, to examine this matter for themselves and to undertake to solve it in an internationally organised system.

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[1] Sept. 13, Oct. 4 and 11.
[2] NATURE, July 23, 1896, **54**, p. 272.
[3] *Library Journal*, Dec. 1912.

Isotope Effect and Hyperfine Structure of the Mercury Resonance Line.

RECENTLY Schüler and Keyston [1] have made some interesting studies on the hyperfine structure of the spectral lines of thallium, from which they conclude that the hyperfine structure is due in part to a relative shift of the spectral terms due to two isotopes of thallium (203 and 205), originating from differences in the structure of the electric field of the atomic nucleus. The isotope splitting is greatest in the terms with relatively small nuclear moment splittings.

In connexion with the investigations on hyperfine structure of the mercury resonance line 2537 A., I have been able to confirm by experiments the existence of the above-mentioned effect. I investigated the hyperfine structure of the mercury resonance radiation excited with different combinations of the 2537 A. line components, the isolation of the components being realised in the way described in a former paper.[2] These experiments showed that every component gives a pure resonance effect; this proves that the normal $1\ ^1S_0$ level of the mercury atom is single.[3]

Further, my studies on the influence of admixture of non-extinguishing foreign gases to the resonating vapour proved that the components of the 2537 A. line can be divided into two groups: (1) components

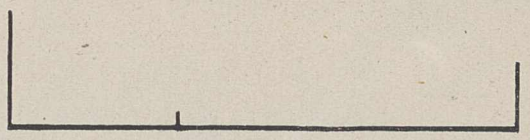

FIG. 1.

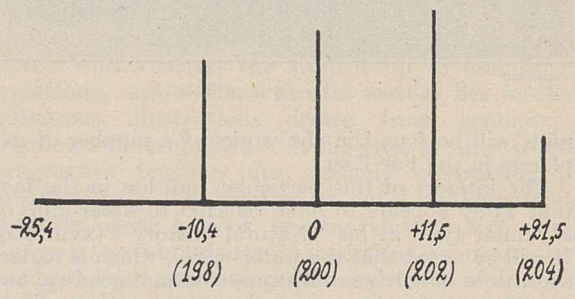

FIG. 2.

with an independent existence; even if considerable quantities of foreign gases are added (40 mm. nitrogen), they show the pure resonance effect—such are the components 0 and +11·5 mA.; (2) components which show a coupling such that they appear all together with the exciting line (−25·4 mA.) with greater additions of foreign gases—such are the lines −25·4, −10·4, and +21·5 mA. The lines of the first kind belong to different isotopes, those of the second to the same kind of atoms. The splitting of the latter is thus certainly due to the existence of the magnetic moment of the nucleus, which would in part confirm the hypothesis suggested by me elsewhere.[4]

The relations of intensities of the three lines of the second group in monochromatically excited resonance radiation with the −25·4 mA. component, in the presence of large quantities of foreign gas (represented qualitatively on Fig. 1), as well as my new investigations on the Zeeman effect in absorption in fields up to 15 kilogauss, show, however, that the structure of the 2537 A. line is certainly more complicated and arises from the incidental overlapping of the lines belonging to different isotopes. The relationships

to which the above-mentioned investigations lead are represented on the Fig. 2 (isotopes with zero nuclear moment): the lengths of the respective lines indicate their relative intensities. These intensities, or the absorption coefficients, do not give us directly the proportion of the various kinds of isotopes, because the probability of the transitions may not be the same for different isotopes, which was demonstrated by me in the case of the 2537 A. line.[2] For this reason a correlation based on the intensities, as Schüler and Keyston have done (cadmium, thallium), cannot be considered as convincing.

In the case of the line 2537 A., calculations can be made using the isotope concentrations given by Aston, which are not subject to the above-mentioned objections, for the life period of different components is known.[2] They show that if we attribute the lines 0 and +11·5 mA. to the isotopes 200 and 202 (in arbitrary succession), the three lines represented on Fig. 1 must be attributed to two isotopes, 199 and 201 (overlapping of a doublet and a triplet ?), with nuclear moments equal to an odd multiple of 1/2. This last conclusion follows from the fact that in the parallel Zeeman effect the parallel zero components, which show a Paschen-Back effect in higher magnetic fields, are not observed.

It is curious that the direction of the isotope shift of the lines shown in Fig. 2 is opposite to that observed with thallium and to that resulting from the motion of the nucleus around the centre of gravity of the atom. This shift has at the same time a relatively high value of c. 0·2 cm.$^{-1}$ for each addition of two protons, which is, however, nearly a half of the shift observed on the line 5351 A. of thallium.[1] It is produced probably by the modification of the electric field surrounding the nucleus, as resulting from the addition or subtraction of two protons.

A full report of these investigations will be published shortly in the *Bull. Acad. Polonaise*.

S. MROZOWSKI.

Physical Laboratory of the Society of Sciences and Letters, Warsaw, May 5.

[1] H. Schüler and J. E. Keyston, *Die Naturwissenschaften*, **19**, p. 320; 1931.
[2] S. Mrozowski, *Bull. Acad. Pol.*, p. 464; 1930; in part also NATURE, **126**, p. 684; 1930.
[3] S. Mrozowski, *Phys. Review*, **37**, p. 845; 1931.
[4] S. Mrozowski, *Zeit. für Physik*, **68**, p. 278; 1931.

Electron Polarisation.

IF the free electron has the spin theoretically assigned to it, the theory [1] of the double scattering of electrons by single stripped nuclei would lead one to expect that when an electron beam impinged successively on two metal targets, the intensity of the secondary scattering would be asymmetric about the direction of incidence of the secondary beam.

The majority of the previous experiments to detect this effect have been carried out either with slow electrons (a few hundred volts energy), small scattering angles, or reflectors of low atomic number. Under these conditions no observable asymmetry is predicted by theory, and this is in accord with the results of most investigators.

Chase [2] has reported that with 90° scattering from 45° lead targets, and with primary electron velocities of from 0·7 to 0·95 the velocity of light, the effect does appear, together with more striking features not predicted by theory. With these high velocities, however, the theory loses much of its meaning, since in its formulation the radiative forces on the electron were neglected. It seemed desirable, therefore, to look for the effect with a primary electron velocity of such a value that the predicted asymmetry should be easily observable, and yet the radiative forces should be small.

The tube was constructed so that the electron beam reflected at 90° from a 45° tungsten polarising target impinged at normal incidence on a tungsten analysing target. The intensities of the secondary scattering at an angle of slightly more than 90° could be measured at 0° and 180° of the azimuth without altering any part of the apparatus. Only the faster group of electrons in the scattered beams was allowed to reach the measuring instrument, all others being prevented by the use of suitable retarding fields (1700 volts for a primary voltage of 10 kv.). Rotation of the polarising target through 180° about the direction of the secondary beam, and the use of a second filament at 180° to the first, was intended to reverse the spin asymmetry and to provide a check against possible diffraction effects in the analyser.

It was found that with 10 kv. and 1 kv. electrons the ratio of the intensities at 0° and 180° of the azimuth did not differ by more than the experimental error (1 per cent). For purely nuclear, ideal scattering (in the sense of the Mott theory) the difference should have been approximately 13 per cent. This figure is based on the theoretical idea that the probability of an electron being scattered in a given direction depends on the orientation of its spin axis. It would therefore attain this value only if all electrons scattered 'into' the polarising target were rediffused with appreciable energy loss, so that the faster group of electrons in the secondary beam would be polarised to the degree predicted by theory.

It would appear to follow from this experiment that either the free electron has not the spin theoretically assigned to it, or that the present approximate theory with its neglect of orbital electron scattering and radiative forces predicts an effect which would not appear in a more complete formulation.

I am indebted to Prof. O. W. Richardson for the suggestion of the problem.

G. O. LANGSTROTH.

King's College, Strand, London, W.C.2, May 8.

[1] Mott, *Proc. Roy. Soc.*, A, **124**, 425; 1929.
[2] *Phy. Rev.*, **36**, 1060; 1930.

Hyperfine Structure in the Spectrum of Copper.

THE principal copper doublet at λλ3248 and 3275 has been studied with great care in the fourth and fifth orders of the large concave grating of the Physical Institute at Tübingen. Each line consists of a very sharp, narrow doublet of separation, 0·043 ± 0·001 A. or 0·41 ± 0·01 cm.$^{-1}$, the long wave-length component being about twice as strong as the short wave-length component.

Extreme care must be exercised in the photography of this pair of lines. They are the 'raies ultimes' of copper, and even when the copper content of the electrodes is so low as 0·001 per cent, the fine structure of the lines indicates the beginning of self-reversal. A similar phenomenon was noticed by Royds [1] in the green line of thallium.

So far as we are aware, the only previous work on the fine structure of these two lines was done by Back [2] with the same apparatus as that used by us. On the basis of the present work, it seems that Back's results can be explained by self-reversal of the fine-structure components. It was possible, with 0·001 per cent copper in the electrode and the use of high excitation, to reproduce the results of Back. Only when the copper content of the electrode had been reduced to

a negligible amount (as an electrolytic impurity) and the excitation kept at a minimum did the structure of each of the lines appear as reported in this letter.

With a view toward interpreting this hyperfine structure on the basis of nuclear spin, the lines were studied in a magnetic field of 43,350 gausses. The Zeeman patterns of these lines have always been reported as simple D-types. Using very fine-grained plates and especial care in development, each of the Zeeman components appears to be doubled, even when using less than 1 per cent copper in the electrodes. But this doubling is considerably wider than the fieldless separation, and we therefore reduced the copper in the alloy (<0·001 per cent) and the excitation to a minimum. Under these conditions, the Zeeman patterns of the lines consisted of extremely sharp single lines, showing that the former patterns were probably due to self-reversal.

The separation 0·41 cm.$^{-1}$ can be attributed to the hyperfine structure of the $^2S_{\frac{1}{2}}$ level of copper, since this level is common to both lines. The hyperfine structure of the ^2P levels is apparently very much smaller and could not be determined in the present investigation.

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JOHN WULFF
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May 6.

[1] *Proc. Roy. Soc.*, **107** A, 360; 1925.
[2] *Ann. d. Phys.*, **70**, 369; 1923.

The Velocity of Light.

IN NATURE of April 4, p. 522, M. E. J. Gheury de Bray pointed out that the decrease of the velocity of light, if it exists at all, could be caused by the change of the earth's magnetic field. But such an explanation of a change in the velocity of light could not easily be accepted, because the immediate relation between the velocity of light and the intensity of magnetic field for Maxwell's theory is unknown.

Let us suppose that Maxwell's relation for the index of refraction for an insulator $n=\sqrt{\epsilon\mu}$ is correct, μ signifying the permeability and depending in ferromagnetic substances upon the intensity of the magnetic field. Then, because the discussion relates to measurements of the velocity of light carried out in air, the change of the velocity of light in the sense of Mr. Gheury de Bray's explanation would mean that the permeability, and accordingly the index of refraction of air, had changed (on account of the change of the earth's magnetic field). The index of refraction of air is 1·00029, and a simple calculation shows that within the last fifty years the index should have increased by some $6{\cdot}7\times10^{-4}$ in order to produce a decrease of 200 km./sec. According to Landolt-Börnstein ("Physikalisch-chemische Tabellen", vol. ii., 1923, p. 959, I. Ergänzungsband, 1927, p. 525) it can be seen that this index had not changed between 1865 and 1925, the difference between the various values being $\leq 3{\cdot}6\times10^{-6}$; moreover, the values do not show any systematic variation during the time.

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Žerjavićeva ul. 16, Zagreb,
May 2.

DR. VRKLJAN'S contribution to the subject is welcome as tending towards the elucidation of the causes, whatever they may be, which are operative in creating the curious, and possibly significant, refusal of the observational evidences to endorse the theoretical dogma of the constancy of the velocity of light.

Dr. Vrkljan, however, has misunderstood me. I did not express the opinion that a decrease of this velocity could be caused by a variation of the earth's magnetic field. I pointed out that the latter no doubt affects the velocity of light and yet that, to my knowledge, no attempt has been made to investigate the relationship and allow for its effect on the observations, although the possible error has been reduced to 1 in 100,000 nearly. I further allude at the end of this note to the possible existence of other factors which may also affect the sought value. The only correcting factors applied are those for the pressure and temperature of the atmospheric air.

The velocity of light is undoubtedly the most important 'constant' in the realm of physical science. Theories are currently discussed which admit an expansion of the universe, soap bubble fashion; if the ether be material—and there are still physicists who hold this view—such an expansion implies a gradual decrease of density of the ether, and the decrease of velocity of light with time follows as a matter of course. To any unprejudiced mind, the observations conclusively put this decrease in evidence. If the ether is a mere abstraction, yet its virtual properties must be consistent with the theories which purport to describe the structure of the universe, and therefore there should be somewhere in the scaffolding with which de Sitter's theory has been erected, some mathematical counterpart of this particular result of the expansion of the universe, which causes the light to take longer, as time goes on, to travel between two points of space defined by their position with respect to the whole, since this whole is expanding, and therefore the distance between these two points increases.

I believe that in any other field of inquiry such a discrepancy between observation and theory would be felt intolerable. Why it is suffered in the present case is not apparent. It is, however, certain that if a decrease of the velocity of light were accepted on theoretical grounds, and if some misguided physicist attempted to demonstrate that it is constant, the present observations would be called to witness to silence him conclusively! Such is the strength of the observational evidence on which this corner-stone of physics is actually resting!

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The Conditions on Schrödinger's ψ.

THE energy levels of an atomic system are found in wave mechanics by selecting the 'characteristic' solutions of a Schrödinger differential equation, and the conditions defining these solutions are usually stated as an arbitrary mathematical postulate chosen so as to secure agreement with experiment.[1] This additional postulate seems to be unnecessary, however; the conditions follow naturally as a consequence of the physical foundations of the theory.

Wave mechanics rest upon the following two fundamental laws:

(1) ψ has the usual significance of a probability amplitude;

(2) When completely expressed, ψ satisfies always Schrödinger's time equation (or its relativistic substitute).

Characteristic-value problems arise as a special case in which the experimental conditions serve to select a system in a 'pure state' as regards some variable, such as energy or angular momentum, which can be 'measured' physically. To follow such a measuring process theoretically, one expresses ψ as a series in terms of that complete set of orthogonal character-

istic functions which belongs to the Schrödinger equation for the variable in question, each function corresponding to a certain value of the variable; the measurement can then be regarded as consisting in a physical separation of the terms in this expansion, followed by a detection of the system as being in a place or state corresponding to one of them;[2] in other words, as a generalised Stern-Gerlach experiment.

The basic requirement for a characteristic function is accordingly that it shall constitute one of such an orthogonal family in terms of which we can expand any ψ that can occur in Nature. Since it follows from (1) that $\psi\psi^*$ must always be integrable in order that the total probability may be unity, the characteristic functions themselves must be quadratically integrable (or, in the continuous spectrum case, Weyl-normalisable). The customary requirements of continuity and single-valuedness of ψ or its derivatives are unnecessary as an addition to the fundamental requirement that ψ shall satisfy a certain differential equation. The condition that ψ shall be finite everywhere, which serves so well in atomic theory, is in almost all cases equivalent to the requirement that $\psi\psi^*$ shall be integrable. The possibility remains open, however, that in exceptional cases infinities may occur without destroying the integrability, as in the Dirac relativistic hydrogen atom,[3] and on this view such an infinity does not necessarily constitute a 'blemish' on the theory.

The basic postulates of quantum mechanics are necessarily somewhat abstract, but when we have a choice, I feel that the less abstract form has decided advantages from the physical point of view.

E. H. KENNARD.

Cornell University,
Ithaca, New York,
April 27.

[1] Cf. Joffé, *Zeit. f. Physik*, **66**, 770; 1930; Langer and Rosen, *Phys. Rev.*, **37**, 658; 1930.
[2] Cf., for example, *Phys. Rev.*, **31**, 876; 1928.
[3] Darwin, *Roy. Soc. Proc.*, **118**, 673; 1928.

An Apparatus for Recording the Ultra-Violet Light of the Sky.

OBSERVATIONS of ultra-violet light are being made in many towns and seaside resorts by means of Sir Leonard Hill's method of recording the fading of a solution of methylene blue in acetone. For simplicity it would be difficult to improve upon this procedure, but in winter, when the days are short, there are many times when the fading is too small to be observable by this method.

Experiments have been carried on here during the last year or two on an alternative method in which photographic printing paper is used to register the ultra-violet rays.

A strip, 3 in. × 1 in., of 'Ultra-violet Glass', which is opaque to visible light but allows a band of rays beyond the violet from about 3400 to 3700 angstrom units to pass, is fitted into a slot, 3 in. × 1 in., in the lid of a shallow metal box, so that the interior of the box is illuminated only with ultra-violet rays when the lid is closed. To measure the intensity of these rays a stepped 'wedge' is constructed of layers of a fine quality of thin tissue paper which provide ten grades of thicknesses through which the light may pass. A strip of photographic paper receives the ultra-violet rays. This paper is laid on the bottom of the box, the wedge is put over it, the lid of the box closed, and the whole exposed to the light of the sky. At the end of the day the photographic paper is examined, and the greatest number of layers of paper in the wedge which the light has penetrated is read off. According to theory, this number is the logarithm of the intensity of the light. The transmission factor of the paper being known, it is easy to construct an arbitrary scale of light values.

The method is sensitive enough to allow a daily reading to be obtained all through the short days of winter except at such times when fog obscures light of every kind.

As the year advances from winter to summer and the light becomes stronger the wedge scale may need extending, and in that case a further suitable number of layers of the tissue paper may be superimposed on the wedge without detriment to the accuracy of the readings.

If necessary this photographic method could easily be adapted to give a continuous record of ultra-violet rays by wrapping the photographic paper on a rotating drum.

The record of average monthly readings with this apparatus compares very well with the monthly averages of the methylene blue apparatus.

Observations are being carried on in Manchester, Rochdale and Hale (Cheshire), and they show a regular diminution of ultra-violet light as we pass from the open country, through the suburbs, to the centre of a manufacturing town, where the light is found to be about one half of what is received in the country.

This is, no doubt, due to smoke in the atmosphere, for direct experiments in the laboratory demonstrate that smoke is effective in obscuring ultra-violet rays.

J. R. ASHWORTH.

55 King St., South,
Rochdale,
May 8.

The Change of Density of Nitrobenzene with Temperature.

IN connexion with the study of the dielectric constant of nitrobenzene as a function of temperature,[1] I have measured the density of nitrobenzene in the temperature interval between 5·6° C. and 30° C., using the method described by H. Kamerlingh Onnes and J. D. A. Boks.[2]

I have already used this method in measuring the dependence of the density of ethyl ether upon temperature;[3] there is therefore no need to dwell upon the details. I will mention only that temperatures were determined with an error not greater than 0·003° C.; the changes in the fourth or even fifth decimal of the value of density were still discernible.

The density of chemically specially purified nitrobenzene increases from 1·1916 at 29° C. up to 1·2134 at 9·8°. Beginning from 9·5°, there is a markedly more rapid increase of density with the lowering of temperature; at 5·5°, that is, in the neighbourhood of the freezing point, the value of the density is 1·2569. These changes of density appear distinctly on the accompanying graph (Fig. 1).

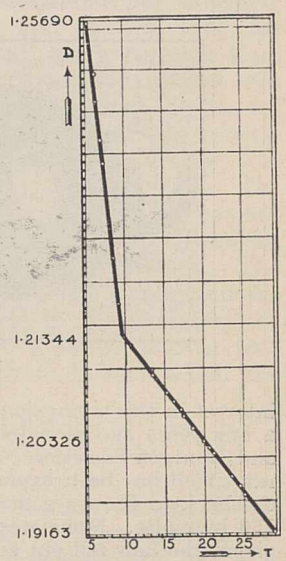

FIG. 1.

In the neighbourhood of 9·5° there is a sharp change

of slope of the curve. This temperature was incorrectly held by many authors to be the freezing point.[4] In the present study I have definitely found that the freezing point is at 5·5° ; at 5·7° nitrobenzene is distinctly liquid.

It is to be noted that the slope in the density temperature graph is the more interesting because at the same temperature of 9·5° the dielectric constant of nitrobenzene, as was shown previously by me, shows a very sharp decrease. Both this sharp change of the value of dielectric constant and the sharp change of slope in the density curve in the neighbourhood of 9·5° lead to the assumption that at this point nitrobenzene undergoes some, as yet not clearly understood, energy transformation.

J. MAZUR.

Physical Laboratory,
Technical Institute, Warsaw,
April 4.

[1] NATURE, **126**, 993, Dec. 27, 1930; and *C.R. Sci. Soc. Polon. de Physique*, **5**, 3 ; 1931.
[2] *Comm. Leiden*, No. 170b.
[3] NATURE, **127**, 270, Feb. 21, 1931 ; and *C.R. Sci. Soc. Polon. de Physique*, **5**, 4 ; 1931.
[4] Landolt und Börnstein, "Tabellen".

The Effect of X-Rays on Hair.

IN NATURE of May 2, Messrs. Asprey and Woods, writing on the subject of the molecular weights of proteins, mention that they have recently been doing some work on the effect of X-rays on the elastic and other properties of animal hair. They state that, after exposing unstretched wool for sixty hours to the full beam of a Shearer X-ray tube, the fibres show many of the properties characteristic of wool which has been exposed in a stretched state to the action of steam. They refer the effect to the disruptive action of high-energy quanta on the length and adhesion of peptide chains, and mention that it must be closely related to the influence of various radiations on biological activity.

The accompanying photograph (Fig. 1) may be of

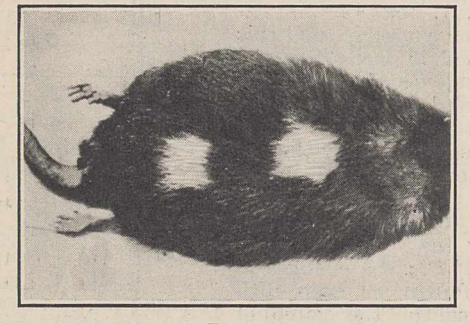

FIG. 1.

interest in this connexion, and is one which I showed a few years ago at a joint meeting of the Physical and Röntgen Societies. The photograph is of a black rat which has been exposed over two small areas of the back to X-rays generated in the region of about 150 kilovolts. Some weeks after the dose had been given, the hair fell out and the new hair which grew was devoid of pigment and considerably altered in texture, the normal straight hair of the animal being changed to a rather thinner fibre which appeared slightly curly. This result must, of course, be attributed to some action of the radiation upon the hair follicles, and the curliness of hair which regrows, once the surface has been epilated, is a not uncommon observation in children where epilation of all the hair of the head has been purposely brought about. The doses in the cases mentioned are probably many times smaller than those mentioned by the authors.

SIDNEY RUSS.

Barnato Joel Laboratories,
Middlesex Hospital,
W.1.

Stellar Structure.

BY an unaccountable slip, a numerical error crept into our recent communication[1] concerning the nuclei of planetary nebulæ. With the assumed data for a typical nucleus, it is the superficial area which is 1/43 of the sun's. With mass equal to the sun, the mean density comes out 400 gm./cm.^{3}, and with the probable mass 80 suns, as 32,000 gm./cm.^{3}. This is still high enough to justify the classification of these stars with the white dwarfs ; but degeneracy of the gas appears to be only beginning, rather than far advanced.

The suggestion that the nuclei of planetary nebulæ are of high density and comparable in physical condition to the white dwarfs was made by Prof. D. H. Menzel,[2] who gave convincing arguments in favour of his position. We regret that we did not notice this in time to mention it in our letter.

The subject has also now been dealt with by Gerasimovič.[3] It seems possible that further additions to the list of 'white' dwarfs which we gave may be made from among the *O* and *B* stars, in accordance with the suggestion of K. F. Bottlinger.[4]

HENRY NORRIS RUSSELL.
R. D'E. ATKINSON.

Princeton University,
Princeton, New Jersey,
May 25.

[1] NATURE, May 2, p. 661.
[2] *Publications Astron. Soc. Pac.*, **38**, 302 ; 1926.
[3] *The Observatory*, April.
[4] *Zeits. f. Astrophysik*, **2**, p. 153 ; 1931.

University Representation.

"UNFORTUNATELY, the case of the universities has been weakened by their own action in selecting members according to their political complexion rather than for their intellectual stature." (News and Views, NATURE, May 30.)

The abolition of plural voting will inevitably result in a decrease (which may be considerable) in the number of votes cast in university constituencies. The *Times* has represented the expected neglect of the university vote as virtual extinction. Voting will tend to be left to those whose interest in the representation of 'stature' is strongest, and the ordinary politically-minded voter with a degree may easily be in the minority.

Is there no organisation adapted to turning this situation to advantage ? The special opportunity seems to be this: The assumed majority will be compact, relatively small, and accessible. Its members, with special national needs in mind, should be prepared to excuse their representatives from attendance on those occasions when Parliament is pursuing what many of us regard as the merely political game. The universities' representatives need not, therefore, find their work unduly heavy, although it might for some time be discouragingly light.

TUDOR JONES.

University of Liverpool.

The Nomenclature of Petrology and Mining.

By Sir RICHARD REDMAYNE, K.C.B.

NOMENCLATURE in the scientific sense may best be described as a system of technical language by which the objects of any science are described, as, for example, the present language of chemical science, usually termed the modern chemical nomenclature, as distinct from the older and less perfect nomenclature. Consideration is here restricted to nomenclature in relation to petrology and mining, and to emphasising the desirability of working to secure a uniform and simple system in respect thereof, for the variety and complexity prevailing in petrological and mining nomenclature are very considerable and hampering.

A first step towards international universality of definition and name would be to secure unanimity of name, meaning, and notation nationally. Great diversity exists at present, especially in the domain of petrology — a state of disorder which is constantly increasing with the growth of terms and expressions. As demonstrating the doubtfulness or inconclusiveness which persists in petrological definition, one may take such well-known words as 'freestone', 'coal', 'lignite', and 'ore', all terms in very common use in petrological and mining literature. We find that such diversity of definition exists in regard to these as almost to amount to chaos. For example, in the county of Durham the term 'freestone' is applied to sandstone only; but in the West Riding of Yorkshire, to limestone. Albert H. Fay, of the Department of the Interior, United States of America, in his "Glossary of the Mining and Mineral Industry, 1920", describes freestone as "any stone, especially a sandstone, that may be cut freely in any direction without a tendency to split", which is perhaps as good and workable a definition as could be devised.

In considering the implication of the term 'coal' we are met with a great variety of meanings. Holmes defines coal deposits as a "general name applied to black carbonaceous deposits, derived from accumulations of vegetable debris which have been compacted by diagenesis into firm brittle rocks exhibiting a dull or shining lustre". Fay's description is not in entire agreement with this—the reason perhaps being due to a difference of definition of 'lignite'—for he defines coal as "a carbonaceous substance formed from the remains of vegetation by partial decomposition (U.S. Geol. Surv.). A solid and more or less distinctly stratified carbonaceous substance varying in colour from dark brown to black, brittle, combustible, and used as fuel; not fusible without decomposition, and very insoluble. In its formation the vegetable matter appears to have first taken the form of peat, then lignite, and finally bituminous coal. The latter by loss of bitumen has in some places been converted into anthracite or hard coal. Lignite gives a brown powder, coal a black; lignites contain a large percentage of water and ash."

Here we have an example of the danger of tacking on a description to a definition. The description, as well as the definition, bristles with debatable matter. The stages of formation as set out are by no means agreed: the fact that there is loss of volatile hydrocarbons in coal on the application of heat does not prove that these hydrocarbons exist in the coal in the form of bitumen, bitumen being composed of solid or semi-solid hydrocarbons. Some true coals, again, contain a higher percentage of ash and of moisture than some lignites.

The term 'lignite' is used very loosely. Commonly, all immature coals are called lignite. It is used to embrace not only true lignites, but brown coals also. According to Holmes, lignite is distinguished from brown coal by containing more than 20 per cent of water, but this is not so. Brown coals are known which contain considerably more than 20 per cent of moisture and some lignites which contain less than that amount. As a matter of fact, lignite is immature coal formed from wood—it is found in brown coal deposits—whereas brown coal has earthy characteristics and probably owes its origin to peat, and lignite to the trees which grew where the peat was formed. The term best applied to those so-called black lignites which approximate to true coal—and there are many of them—is that adopted by the United States Geological Survey: 'sub-bituminous' coal.

The importance of a correct definition of 'coal' from a legal point of view alone is very great. The mineral mined at Torbane Hill, in Scotland, will be remembered in this connexion. It was this mineral which Mr. Young first used, in 1856, for the extraction of paraffin oil, which gave the start to mineral oil lamps in Great Britain and was extensively exported to the United States of America. The distillation of oil from this mineral led to much litigation. The great question was whether this mineral was or was not coal. The bulk of the evidence went to prove that it was not coal but a bituminous shale or clay. However, the use of the term 'coal' was retained. The litigation was in part between Mr. Young and the distillers of oil from cannel in England and the producers of petroleum in America, and in part with the owners of the ground from which the mineral was taken.

A commonly accepted definition of 'ore' is "a metalliferous mineral of economic value", and of 'ore deposit' "a rock containing a metalliferous mineral of economic value in such amount that it can be profitably exploited". But these definitions are inadequate and unsatisfactory, for there are ores and ore deposits which, by reason of poverty of metalliferous mineral contained in them, or for other obvious reasons such as difficulty of transport, cannot be profitably exploited at the present time, but may, on the exhaustion of richer deposits and on improvement in transport, be brought

within the category of profitability. A better definition of ore would be "A metalliferous mineral of economic interest", or Crook's definition in his work on mineralogy, namely, "A metalliferous mineral which owes its economic value to the fact that it is smelted or otherwise treated to obtain a metal".

Various attempts have been made from time to time to standardise geological nomenclature, notably at the Congrès Géologique International in Paris in 1901, which, however, succeeded only in showing the wide divergence of opinion existing in that respect, and at which no final decisions were made. Holmes, in his book, "The Nomenclature of Petrology", has taken stock of the situation and recorded the existing nomenclature in accordance with its current usage in so far as Britain is concerned. The introduction to this work contains an excellent résumé of the question in relation to petrology. With regard to his statement, "at the present time the field of petrology still contains many uncultivated corners, and, until the whole has become familiar ground, existing systems of classification and nomenclature must be regarded as on probation", there must be general agreement; but there will be considerable divergence of opinion concerning his belief that "stability will be approached not principally as a result of any Committee, international or sectional, but by the co-ordinating work of a single petrological genius, whose authority, the outcome of his own success and influence, will be far superior to the merely temporary and democratic authority of a Committee". It seems to the present writer that a most useful end would be served by setting up, in the first instance, national committees with the object of securing, nationally, uniformity and simplification in naming and classification, and thereafter by an international committee, compounded of representation from the national committees, proceeding to deal with the subject internationally. Perhaps the aid of the League of Nations might, with advantage, be invoked in this connexion.

In regard to mining, except to the extent where the law has stepped in to regulate the industry and thereby brought about accuracy, clarity, and standardisation of definition, the terminology is varied, unsatisfactory, and often chaotic. For example, the simple word 'pit' is applied indiscriminately to indicate a shaft, or a colliery with two or more shafts or pits, and sometimes even to a mine worked by adits. Then, again, the word 'colliery' is used to denote one unit or a collection of units of production under the same management. In respect to these, the French nomenclature is better than ours. Another example is the diversity which exists regarding the terminology applied to a bed of coal. 'Seam' is the word used in the north of England, 'mine' in Staffordshire, and 'vein' in Wales. Then the 'floor' of a seam is termed 'pavement' in Scotland and 'thill' in Durham and Northumberland. These and many other examples show the advisability of agreeing among ourselves as to mining nomenclature before entering upon an international conclave, and that when we do discuss the subject internationally we do so in the first instance on broad and simple lines. Agreement is far more likely to be reached if we do not strain at attaining too much in the first instance. What is meant by this will be made clear by the following example.

Hitherto it has been impossible to institute proper statistical comparisons between different countries, or make correct deductions in regard to output, consumption, and value of minerals, by reason of the absence of uniformity in statistical records. It was in consequence of this that the Imperial Mineral Resources Bureau,* in the year 1924, drew up a statement of what it conceived to be the essential requirements regarding statistical returns from different parts of the British Empire. Thereafter it engaged upon the work of drafting skeleton forms in which returns should be made in order to meet requirements in the light of the criticisms which the Bureau had received. These forms were submitted to various government departments of Great Britain and the Dominions, India, and the Crown Colonies for criticism and comments, and the forms redrafted to meet the greatest common measure of agreement, being then passed to the economic statistical branch of the League of Nations.

The ultimate end sought to be reached by the Bureau was an ambitious one, namely, to obtain, in respect of each country, statistical returns as to: (*a*) production, (*b*) exports, (*c*) imports, (*d*) consumption, (*e*) value, (*f*) persons employed at mines and quarries, (*g*) accidents and health; and where possible (*h*) cost of production, (*i*) wages, (*j*) workmen's compensation. It was realised, however, that it was not possible to obtain complete and uniform statistics under all these heads.

It must be remembered that in connexion with returns of production and value, these are in many cases given voluntarily to government departments by the mine-owners. Thus, in Great Britain in the case of minerals, under the Metalliferous Mines Act the return of mineral sold is of a voluntary character, whereas in the case of coal the returns as to production and value are compulsory. The variations in respect of weight are very great even with English-speaking nations, the ton sometimes termed the long ton (2240 lb.), the short ton (2000 lb.), and the metric ton (2204·62 lb.) being in use. The Bureau suggested that within the Empire the long ton should be used, except in certain cases such as the precious metals, in which the usual practice should be followed of giving the weight in troy ounces.

The views of the Imperial Mineral Resources Bureau have been very largely accepted by the International Convention on Economic Statistics held at Geneva in 1928, which in itself must be regarded as a notable achievement; but it now remains for the several countries to implement and bring into effective operation the decision of their representatives. This has not yet been done, though more than two years have passed since the date of the Convention.

* Now the Mineral Department of the Imperial Institute.

Dietary Surveys.

SOME account was recently given in these columns (NATURE, vol. 126, p. 963; 1930) of the results of studies of human dietaries in Scotland and the United States of America. In both, it appeared that the caloric consumption was usually adequate, but that the intake of protein and minerals was frequently below the standard. In all such studies, it is usual to take as standards figures which have been obtained in earlier investigations, including experiments on metabolism; but it does not necessarily follow that these figures are applicable to people accustomed to a manner of living different from that under which they were originally obtained. Careful studies, therefore, of the actual food consumption of families in different classes of society may not only point to dietary deficiencies but also to the necessity of revising our ideas of the adequacy of a diet. This does not imply that previous investigations have given erroneous results, but merely that a different standard may be necessary when the food ordinarily preferred or available differs according to the customs of the people studied.

To increase our knowledge of the actual food consumption of the inhabitants of Great Britain, Cathcart and Murray undertook an inquiry into the diet of a number of families in St. Andrews.[1] All classes, rich and poor, were included in the study, which comprised 745 persons, or one-thirteenth of the total population. The diet of each family was obtained for a period of one week by a skilled investigator and the energy value and distribution of the calories between protein, fat, and carbohydrate, as well as the amount of money spent, determined. No attempt was made to investigate the mineral or vitamin intake, the study being confined to the quantitative rather than the qualitative aspect of nutrition. In all such work it is necessary to express the food requirements of women and children as a fraction of that of a man: the total gives the 'man' value for the family. The figures actually used were based on those given by Lusk and Atwater. At the same time, it is also necessary in a week's study to make allowances for absences from meals or the presence of guests. The 'man' value per family in this investigation was 3·37 and the 'diet man' value 3·51. The correctness or otherwise of the coefficients used for the 'man' value of women and children will be discussed later.

The average of all the figures showed a caloric consumption of 3119 per man per diem, obtained from 89 gm. protein, 119 gm. fat, and 411 gm. carbohydrate, the distribution of the calories between the proximate principles being 11 per cent from protein, 35 per cent from fat, and 54 per cent from carbohydrate. These figures agree with those obtained previously in Great Britain and the United States, but differ from those of the standard diets of Voit and Rubner in the smaller consumption of protein and the much greater intake of fat. This variation appears to be a national characteristic and has little relationship to income, occupation, social standing, or season.

Thus, when the families were grouped according to total weekly income, it was found that the caloric intake per man was greater the higher the income; the increased calories were obtained chiefly from fat and to a lesser extent from protein. The latter accounted for 11 per cent of the total in all groups, so that the low consumption of this dietary constituent appears to be due to choice and not necessity. It was also clear that the number of calories obtained per penny spent increased as the income of the family fell.

When the families were arranged according to their occupation, it was found that the sedentary worker consumed more food than the artisan. As obesity is not common among the well-to-do, the excess calories must be metabolised, probably in part by the normal metabolism and nutrition being at a higher level than in the poorer sections of the population and in part by the habit of violent exercise. Comparison of the diets of families of the same occupation showed that they varied considerably, apparently from variations in taste and appetite.

The adequacy of a family diet is reflected in the state of nutrition of the children, which was found in this study to be usually satisfactory; in fact, in the better-class families the children were above standard and only in those of the unemployed were they below. The variations from standard affected the height more than the weight, and the authors consider it probable that hereditary influences play a very considerable part in the subnormality of the children of the unemployed, as in the greater height of those of the better-class families.

One other point must be referred to: the 'man value' coefficient implies that all members of the household vary their caloric intake in accordance with the value given to the man; this is probably not correct, and the point is of considerable importance when the diet is at the lower level of adequacy. Examination of the actual food consumed by the different members of a few families showed that the man might consume 12 per cent more calories than was indicated by the 'man value' figure, made up from a 19 per cent increase in the protein and a 25 per cent increase in the fat intake; the mother, on the contrary, obtained the bulk of her calories from carbohydrate. As a result of this work, a new set of family coefficients is tentatively proposed, somewhat lower in general than those actually used in this research.

It may be of interest to refer briefly to another dietary study carried out under very different circumstances on another race.[2] The natives of Nigeria studied have a high death-rate and a low birth-rate with an almost stationary population: they are undernourished, being below the white standard in both height and weight; they show a low resistance to disease, anæmia and intestinal toxæmia are common, and epidemics take a severe toll. The staple diet consists of two cereals, guinea corn and pearl millet, with varying amounts of green leaves, fruit, partly cooked meat, sour milk,

and ground-nut oil. The diet is deficient in protein, salts, especially calcium and iron, and vitamins. Biochemical investigations showed that the blood sugar was above and the serum calcium below the generally accepted standards: the urea and chloride output in the urine were low, indicating a subnormal consumption of protein and chlorine. The protein intake was of the order of 85 gm. per diem, whereas with such biologically poor proteins as those from guinea corn and millet, at least 110-120 gm. should be considered the minimum necessary. It may be pointed out that the total amount of protein consumed by the Hausa is about the same as that taken by the population of St. Andrews; but the latter obtain their supply from both animal and vegetable sources, whereas the former utilise mainly cereal proteins of poor biological value. McCulloch makes several recommendations for improving the diet of the Hausa: more milk should be drunk and the breed of cattle improved by supplementing the deficiencies in their diet; the protein of the ground-nut should be eaten and not discarded as at present, 15-25 per cent ground-nut flour, containing not more than 5 per cent oil, being added to the ordinary flours used; the salt consumed should contain small amounts of iodine, and the consumption of green leaves should be increased. By these means, the protein, salt, and vitamin deficiencies could be overcome and the nutrition and resistance to disease of the population markedly improved, without any great interference with their present dietary habits.

[1] Medical Research Council. Special Report Series, No. 151: A Study in Nutrition; an inquiry into the diet of 154 families of St. Andrews. By E. P. Cathcart and A. M. T. Murray, assisted by Miss M. Shanks. (London: H.M. Stationery Office, 1931.) 1s. net.

[2] "An inquiry into the dietaries of the Hausas and Town Fulani of Northern Nigeria, with some observations of the effects on the national health, with recommendations arising therefrom." By Dr. W. E. McCulloch. *West African Medical Journal*, vol. 3; 1929–30.

James Clerk Maxwell, 1831–1879.

IN the history of science, names such as those of Galileo, Newton, Faraday, Darwin, Helmholtz, and Kelvin stand out like the peaks of a great range of mountains amid the surrounding lesser heights. One such name is that of Maxwell, the centenary of whose birth falls on June 13, and to whose memory homage will be paid at Cambridge in October by Profs. Einstein, Planck, Langevin, and others. Maxwell's work belongs to the third quarter of the nineteenth century, and fifty-eight years have now passed since the appearance of his "Treatise on Electricity and Magnetism", but the passing of time has shown much of his work to be of fundamental importance, and there is no investigator of physical subjects who does not owe something to him. He died at the age of forty-eight, when in the prime of life, a man loved and honoured by all who knew him, for the kindliness of his disposition and the charm of his character. Of his writings, it has been said that every one of them is stamped with the subtle and unmistakable impress of genius.

Maxwell was born in Edinburgh and was an only son. His mother died in 1839 and his father in 1856. The family name was originally Clerk, to which Maxwell had been added, thus becoming Clerk-Maxwell; but while this is the correct form, it is by the second of the names that Maxwell is generally known. Without the remarkable precocity of Young or Rowan Hamilton, Maxwell showed the possession of unusual powers at an early age, and as a schoolboy attending Edinburgh Academy he wrote a paper on oval curves. At the age of sixteen he entered the University of Edinburgh, being taught mathematics by Kelland, physics by J. D. Forbes, and logic by Sir William Hamilton. Three years later he left Edinburgh for Cambridge, where, after a term spent at Peterhouse, he entered Trinity College, having Hopkins as tutor. In 1854 he graduated as second wrangler and Smith's prize-man, Routh being senior wrangler and tying with him for the Smith's Prize. In October the following year, Maxwell was made a fellow of Trinity College, and in December published his first paper, on "Faraday's Lines of Force", a subject which was to engross much of his attention for the rest of his life.

From Cambridge, Maxwell went first to Marischal College, Aberdeen, and then to King's College, London, holding in both institutions the chair of natural philosophy. Four years were spent in Aberdeen and five in London, and to those years belong his memoirs on colours and colour-blindness, on the dynamical theory of gases, on the motion of Saturn's rings, and also his classic paper on a "Dynamical Theory of the Electromagnetic Field", read to the Royal Society on Dec. 8, 1864. It was this paper to which the attention of Hertz was called by Helmholtz, just when Hertz was on the threshold of his fruitful investigations of electro-magnetic waves.

From London, in 1865, Maxwell, who had suffered from serious illness, retired to his estate in Dumfriesshire—only, however, at the end of about five years to become the first professor of experimental physics at Cambridge. His inaugural lecture was delivered on Oct. 25, 1871, and on June 16, 1874, the now famous Cavendish Laboratory, erected by the seventh Duke of Devonshire, then Chancellor of the University, was opened. Maxwell's great "Treatise on Electricity and Magnetism", "one of the most splendid monuments ever raised by the genius of a single individual", was published in 1873; in 1878 he delivered the Rede Lecture, and just before his death, which occurred at Cambridge on Nov. 5, 1879, he had completed the editing of the electrical researches of his great forerunner, Henry Cavendish. "The Life of Maxwell", by Campbell and Garnett, appeared in 1882, his "Scientific Papers", edited by Niven, in 1890; and in 1896, Sir Richard Glazebrook published his book "Clerk-Maxwell and Modern Physics". To Sir Richard Glazebrook we also owe the account of Maxwell in the "Dictionary of National Biography".

Obituary.

PROF. RAOUL GAUTIER.

SCIENCE has lost a distinguished member, and English geodesists and astronomers a friend, in Raoul Gautier, who died on April 19, at Geneva.

Raoul Gautier came of a family which has served Swiss and international science for many years. We find Jean Gautier, for example, professor of philosophy and physics at the University of Geneva in the beginning of the eighteenth century. An account of his observation of the eclipse of the sun in 1706 appears in *Philosophical Transactions* (vol. 25, No. 306, pp. 2241-2246). In the early years of the nineteenth century another Gautier, Jean Alfred, was beginning to make his name as an astronomer. To him is due the present Geneva Observatory, built in 1830, although Arago seems to have shared to some extent the responsibility for it, in so far as his comments on the previous observatory did not lack candour. In 1842, Émile Gautier was collaborating with Airy in the observation of another eclipse. We hear of Émile in London, Oxford, and Cambridge. He is not, perhaps, the only one who records a disinclination " pour parler d'affaires " after an excellent lunch in Trinity. In 1883, after a truly international training, he took charge of the Observatory, and he is, perhaps, as well known as a meteorologist as an astronomer. A point which impressed his countrymen, as well as his foreign colleagues, was that humanity and helpful understanding which stood both himself and his wife in such good stead during his term of office.

Raoul, their son, was born in 1854. His education was singularly complete on the physical as well as on the mental side. He travelled early, learnt English and German when young, and studied the classics, as well as mathematics, anatomy, and zoology. He was a fencer, a mountaineer, and a horseman. He became a man of the world with a singular charm of manner, at the same time as he laid the foundation of his scientific career. When master of arts, he took up the family tradition of astronomy.

Five years at Leipzig, education and friendship from Bruhns, Frederic Zoellner, Neumann, and other mathematicians, a visit to Uppsala, where Struve presided over a meeting of the Astronomische Gesellschaft, and where he met Gylden, Schönfeld, and Backlund, began to polish the expert. Gautier's first essay in journalism was a report for the *Journal de Genève* on this Uppsala meeting. His next undertaking was a study of planetary orbits (an inherited taste), and it was certainly a 'gros travail' to observe, to compute, and to analyse the facts that led to the publication of " La Comète périodique de Tempel 1867 II, étude consacrée spécialement aux apparitions de 1873 et de 1879 ".

This planet was not altogether a happy one for Gautier. The strain of calculation brought him his doctor's degree, but cost him two years of enforced rest. In 1885, we find him once more engaged in wrestling with the considerable influence of Jupiter's neighbourhood upon the same planet. *Astronomische Nachrichten*, the *Comptes rendus*, and *Archives des Sciences physiques et naturelles* contain the results of his labours on the hoped-for reappearances of 1892, 1898, and 1905. Unfortunately, the planet did not reappear.

In the 'eighties, Gautier frequently visited the Neuchatel Observatory to work with its director, Hirsch. In 1887, Gautier secured his doctor's degree in mathematical science. At thirty-three years of age, with three children, and three branches of mathematical science in which to qualify, Gautier confessed to a lack of that elasticity one expects of twenty, but he secured his degree, and in 1889 succeeded to the chair of astronomy and the directorship of the Geneva Observatory. In 1885, he was given the chair of physical geography, re-established in that year after a period of eclipse. We find him more interested perhaps in meteorology and oceanography than in morphology. At this time, Gautier was professor at the University, secretary of the faculty of science, and secretary of the senate. He was Vice-Rector of the University from 1916 until 1918, and Rector from 1918 until 1920.

An evidence of Gautier's activities in the 'nineties is contained in " Le Service chronométrique à l'Observatoire de Genève et les concours de Genève avec une étude des épreuves instituées dans d'autres observatoires ". This side of his work has found recent expression in the new Salle des Chronomètres (1924).

In 1900, Gautier observed the eclipse in Algeria, and in 1905 was with Sir Norman Lockyer in Majorca, where they had the mortification of finding bad weather whilst Algeria remained clear and fine. In 1908, important spectroscopic observations on Morehouse's comet, and in 1909–10 Halley's comet, must have brought him back, with satisfaction, to his first love, whilst Nova Persei, Nova Aquilæ, and Nova Cygni he found " fort intéressantes ".

As a meteorologist, Gautier began to install new apparatus in the Geneva Observatory in 1897. For many years he was engaged in the study and comparison of meteorological observations, prior to 1926, made in the vicinity of Geneva. 1912 was almost wholly devoted to this end, and his results —not, unfortunately, final—are given in *Archives*, vols. 31 and 32. His interest in meteorological observation at the Great St. Bernard (where he installed a Fuess barometer in 1903) and his arrangements for pilot balloon observation will not be forgotten, nor will his services in the creation of the observatory at the Jungfraujoch. In this latter enterprise he was able to count upon the generosity of fellow-townsmen, who knew how to appreciate his services and contribute to his undertakings. Gautier must have felt his retirement in 1928, but he was confident in his successor, and glad, in a measure, to relax the strain. His public services had been great. He was consecutively member, secretary, and head of the Swiss Geodetic Commission. An active member of the old International Geodetic Association, he worked with Ferrero, Bakhuysen,

Arrillaga, and Helmert. Copenhagen, Budapest, London, and Cambridge saw him at their meetings. It was at the London Conference of 1909 that he first became well known to British geodesists. Those of us who recall that Conference, at which Baron Eötvös also first made himself generally known, look back with regret on his manly figure and peculiar charm. During the War, he acted as president of that geodetic association of neutral countries which helped to keep international enterprise alive. In 1920, he was chosen to represent his country on the International Geodetic and Geophysical Union. We met him at Rome, at Madrid, and at Prague, and the memory we shall retain of him is that of a courteous, statesman-like gentleman whose ripe judgment and unfailing interest were of quite exceptional value to the Union.

Gautier was elected vice-president of the Geodetic Section of the Union in 1922. He was president of the Swiss National Committee for Geodesy and Geophysics; president of the federal meteorological committee, and a member of the international committee of weights and measures. It does not surprise one that he was also the chief engineer of the 1st Corps of the Swiss Army. We bid good-bye, then, to as versatile a man as modern science can show, and to one whose peculiar social and administrative gifts were of the greatest help in any international gathering.

Dr. Frederick Muir.

In the death of Dr. F. Muir, which occurred on May 13, entomology loses one of its keenest and most experienced devotees. Born in 1872, Frederick A. G. Muir served in his early life with the Eastern Telegraph Company and was stationed during different times at various localities on the eastern shores of Africa and also at Aden.

Being an ardent entomologist from boyhood, Muir's tropical experience broadened and intensified his great natural ability as a student of insect life. It was while he was still in the telegraph service that he first came into touch with the late Dr. David Sharp. In 1905 it was through Dr. Sharp's influence that Muir adopted entomology as a profession and joined the scientific staff of the Hawaiian Sugar Planters' Association in Honolulu. The worst troubles of the sugar-cane growers in the Hawaiian Islands were imported insect pests, and it fell to Muir to explore many lands in order to discover the native countries of these pests, with the object of investigating their indigenous enemies. In this work Muir made repeated and often extremely arduous journeys to such lands as Japan, China, the Philippines, Formosa, the East Indies, Queensland, and other parts.

Few naturalists of recent years have had the same intimate knowledge of the Malay Archipelago as Muir. His duties took him on more than one occasion to Java, New Guinea, Amboina, Ceram, and other of the islands, where he had to face hardship and sickness, and to work under improvised conditions of the most primitive kind. Muir fortunately lived to see the results of his work on biological control bear abundant fruit. The predaceous Capsid-bug *Cyrtorhinus mundulus* discovered by him in Fiji and Australia in 1919 was the agent which finally achieved complete economic control over the sugar-cane leafhopper. His work on the Tachinid fly, *Ceromasia sphenophori*, which, after much journeying, he eventually obtained in New Guinea, has been the major factor in the subjugation of the cane borer weevil. Perhaps his most striking success in the field of biological control was his introduction of the solitary wasp *Scolia maniliæ* from the Philippines into the Hawaiian Islands, in 1916, where it achieved, in a remarkably short time, a high degree of control over the *Anomala* beetle.

Muir's pioneer work in the field of biological control has had an enormous influence over the prosperity of the Hawaiian Islands, where his name is very widely known. His interest in entomology, however, covered almost all fields of the subject. On the taxonomic side he became the recognised authority on the difficult group of the Fulgoroidea. His skill in minute dissection led him to explore various aspects of morphology, and his fundamental study, in conjunction with Dr. David Sharp, on the genitalia of Coleoptera is a standard monograph. In his travels Muir had little opportunity to publish, and his many papers were mostly written during periods at headquarters or while on leave. In the few years of his retirement at Warnham, in Sussex, he took full advantage of the opportunity for unfettered research. Severe illnesses, however, incapacitated him for much of the time, but his optimism led him to plan work for the future. Long subjection to tropical conditions unquestionably sowed the seed of illnesses that led to his premature death. One of the last published contributions from his pen was in the form of a letter, dated May 11, entitled "Disease in Nature", which appeared in these columns so recently as May 23.

At the time of his death, Muir was still a member of the scientific staff of the Hawaiian Sugar Planters' Association, his services being retained in a consultative capacity. In 1918 he married Miss Margaret Anne Sharp, third daughter of Dr. David Sharp, and leaves one son. A few years ago he received the honorary degree of D.Sc. from the University of Hawaii, and in 1930–31 he was a member of the council of the Entomological Society of London, being a vice-president for the year 1930.

A. D. I.

We regret to announce the following deaths:

Prof. I. P. Church, emeritus professor of civil engineering at Cornell University, on May 7, aged eighty years.

Prof. Louis Dollo, professor of geography and animal palæontology in the University of Brussels and curator of the Royal Museum of Natural History, on April 19, aged seventy-four years.

Mr. T. T. Gray, president of the Gray Laboratories of Newark, New Jersey, known for his work in petroleum technology, on April 27, aged forty-nine years.

Mr. C. T. Heycock, F.R.S., Goldsmiths' reader in metallurgy in the University of Cambridge and Prime Warden of the Goldsmiths' Company in 1922, on June 3, aged seventy-two years.

News and Views.

DR. C. DAVISON, author of "A History of British Earthquakes" and other important works on seismology, writes: "With the reports of the first day only before us, it is difficult to give a satisfactory account of the greatest earthquake that is known to have disturbed Great Britain, on June 7. It is clear from them, however, that the earthquake was not of British origin, and it is fortunate indeed that the epicentre of so strong a shock lay far out in the North Sea. For the exact position of the centre or of the region from which the first vibrations proceeded, we must rely almost entirely on seismographic evidence. Some slight damage, such as the fracture or overthrow of a few chimney-stacks, occurred at several places in the east of Yorkshire, such as Filey, Bridlington, Beverley, and Hull; at a few in the north of Norfolk, such as Wighton (near Wells), Cromer, and Sheringham. With materials so scanty, it is impossible to fix the epicentre with precision, but it may lie about lat. 54° N., long. 2¼° E., or about 115 miles east of Hornsea in Lincolnshire."

"THE area over which the shock was felt includes quite half of Scotland from Elgin on the north, the Isle of Man, the whole of Wales with the exception perhaps of Pembrokeshire and Carmarthenshire, and all England but Cornwall, Devon, and part of Somerset. In France it was observed at Cherbourg, near Lille, and at Calais and Dunkirk; in Belgium, at Brussels and Ostend; in Holland, at the Hague, Haarlem, and Amsterdam; and in the south of Norway. Thus, the disturbed area can scarcely have been less than 760 miles long from north to south and 480 miles wide, or have contained less than 280,000 sq. miles, that is, more than twice as much as that of any known British earthquake."

IT was a happy thought that the rectorial address of Sir Arthur Keith to the students of Aberdeen, delivered on June 6, should have been associated with the celebrations connected with the 500th anniversary of the birth of Bishop Elphinstone, the founder of the University. Sir Arthur took as the subject of his discourse "The Place of Prejudice in Modern Civilisation". He illustrated the significance of the opposing and yet overlapping mental characteristics generally spoken of as 'mind' and 'heart', the latter resident in the basal centres of the brain; the appetites and desires, the zest for life, unreasoned likes and dislikes—in a word, our prejudices. These prejudices, local and national, are traceable to the prehistoric world, where the tribal sense was Nature's way of ensuring an isolation in which new traits could be developed. They are an integral part of human nature: the strength of nations which have not permitted the heart to overrule the head. To ignore these prejudices is impossible, to root them out is to sacrifice a natural birthright. So the universal brotherhood of man is seen to be as impossible of attainment, and even as undesirable, as the Determinism which, given a free hand, would make Europe again a vast conglomeration of warring tribal states. Both reason and prejudice must be allowed a place in national policy; but the place of prejudice in modern civilisation should be that of servant, not of master.

DR. WHIPPLE, of Kew Observatory, was among those Londoners who saw a great arc of light in the north-eastern sky late on the evening of June 4, and he has kindly furnished some notes on the phenomenon as seen from Chiswick. The curvature of the arc was very slight, but was unmistakable when it was viewed against a straight edge. Its general appearance was like that of a rainbow, but without the colours of the ordinary rainbow. Had the sun or moon been present in the sky, the phenomenon would at first have been regarded as one of the many forms of solar or lunar halo, but its movement during the time that Dr. Whipple observed it was sufficient to show that this was no halo. At 10.30 P.M. (21 h. 30 m. G.M.T.) it reached above the star Vega, but by 10.43 P.M. was 11° below that star at its highest point. At 10.56 P.M. it passed through alpha Cygni; at 11.4 P.M., just before low clouds hid it from view, 9° lower. The breadth of the arc was about 2°, that is to say, about four times the diameter of the sun or moon.

ACCORDING to information published in the *Daily Weather Report* of the Meteorological Office, Air Ministry, there was some cirrus cloud earlier in the evening moving from about south-west. Measurements of upper air temperature made at South Farnborough showed that conditions aloft were warmer than is normally the case even two months later, when the troposphere is generally at its warmest. This warmth might have been expected, from the fact that a deep depression had been nearly stationary to the south-west of Ireland for several days, causing northward movement of tropical air in front of it. The progressive retreat of the arc towards the north-east horizon is consistent with the idea that the arc may have been some abnormal development of the cirrus clouds which were drifting in that direction. Such a cloud might mark the boundary of air currents of different origin, probably, in the circumstances, both drawn from lower latitudes. If anyone is able to furnish an account of observations similar to those made by Dr. Whipple, but at some distance from London, it might be possible to determine the height of the arc, which would probably be from four to six miles, if it was formed of cirrus cloud.

PRESIDENT KARL T. COMPTON of the Massachusetts Institute of Technology has been awarded the Rumford Medal of the American Academy of Arts and Sciences. The award is made in recognition of Dr. Compton's contributions in the field of thermionics, the study of electron emission from hot filaments and cathodes, and in spectroscopics, the study of matter by means of light waves. Formal presentation of the medal will be made at the meeting of the Academy next autumn. Dr. Compton is the thirty-sixth

recipient of the Rumford Medal; his brother, Dr. Arthur H. Compton, was awarded the medal in 1927. The Rumford Fund of the American Academy of Arts and Sciences was established in 1796 by Benjamin Thompson, the great physicist, who was a native of Massachusetts, and later became Count Rumford of Bavaria. He was the founder of the Royal Institution. The Rumford Medal is awarded to authors of the most important discoveries or useful improvements in light and heat, in any part of North America or in the American islands.

IT is with pleasure that we offer our congratulations to Sir Oliver Lodge, who attained his eightieth birthday on June 12. In doing so, we identify ourselves with the good wishes of the whole scientific world, since, during the last sixty years, Sir Oliver has not only built up for himself an international reputation for original conceptions and research in physical science but also as a brilliant expositor of scientific facts and principles. His work has been recognised in a number of honours which have been conferred upon him by universities and other learned bodies. In 1898, he was awarded the Rumford Medal of the Royal Society, in recognition of his researches on radiation and on the relations between matter and ether. The discovery of electro-magnetic radiation by Hertz was contemporaneous with the work carried out by Sir Oliver Lodge on the surging or oscillatory character of the transmission of electric discharges along wires. He did much to make known in Great Britain the brilliant achievement of Hertz, and added much to our knowledge of the subject by his own investigations.

FOLLOWING this epoch-making work, Sir Oliver Lodge engaged himself with an investigation of the phenomena presented by Röntgen rays and the circumstances under which these rays are produced. With these fundamental observations, he has carried on, for several decades, his contributions to our knowledge of radiations in ether, and also made suggestive speculations as to the properties of the ether itself. The work of Sir Oliver on radiation, matter, and ether and its correlation with the works of such well-known contemporary workers as Hertz, Michelson, and Morley is too familiar to call for any emphasis at present. His researches into psychical phenomena began at a slightly more recent date. The spiritual world which Sir Oliver considers to interact with the material, yet is not of it, has claimed his attention for a considerable time. His stimulating address before the British Association in the Manchester College Chapel at Oxford in 1926 emphasised the necessity for a more scientific examination of these 'phantom walls' between the two worlds. His exposition of his own views on efforts to find a place for life and mind beyond the world of physics, his fair discussions of the views of others, and his attractive methods for presenting his material, both in writing and in speech, have succeeded in giving him an exclusive place in the scientific world.

THE Royal Research Ship *Discovery II.* reached London on June 5, after a commission in the South Atlantic and Antarctic which lasted about eighteen months. The scientific work accomplished includes extensive observations on the biological and hydrological conditions in the southern whaling areas and generally in the South Atlantic. In each of the two seasons spent in the south, an intensive survey has been made of the South Georgia grounds, with other observations covering the whole of the Dependencies of the Falkland Islands, and the value of the results has been enhanced by the fact that these two seasons have differed very widely in respect of ice conditions. Sectional lines providing very full data on both plankton and hydrology have been run between the Cape of Good Hope and the ice-edge, and from the South Sandwich Islands to lat. 15° N.; while the ice-edge, a favourite resort of the whalers, has been examined almost continuously from Bouvet Island in the east to lat. 101° W., a distance of about 2600 miles. The *Discovery II.* has also carried out coastal surveys of the South Sandwich Islands, Bouvet Islands, and parts of the South Shetland Islands and South Georgia. Good results have been obtained with the Admiralty pattern of echo-sounding apparatus, with which many thousands of deep-water soundings have been taken. The work is controlled by the *Discovery* Committee, appointed by the Secretary of State for the Colonies. It has been carried out under the direction of Dr. S. Kemp, with Comm. W. M. Carey, R.N. (retd.), in executive command.

BY television is meant the transmission to a distant station by electrical means of moving scenes, which are viewed at the station practically simultaneously with their original occurrence. Although it has been talked about for nearly fifty years, it is only six years ago since Mr. J. L. Baird proved that it was practical. Since then rapid progress has been made notwithstanding the great difficulties that had to be overcome. Quite recently, screens have been shown in the theatre, and the audience has seen and heard people at a great distance away addressing them. From the commercial point of view a great step will be made in advance if people can see sporting events—races, football, cricket and tennis matches, ceremonial processions, etc.—on the apparatus in their own rooms and hear also an expert announcer describing them. We learn from the *Times* of June 4 that the Baird Television Company, in co-operation with the B.B.C., broadcast a television transmission of scenes from the Derby. It included the parade of horses before the start and the scene at the winning-post during the race. This is the first attempt in Great Britain or any other country to secure a television transmission of a topical event held in the open air, where artificial lighting is impossible. The engineers considered that the transmission was a success, and, more important still, they considered that it was quite possible that the outstanding interference difficulty with other transmissions could be overcome. As the art of television has had to overcome many difficulties, including the apathy of electricians, we are glad that real progress is at last being made.

JAMES CLERK MAXWELL was born on June 13, 1813. The celebrations of his centenary are to be held in

Cambridge on Oct. 1 and 2 of this year, following the Faraday celebration and the centenary meeting of the British Association in London. Delegates have now been nominated by the principal academies of the world and by the home universities; it is expected that about one hundred and fifty delegates will be present. The celebrations will open with a ceremony in the Senate House, when the delegates will be welcomed and a memorial lecture delivered by the Master of Trinity. Receptions will be given later at Peterhouse and St. John's College. On Oct. 2 addresses will be given by Prof. M. Planck, Sir Joseph Larmor, and Prof. P. Langevin. There will be a luncheon in Corpus Christi College, and, in the afternoon, addresses by Sir James Jeans and by contemporaries of Maxwell and a display of Maxwell apparatus and manuscripts in the Cavendish Laboratory. The celebrations will conclude with a banquet in Trinity College. Hospitality for delegates and guests of the University is being provided by the Colleges. The University Press will publish a Maxwell Commemoration Volume, containing the addresses given at the celebration, with a contribution from Prof. Einstein. The Dean and Chapter of Westminster Abbey have given permission for a memorial tablet to Maxwell to be placed in the Abbey. It is hoped that a tablet to Faraday will be placed at the same time, and that the two will lie together by Newton's tomb.

THE issue by the British Association of a catalogue of the objects in the Memorial Rooms of Down House, Darwin's home at Farnborough, where he lived and worked for almost forty years, will be widely appreciated in view of the approaching centenary meeting of the Association in London. Doubtless many of those who attend the meeting, especially from overseas, will be glad to avail themselves of the opportunity to visit this interesting and impressive memorial of "one of the greatest men of all time". Mr. Buxton Browne, the curator and generous donor of Down House to the British Association, "to be held in custody for the nation", has restored the Memorial Rooms as nearly as possible to the state in which they were when Darwin lived there. Much of the furniture is original, and, thanks to the generous assistance of members of the Darwin family and admirers of Darwin, the pictures and other objects and the articles which Darwin had in daily use are here in what was formerly their accustomed place. Among the latest acquisitions are selections from the letters (in facsimile) from Darwin to Fritz Müller, the German naturalist, who was Darwin's correspondent in Brazil between 1865 and 1882. These letters were acquired in 1929 by Prof. H. Fairfield Osborn, of the American Museum of Natural History, New York. Prof. A. C. Seward, professor of botany in the University of Cambridge, has recently expressed his intention of placing on loan at Down House the major part of the Darwin Library, which was bequeathed by Sir Francis Darwin to the professor of botany in the University for the time being. The catalogue, which has been prepared by Mr. Buxton Browne and the secretary of the British Association, gives brief historical and descriptive notes on the house and grounds, and is illustrated. Its price is sixpence.

THE subject for the Friday evening discourse at the Royal Institution on June 5, by Prof. E. W. MacBride, was "Habit—the Driving Force in Evolution". Prof. MacBride stated that evolution means the gradual growth of one species of animal into another. All the available evidence shows that it has been an exceedingly slow process; and our knowledge of its actual course must be based on indirect evidence, for the amount of evolution observable during the span of a human life is infinitesimal. There are only three reliable guides to evolution, namely: (*a*) the relation to one another of local races within the species; (*b*) so-called lineage series of fossils where change in the same animal is observed as we ascend through a series of beds in the same locality; (*c*) the life histories of individuals. All three classes of evidence when analysed yield the same result, that the individual steps in evolution are correlated with and caused by changes of habit: the life history of the individual in its original form is seen to consist of superposed memories of a series of different habits. That animals forced to live under different conditions and to accept different food from that to which they are accustomed acquire new habits and that these habits once formed are in some measure passed on to their descendants, has been proved by the experiments of Duckham on the white butterfly, by those of Heslop Harrison on the gall fly, and by those of Nuttall on the louse. When by constant repetition a habit becomes deeply engrained in the hereditary constitution, the structure becomes permanently modified, because all structure is due to growth and habit affects growth. It is suggested that as new habits imply the reaction not of a single organ but of the animal as a whole to a new situation, this reaction causes the deposit of some substance in all the nuclei of the body, including the nuclei of the germ-cells. When the germ-cell nuclei become active from the new animal, this deposit is emitted at the proper period of development and affects growth and, through growth, structure.

IN connexion with the International Colonial Exhibition which is being held this year in Paris and was recently opened by the President of the Republic, a Congrès International du Bois et de la Sylviculture is to be held on July 1–5. During this period there will be a day's excursion to Havre, and various receptions and so forth. On July 6, a seven days' excursion will be begun, to visit some of the finest alpine forests in Savoie, Dauphiné, and Provence. The work in Paris will be undertaken in morning and afternoon sessions of the several groups into which the Congress will be divided. The aim of the Congress is to collect together all those who are in any way, either as owners, forest workers (State forest officers and others similarly employed), or commercial individuals, interested in the management of forests or in utilising forest produce; at one or other of the sections it will be possible to study economic, technical, industrial, and commercial questions which affect

forest management; as also international conventions which may assist in the better distribution of forest produce, in standardisation, and so forth. The Congress will consist of French and foreign members and associate members. Members may submit papers to be read and discussed at the Congress. The French language will be the only one used at the sessions, and reports will be published in that language only. The Congress is organised by the Touring-Club de France, under the auspices of the Directors-General of Forests and Technical Education, l'Institut des Recherches Agronomiques, le Comité national des Bois Coloniaux, and the Timber Group of la Confédération Générale de la Production Française. All communications on the subject of the Congress should be addressed to Conservateur des Eaux et Forêts, Secrétaire Général du Comité Exécutif, Touring-Club de France, 65 Avenue de la Grande-Armée, Paris (16e).

A COMMUNICATION from the U.S. Bureau of Standards, which appeared in the *Journal* of the Franklin Institute for May, on the liquefaction of helium, is of general interest. On April 3, helium was liquefied in the Bureau's laboratory at a temperature of −271·2° C., and this temperature was maintained for two hours. It is only 1·9° C. above the absolute zero. It will be recalled that the late Prof. H. Kamerlingh after liquefying helium, reached a temperature of 0·9° A. (NATURE, Mar. 6, 1926, p. 350). Helium has been liquefied previously in the Universities of Leyden, Toronto, and Berlin. It has also been liquefied at the Reichsanstalt. The temperature of liquid helium at atmospheric pressure is −269° C., but it was cooled further by reducing the pressure of the helium vapours over the boiling liquid by means of a vacuum pump. The liquefier used is very similar to that designed by Dr. M. Ruhemann, of Berlin. The helium is first purified and placed in a metal container and surrounded with liquid air at −190° C. The helium, after being cooled by liquid hydrogen to −253° C., expands through a valve from a high pressure to a low pressure. The amount of refrigeration is so small that the success of the apparatus depends on obtaining almost perfect thermal insulation. The vapour pressure of the helium was determined, and hence its temperature was computed by a formula. As further evidence, lead and tin electrical resistances were placed in the helium. When the helium was liquid, both the metals lost their resistivity and became supra-conducting. It is interesting to remember that although tin, lead, mercury, and a number of other metallic elements and alloys become perfect conductors at these low temperatures, metals like gold, silver, and copper, which at ordinary temperatures are the best conductors, do not become supra-conducting. Many of the metals which at ordinary temperatures are poor conductors of electricity, at liquid helium temperatures become almost infinitely better conductors than gold, silver, and copper.

THE liberation of eighty-eight specimens of the Mandarin duck (*Aex galericulata*) on various London waters last year is worthy of note, as the bird is not only one of the most remarkable of wild-fowl, but one of what may be called the world's most sensational birds; and the specimens in question were only wing-clipped, not pinioned, so that they have long ago, having moulted, regained the power of flight. It is only in the case of wild-fowl thus treated that the life-history of such birds can be really studied, for they are so much persecuted everywhere that on park waters alone can they be readily observed in most cases, while pinioned birds must always be inferior in some respect to intact specimens. That they are often constitutionally impaired is shown by the fact that the Mandarin drake often fails to grow the characteristic and unique fan-feather in the mutilated wing; while, as the species perches freely and nests in holes in trees, it cannot carry out its natural activities when deprived of flight. Full-winged birds have been living and breeding for years past on several private estates, and the species is probably now established as a British bird, although seldom noticed; its semi-nocturnal habits, and the fact that the showy male exhibits none of its decorations when in flight, would cause it readily to be overlooked—even pinioned birds in an enclosure cannot always be seen when looked for, if there be any cover available. Up to Christmas of last year, a sufficient number had been seen to account for about half the total liberated; all had been ringed, and at least one has been reported this year as shot in Hungary, but most will no doubt settle down and breed in England somewhere or other.

THE Zoological Gardens at Regent's Park are just now rich in ancestral and unique types of animal life. Of particular interest is the exhibition of all the genera of dipnoan fishes, *Lepidosiren*, *Protopterus*, and *Neoceratodus*, and of the two aglossal anuran amphibians, *Dactylethra* and *Pipa*. Among the mammals are to be noted especially the Anoa or pigmy antelope-buffalo of Celebes, which looks much more like a large bush-buck than an ox, but, curiously enough, exhales in its breath the characteristic sweet odour of cattle. This interesting species bred last year, and the calf is still to be seen; the pigmy hippopotamus has also bred recently. The new bird-house holds a particularly fine series of the family of barbets, little-known birds which so perfectly connect woodpeckers and toucans that they are no doubt ancestral to both. Of nearly a dozen species on view, the Asiatic *Megalæma virens* and its subspecies *marshallorum* strikingly recall in size of body and beak the smallest-billed toucan, *Selenidera maculirostris*; *Chotorhea mystacophanes*, also Oriental, has a bill very like a woodpecker's, while the Abyssinian *Trachyphonus margaritatus* is so exceedingly unspecialised that it looks more like a small jay than anything else, and might well represent the ancestor of the triple woodpecker-barbet-toucan alliance. Even more interesting is the Australian semipalmated goose *Anseranas*, which would have been better named *Anseribis*, for its feet, bare above the heel-joint, scarcely half-webbed, and provided with a long low-placed hind toe, are those of an ibis, not of a goose; moreover, its plumage is not waterproof, it does not moult all its quills at once like other *Anatidæ*, and, as the specimens in the Waders' Aviary in the Gardens show, is more ready to wade

than to swim. It forms a most interesting contrast with the very specialised terrestrial goose *Cereopsis*, also Australian, and to be seen close by, along with our familiar grey-lag.

OUR notice regarding the law relating to treasure-trove (NATURE, April 25, p. 647) has led a Scottish correspondent to point out that treasure found in Scotland must be offered, not to the British Museum, but through the agency of the King's and Lord Treasurer's Remembrancer to the National Museum of Antiquities in Edinburgh. That is, indeed, so. Our main object, however, in publishing the notice, was to keep the proper balance between finders, who are often scientific excavators, and the museums. So far as we know, the law defining treasure-trove is the same for Scotland as for England: that is to say, treasure-trove can consist only of objects of gold or silver; so that any attempt on the part of museum authorities to compel, by threat, the ceding of other sorts of objects, on the pretence that they are treasure-trove, would appear to be quite unjustifiable.

ON more than one occasion we have commented upon the possibility of damage to agriculture which may be caused by the escape and spread of imported musk-rats in Great Britain. We note with interest, therefore, that the Ministry of Agriculture and Fisheries has issued a notice requesting that any persons now keeping and breeding musk-rats in England and Wales—whether for stock or pelts—would communicate at once with the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, stating the number of musk-rats kept. Since the chief interest of the Ministry must be the protection of the farmer, it may seem a little disingenuous to request from the musk-rat breeders the evidence which may be used against them, under the plea that the Ministry is "anxious to obtain as full information as possible on the extent to which the musk-rat (or musquash) farming industry is established in England and Wales".

THE Association of British Zoologists discussed at its general meeting the question of the payment of fees to zoologists for expert advice. It is well known, as Prof. E. B. Poulton says in a letter to us on behalf of the Council of the Association, that a somewhat unscrupulous public takes for granted the good nature [and affluence!] of zoologists in requesting their professional help without offering payment in return. Whether it be a matter of the identification of a species or the delivering of a popular lecture, both demand the expenditure of time and energy, which the expert could have devoted profitably to his own purposes. The Council's proposal is that, in the interests of their science, zoologists should demand fees for the work of identifying specimens and giving lectures. They say that such a demand would enhance the respect felt for the science, just as medical advice tends to be valued according to the size of the fee. We are not quite sure of this; there is a great difference between the urge of the man going to the best physician to have his own health established, and that of the man inquiring about an unknown insect. Insistence upon fees, at least in trivial cases, such as the annually reiterated identification of *Sirex gigas*, would simply drive the sender to drop the subject, and a promising helper might thus be lost. In the case of technical advice accompanied by identifications and in the case of lectures to outside bodies, fees might well be insisted upon. Since the difficulty largely arises from the unwillingness of zoologists to be looked upon as mercenary, the Association would be making things easier for individuals if it were to print slips bearing a standard rate or rates of fees for advice and lectures, an impersonal hint which might be included with replies to importuners.

SUGGESTIONS have recently been put forward that, so far as can be seen from photographs of the airship *R101* wreckage, certain of the lower members were crumpled as if by a compressive load, and that the cause of this was excessive bending due to the tail load arising from the maximum up position of the elevator. From this it is inferred that elevators at the bows would be preferable. This comment is unjustified, in that the findings of the Court were that the methods of stressing the structure were fundamentally correct, and that their application to this particular design had been amply confirmed by tests upon experimental sections, built especially for test purposes. It is impossible to conceive that the possibility of having to use the maximum control moment had not been foreseen by the designers, and also the independent airworthiness panel. Conditions producing compression in the lower members might easily have arisen at the instant of striking the ground at a shallow downward angle. The forward movement of the nose would be arrested while the momentum would carry the tail end onwards. The principal objection to placing the elevators in the bows is that the disturbance of the air flow along the body would increase the resistance and interfere with the stability. The effects of either of these might easily be so great as to make the ship a practicable impossibility.

REFERENCE was made in NATURE of May 9, p. 717, to the issue of the *Power and Fuel Bulletin* by the British National Committee of the World Power Conference. Further issues of the *Bulletin* have since been received, and the publication of these abstracts directs attention to an important question, namely, the rationalisation of abstracting. Too many organisations are engaged in the abstracting of narrow fields of scientific and technical literature. The constituent bodies responsible for this *Bulletin* in pooling resources have set an example which should receive consideration by others. Whether the present production will satisfy everyone is, however, open to question. The documentation by nations has certain advantages, but in this *Bulletin* it leads to the inclusion of material published in trade papers as scarcely veiled advertising matter. This applies particularly to engineering plant, and the mere mention of such papers is doubtless sufficient. The *Bulletin* is mainly concerned with engineering literature, and those responsible seem at times to deal with original research in the same manner. Divergent views may be held as to what constitutes an abstract. Should it be merely a table of contents, or should it be an attempt to give an idea

as to what the author claims to have done clearly and briefly, stripped of every superfluous word? In this *Bulletin* the first view seems to find favour, with results not always satisfactory.

IT is announced in *Science* that Sir James Jeans has been given the honorary degree of doctor of laws by the Johns Hopkins University, Baltimore.

THE Albert Medal of the Royal Society of Arts for 1931 has been awarded by the Council to H.R.H. the Duke of Connaught, K.G., "in grateful appreciation of his Presidency of the Society since 1911".

PROF. H. LEBESGUE, professor of mathematics at the Collège de France, and Prof. A. F. Molengraaf, professor of geology at Delft, have been elected associates of the Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.

IN April last, Mr. C. W. A. Scott set up a new record for the journey by air from England to Australia. It will be remembered that he took just over nine days for the flight (NATURE, April 18, p. 604), thus beating Air Commodore Kingsford Smith's time by nearly a day. He has now flown from Australia to England in eleven days, again beating a record set up by Air Commodore Kingsford Smith. Mr. Scott started from Wyndham, in the Northern Territories, early on May 26, and arrived at Lympne aerodrome on the evening of June 5, his time being given as ten days twenty-three hours for the journey. The last stage of the flight was from Brindisi to England, which he accomplished without a stop in very stormy conditions. The machine he used was a small Gipsy Moth placed at his disposal by Lord Wakefield; it is an older pattern than the machine he used on his outward flight.

Two interesting and successful receptions were held at the National Institute of Industrial Psychology on June 1 and 2. Guests were received by the president, Lord D'Abernon, Mr. H. J. Welch, Lady Ruth Balfour, Dr. Myers, and Dr. Miles, and on each occasion about 350 guests witnessed a series of fourteen brief demonstrations, as well as films, illustrating the applications of psychology which have been made in different industries, and the methods by which psychologists are giving aid in the selection of workers. The broad appeal which this very young applied science makes is evidenced by the distinction and variety of the guests. Those responsible are to be congratulated, not only on drawing such large numbers, but also on the skill with which the guests were both instructed and interested for nearly two and a half hours. The demonstrations included: methods and results of industrial investigations, assembly operations, measurement of ventilation and lighting conditions, influence of rhythm on motor activity, a test for motor-driving, selection tests, tests of perseveration, colour discrimination, movement study, vocational guidance, and psychogalvanic reflex. These demonstrations well illustrated the very practical work which is being carried on by the Institute, both in industry and for private individuals, under the supervision of the director, Dr. Miles, and the researches conducted under the direction of the principal, Dr. Myers.

A VOLUME of "Sydney University Reprints" (Medical Sciences, non-clinical) has recently been issued (series 9, vol. 2, Nos. 13-38, 1930). It includes two papers by W. Bishop on the occurrence of lead in the egg of the domestic hen, papers on micro-methods of chemical analysis and estimation of chlorides in tissue by W. R. Mankin, and a titration method for the determination of potassium in urine by A. Bolliger and E. M. Day, all of which should prove of service in the clinical pathological laboratory.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A research student at the Institute of Pathology and Research, St. Mary's Hospital—The Secretary, Institute of Pathology and Research, St. Mary's Hospital, Paddington, W.2 (June 16). A lecturer in agricultural botany at the Royal Agricultural College, Cirencester—The Principal, Royal Agricultural College, Cirencester (June 17). An assistant lecturer in geography at the University College of the South-West of England—The Registrar, University College, Exeter (June 18). Three probationary forest officers under the Forestry Commission—The Secretary, Forestry Commission, 9 Savile Row, W.1 (June 18). A civil or mechanical engineer under the Safety in Mines Research Board, in connexion with the development of research into haulage problems in mines—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (June 20). An assistant pathologist at the South Devon and East Cornwall Hospital, Plymouth—The General Superintendent and Secretary, South Devon and East Cornwall Hospital, Plymouth (June 20). A full-time graduate assistant in the Department of Engineering of the Leicester College of Technology—The Registrar, College of Technology, Leicester (June 23). An assistant lecturer in zoology and two research biologists, the latter with special experience with plankton work, at the University College of Hull—The Registrar, University College, Hull (June 23). A junior assistant at the Ditton Research Laboratory, East Malling, Kent, for work on the preservation of fruit—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (June 27). A registrar of Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (June 30). Junior assistants in the Physics and Aeronautics departments of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (June 30). A professor of mathematics and an assistant lecturer in physics at University College, Southampton—The Registrar, University College, Southampton (July 6). A William Hudson professor of economics at Natal University College—Webster, Steel and Co., 9 St. Helen's Place, Bishopsgate, E.C.3 (July 15). A geography tutor at the Chester Diocesan Training College—Rev. Canon Thomas, Diocesan Training College, Chester. An assistant master to teach mechanics and metal work in the senior school of Sawston (Cambridgeshire) Village College—The Education Secretary, County Hall, Cambridge.

Research Items.

Nose-piercing as a Puberty Ceremony.—Among the Kamia, an Indian tribe of Imperial Valley, south-eastern California, nose-piercing is practised as the essential feature of the boys' puberty ceremony. According to information obtained by Mr. E. W. Gifford and recorded in *Bull. 97* of the American Bureau of Ethnology, no youth can marry until he had undergone this operation. The usual age for marriage was about fifteen years. Not less than four boys can be operated on at one time, and if the number ready for the ceremony is insufficient it has to be postponed. The chief takes the initiative, but the parents' consent has to be obtained. Large quantities of food are necessary, of which the greater part is supplied by the chief and the rest by the parents. The chief's 'policeman' removes the boys to the bush during the latter part of the night, and remains with them until they return to their homes. The operation is performed by four operators, who use needles of screw-bean wood. Immediately after the operation the 'policemen' force the boys to run six or seven miles to a house and back. They are then kept at the place of operation for four days, and are allowed to eat only watermelon and corn mush. Each morning the 'policeman' washes their noses with hot water, and day and night men and women sing continuously near the place of confinement. When on the morning after the fourth night they go home, they remain naked for a month and eat no fish, deer or jack rabbit. The hole in the septum is kept open by a piece of arrow-weed stick. Later, strings of white clamshell beads are worn hanging from the septum. Sometimes these are long enough to hang in front of the lips and have to be lifted when the man wishes to eat.

Food of the Sea Trout.—Our knowledge of the food of the sea trout has been drawn only from isolated observations from widely scattered localities. It is necessary therefore that a more intensive survey should be made of the food of these fish, both as regards the time of the year and its composition in different habitats. A preliminary investigation with this end in view has been made by Dr. C. H. O'Donoghue and Miss E. M. Boyd (*Fisheries, Scotland, Salmon Fish*, 1930, No. 3). A start has been made by the examination of the stomachs of a number of sea trout from two localities, nineteen fish having been examined in May and June from Spey Bay, a purely marine habitat, and 144 at fortnightly intervals from the beginning of May to early September from the tidal limits of the River Forth near Stirling, typical of an estuarine habitat. It was found that while all the fish from Spey Bay were feeding, the majority of those from Stirling had empty stomachs; those from the marine environment had been feeding chiefly on the sand eel (*Ammodytes lanceolatus*) or on the young metamorphosing stages of the herring. The fish from Stirling, the stomachs of which contained food, had, however, been feeding more on crustaceans such as gammarids and mysids, and also on ephemerid nymphs; these estuarine fish also do not contain nearly so much food as do those from Spey Bay. It is clear that continuous and intensive observations of this kind are needed to help to understand the large differences in rate of growth noticed in fish from different localities.

Anopheline Mosquitos in Southern Rhodesia.—Southern Rhodesia, with an area of about 150,000 square miles, is a vast country for purposes of conducting an *Anopheles* survey. No. 4 of the Memoir Series of the London School of Hygiene and Tropical Medicine (March 1931) is a report by Mr. H. S. Leeson on observations carried out on these insects during the years 1926–1928. It deals first with the anopheline mosquitos of the country in a general way, and secondly, with those of a particular area where blackwater fever is endemic. By diligently collecting mosquitos ever a wide area, it appeared likely that it may be possible to distinguish between those species prevalent in the zone of high blackwater fever incidence and those found elsewhere. Special attention was paid to collecting in the neighbourhood of Shamva and Salisbury—the former being in a so-called blackwater fever area, and Salisbury in a region now entirely free from that disease. Five species of *Anopheles* made up 97 per cent of the total number of adults collected. *A. funestus* and *A. gambiæ* occurred in largest numbers in the Shamva area, and when the incidence of malaria was at its highest. When the number of malaria cases was lowest, *A. funestus* was in hibernation and *A. gambiæ* was entirely absent. In the Salisbury area these two anophelines were extremely uncommon. The freedom of Salisbury from blackwater fever is due largely to improved conditions of sanitation. In order to reduce the number of anophelines in Shamva it is essential to create an environment unsuited to these insects. The report concludes with a series of measures recommended to be carried out towards achieving this end.

Crustacea of the Vanderbilt Museum.—Miss Lee Boone describes a large number of Crustacea in the third volume of the "Scientific Results of the Cruises of the Yachts *Eagle* and *Ara*, 1921–1928, William K. Vanderbilt, Commanding". (*Bulletin* of the Vanderbilt Museum. Volume 3. Crustacea: Anomura, Macrura, Schizopoda, Isopoda, Amphipoda, Mysidacea, Cirripedia and Copepoda, 1930.) The previous volume (vol. 2) dealt with the crabs. This part is on the same plan and is a handsome book, well printed and with excellent illustrations, both photographic and in line. The line drawings by Mrs. Helen Ziska are to be commended specially. The specimens consist chiefly of the Anomura and Macrura, although there are a few schizopods, isopods, and amphipods, usually represented by one or two species in each group, one cirripede, and three copepods, two of which are parasitic. Notes made when the specimens were collected are, as before, a feature of the descriptions; and the information as to colour and habits, besides much that is new in the way of distribution, makes the work a valuable addition to our knowledge of the Crustacea. Many of the species described are widely distributed, but some are very rare and so far only known from the type specimens. Amongst the more interesting finds are a new species of *Porcellana*, *P. rosamundæ*, from Simon Bay, Panama; two specimens of the interesting little abyssal hermit crab *Parapagurus pilosimanus abyssum* from 1100 fathoms, off Miami, Florida; and seven specimens of *Caligus aliuncus*, the male of which is recorded for the first time, from the skin of a dolphin.

Drought Resistance in Plants.—An important physico-chemical study of the nature of drought resistance in Canadian crop plants is presented by R. Newton and W. M. Martin in the *Canadian Journal of Research*, 3, 336-427, 1930. Ratio of water loss by evaporation under controlled humidity conditions, in the case of cactus segments and detached grass leaves, showed the remarkable ability of the cactus to retain moisture, but showed no relation to the relative

drought resistance of the grasses. The osmotic pressures of the tissue fluids did not prove a reliable index to the capacity of the tissues to resist droughts, but 'bound-water' content proved much more dependable. This property was usually determined by the lowering of the freezing point, resulting from the addition of known quantities of cane sugar to the expressed juice. In proportion to the extent that water was 'bound' by the plant colloids present, the concentration of the cane sugar was greater than it should be as calculated from the total water content present, and the lowering of the freezing point accordingly increased. In view of the considerable difficulty at present in the way of the interpretation of this concept of 'bound water', the elucidation of these experimental results may have to wait; but these physico-chemical studies supply much necessary data for the further understanding of the complex factors involved in the plant's resistance to drought.

Silver Leaf Disease of Plums.—The sixth part of a very intensive study of silver leaf disease of plums by F. T. Brooks and his associates has just appeared (*Jour. of Pomol. and Hort. Science*, vol. 9, No. 1, "Silver-leaf Disease—VI.", by F. T. Brooks and G. H. Brenchley, pp. 1-29, March 1931). It is good to note that these workers have begun experiments on the incidence of disease on trees worked on different stocks, though no definite results are as yet available. The appearance of the so-called 'gum-barrier' below wounds has been investigated, and its rôle in impeding the spread of the fungus is discussed in the paper. The protection of pruning wounds by soft grafting wax or home-made white lead paint is again emphasised. Manurial treatment of the host seems to have no direct effect on the incidence of the disease, but vigorously growing plum trees are more likely to recover from the malady than those of weaker growth. The danger of cutting back stock shoots in the process of propagation is shown, and it is suggested that such wounds be protected by means of soft grafting wax. The present paper raises many problems for future investigation, especially those concerning the formation of the 'gum-barrier' of a tree which recovers from an attack of the fungus.

Virus Diseases and Associated Protomyxean Organisms.—Several workers on virus diseases of plants have reported that various primitive organisms are often found in the tissues of the hosts attacked. Iwanowski, so long ago as 1900, noted the association of bacteria with virus-infected cells, but could find no causal relation between the former and the disease. A very detailed piece of work by Miss Ethel I. McLennan has just been published in the *Australian Journal of Experimental Biology and Medical Science*, vol. 8, pt. 1, March 1931, pp. 9-44, and adds yet another such example to our knowledge. A disease of hops which is very prevalent in Tasmania is described, and is adjudged to be in all probability a virus disease, on account of the similarity of its symptoms to those described in England by Salmon and Ware, and sometimes called 'false nettle head'. The relation of the new disease to true 'nettle head' is discussed, and the two are thought to be quite distinct from each other, since no eelworms are associated with the Tasmanian malady. The protomyxean organism which has been isolated and cultured is *Leptomyxa reticulata* Goodey, var. *humuli* nov. var. It is normally a soil organism, and is associated with some of the virus-infected plants. The parasite has been found to enter the host through the cells of the epidermis or through root hairs, and it is thought that the virus disease lowers the resistance of the plant to such parasites. No attempt to find a causal relation between the parasite and the virus disease has been made.

New Guinea Tobacco.—Dr. A. C. Haddon's interest in the cultivation and introduction of economic crops and their bearing on the development of the people concerned is well known. Anthropology Report No. 11, published by the Government Printer, Territory of Papua, entitled "The Species of Tobacco grown in New Guinea", is an example of this. This investigation was initiated by Dr. Haddon, who in a preface states that he has long been interested in the decorated pipes of New Guinea and the distribution of the methods of smoking in the island. A collection of the different kinds of tobacco found under cultivation in the island has been made and an examination of the material has been undertaken by Mr. J. S. L. Gilmour, of Clare College, Curator of the Herbarium, Botanical Museum, Cambridge, who is the author of this report. This examination involved the raising of many samples from seed. So far as the material examined represents the types under cultivation, it is shown that all of them are varieties of *Nicotiana tabacum* Linn., and types of China, Manila, and Java tobacco are represented. This confirms the opinion of Dr. O. Finsch ("Samoafahrtens", Leipzig, 1888, p. 58) that this tobacco is *N. tabacum*, but is contrary to the view expressed by J. H. Maiden in a paper contributed by him to the *Proc. Linn. Soc. N.S.W.*, 1888, on New Guinea tobacco, which stated that East Indian, Manila, and Turkish tobaccos are the produce of *N. rustica* Linn. This statement of Maiden's was made although Mr. Hugh Dixson, a high authority on tobacco in New South Wales, pronounced that the samples which were submitted to him by Maiden were "the same species as the tobacco of commerce".

Tidal Frequency of Earthquakes.—The relation between tidal phases and the frequency of earthquakes is discussed in a recent paper by S. Yamaguti (*Bull. Earthq. Res. Inst.*, vol. 8, pp. 393-408; 1930). In earlier investigations on the subject, the origins of the earthquakes considered were unknown. Mr. Yamaguti confines his study to the after-shocks of the Kwanto earthquake of 1923, the Tango earthquake of 1927, etc., in which the epicentres were distributed within well-defined areas. In all of these, he finds that the frequency is greatest at, or a little before, the time of low-water at a neighbouring station; while a secondary maximum appears before high-water on the Kwanto curve and a little after high-water on the other curves. There is, however, an interesting difference between the Tango after-shocks that originated beneath the sea-bed and on land on the northern side of the Yamada fault. The former have two maxima, $1\frac{1}{2}$ hours before and after high-water; the latter a principal maximum about low-water and a secondary maximum about high-water.

Oceanographical Research North of Siberia.—In the Norwegian magazine *Naturen* for January 1931 (vol. 55) Dr. H. U. Sverdrup, in his paper "Resultater av Maudferdens Oceanografiske undersøkelser", describes the results of his oceanographical researches in the seas north of Siberia, the hydrographical stations being mainly in the region of the New Siberian Islands, the East Siberian Sea, and, eastward, in the water between this and Alaska called the Chakotsk Sea. The bulk of the work was done in the East Siberian Sea, depth, currents and winds, salinity, oxygen content, and hydrogen ion concentration all being investigated. There is much ice in these parts, and samples were taken even when the vessel was ice-bound. Plankton samples were also

taken to a small extent, the Chakotsk Sea having a good deal of phytoplankton in its surface waters. It is noted, however, that the phytoplankton, although it can live where the ice is, does not develop freely under ice-bound conditions. The bulk of the work is on oceanographical hydrography, and there are clear maps showing the main regions with the stations and diagrams illustrating the various aspects of the researches which are interesting and valuable.

Diffraction of Very Fast Electrons.—An experiment is described by E. Rupp in the *Annalen der Physik* (vol. 9, No. 4) which verifies the de Broglie formula for the wave-length of an electron—Planck's constant divided by the momentum—under conditions when the relativity correction to the mass is large. Using an interference apparatus similar to that of Prof. G. P. Thomson, with a gold scattering foil, the interference rings produced by electrons which had fallen through a potential difference of a little more than 200 kilovolts were obtained and measured From the ring pattern the electron wave-length was calculated to be $2{\cdot}162 \pm 0{\cdot}013 \times 10^{-10}$ cm., the lattice constants for gold crystals being taken from X-ray data; the corresponding quantity calculated from the de Broglie relation and the accelerating potential acting on the electrons was $2{\cdot}183 \pm 0{\cdot}035 \times 10^{-10}$ cm., showing that the relativistic formula for the change of mass with velocity is accurate in this region to at least one per cent.

Colours of Metallic Films.—Films of gold and silver have attracted a great deal of attention at various times on account of the colours which they impart to transmitted light, and have been studied by Faraday, Beilby, R. W. Wood, and others. An investigation of the effect of temperature on their optical properties is described by S. R. Swamy in the May number of the *Proceedings* of the Royal Society, and it has been shown that the electromagnetic theory of the phenomenon due to Garnett can be made to account for a great part of what is observed. Dr. Swamy makes the fundamental assumption that the effect of warming is to disintegrate a film, some parts turning dense at the expense of other parts which become thinner or vanish completely; the latter places act as effectively transparent windows, which transmit unchanged part of the incident light and so dilute the true absorption colour. This idea certainly receives support from the mottled appearance presented by the microphotograph of a heated gold film, but is perhaps inadequate to account for all of Prof. Wood's results.

Propagation of Magnetisation.—When the magnetisation of a ferromagnetic body alters with the specimen under the influence of a mechanical stress, the hysteresis loops contain abnormally large discontinuities. An investigation of this phenomenon, which is allied to the well-established Barkhausen effect, is described by L. Tonks and K. J. Sixtus in the second April number of the *Physical Review*. It appears that the change in magnetisation starts at a nucleus. From this a magnetic wave travels away with a speed which is related in a simple manner to the field in which propagation occurs and varied from 500 to 40,000 cm. per sec. under the conditions studied. As the wave progresses, eddy currents are set up in the metal, and, by dissipating the energy available from the magnetic change, limit the velocity with which the change penetrates the specimen; the effect of changing the lateral dimensions of the piece of material indicates that the velocity depends primarily upon surface phenomena. A reasonable picture offered for what occurs is that the magnetic reversal takes place within a very small distance of an approximately conical surface—in a wire—the edge of the base of the cone being the front of the wave. In addition to depending upon the magnitude and nature of the stress, the effect changes with the composition of the material, but so far no new relation to other properties has been ascertained.

Electrical Discharges in Gases.—The April number of *Reviews of Modern Physics* contains a second article on electrical discharges in gases by I. Langmuir and K. T. Compton. The first article, which appeared earlier in the same journal, gave a summary of those properties of atoms and electrons, considered as individuals, which are important in conduction. The present paper deals with the collective behaviour of the particles under relatively simple conditions, and is largely an account of the electrostatics of charges which are distributed throughout spaces of definite shape. It thus differs from classical treatments of the subject in being not mainly concerned with charged surfaces only, but also to a large extent with rather general solutions of the Poisson equation. Practical knowledge of this nature is naturally of much value in the design of thermionic apparatus for the utilisation of high vacuum discharges, but is far from being confined to this, being fundamental both in the theory of the use of exploring electrodes for the analysis of various forms of gas discharge, and in the theory of the mechanism of the grid-controlled arcs, or thyratrons, which are now finding many experimental and technical applications. The theory also differs considerably from classical electrostatics in its continual use of numerical data, both with the view of practical applications and in consideration of the validity of approximations which are frequently useful or necessary; and, for similar reasons, it is usually desirable to express complicated results ultimately in series, rather than by the use of special functions. It is no exaggeration to say that these ideas which, although they are in a sense the logical outcome of the earlier work of Sir J. J. Thomson and of Prof. Townsend, have been carried to their present stage almost entirely by Dr. Langmuir and his collaborators at Schenectady, have revolutionised the outlook on the nature of electric discharges through gases, and seem likely to make it possible to analyse fairly completely the processes operative in any particular type.

Pipe Line Corrosion.—The extensive corrosion which has occurred on some sections of the pipe lines used by the oil companies of the United States has led to the co-operation of the companies and the Bureau of Standards in an investigation of its causes, and the results are given in the April issue of the *Journal of Research*. Nine pipe lines between the Gulf of Mexico and Kansas have been examined, and it has been found that every line has electric currents flowing along it, generated by differences in the states of the metal and of the soil where they come into contact. These currents are found to flow into the pipe from the soil where the soil has a high electrical resistivity, and out of the pipe into the soil where the soil has a low resistivity. The corrosion occurs where the electric current flows out of the pipe into the soil, that is at points where the resistivity of the soil is low, and at such places the pipes should be suitably coated. The Bureau has produced a simple apparatus for measuring soil resistivity, which consists of two sticks shod with iron cones connected by wires in the axes of the sticks through a milliammeter to two dry cells. The sticks, which are about the size of walking-sticks, are thrust into the ground about 20 centimetres apart, and the current read. From the current and the constant of the apparatus the resistivity of the soil is calculated.

The Royal Observatory, Greenwich.

ANNUAL VISITATION.

THE visitation of the Royal Observatory was held on Saturday afternoon, June 6. A large number of guests were present, and took part in the inspection of the instruments and other exhibits.

The report of the Astronomer Royal to the Board of Visitors begins with the very welcome announcement that Mr. William Johnston Yapp has made the generous donation of £15,000 for the purpose of providing a 36-inch reflector, with a spectroscope and a 34-foot dome. This magnificent gift has been gratefully accepted by the Lords Commissioners of the Admiralty, and the order for the erection of the instrument will be placed with Messrs. Sir Howard Grubb, Parsons and Co.

Another satisfactory announcement is that the Lords Commissioners have sanctioned the purchase of a new transit-circle; the present one has been in use for eighty years; the object-glass has become so thin that it will not bear further repolishing, and many of the divisions on the circle are almost obliterated; attempts at recutting these have not proved permanent. A model of the proposed new instrument was on view. It will be, in general, similar to the reversible transit-circle at the Cape, and will be entrusted to Messrs. Cooke, Troughton and Simms, who made that instrument; it will be somewhat smaller than the present instrument; an aperture of seven inches and a focal length of eight feet are proposed, also a motor-driven micrometer for recording transits. The roof will be in the form of two semi-cylinders, with axes running east and west, and sliding apart so as to give a wide central aperture. The design is to give free circulation of air, and avoid abnormal refraction; with this aim the transit-room will be put at some distance from other buildings. It is recognised that the opening in the roof of the present instrument is too narrow, and that the shutters, when open, impede the free circulation of air. The collimators of the new instrument will be outside the main building.

More than eleven thousand transits and circle-readings were obtained with the transit-circle during the year, the sun being observed on 131 days and the moon on 79. The report gives the errors of the sun in longitude since 1901, when Newcomb's tables were introduced; the error gradually rose from zero to 1·65″ in 1922 (observed greater than tabular); since then it has remained nearly stationary. The errors of Brown's tables of the moon have steadily diminished from 7·1″ in 1922 (observed greater than tabular) to 5·2″ in 1930.

The observations for the catalogue of 10,800 stars between N. Decl. 32° and 64° were completed last December. The new catalogue will cover the regions 0° to 24°, and 64° to the pole. The Astronomer Royal notes that this will probably be the last considerable undertaking with the present transit-circle. It is now considered unnecessary to observe stars fainter than magnitude 7·5 or 8 on the meridian; fainter stars are observed photographically on plates of large area, on the plan initiated by Prof. Schlesinger.

The 28-inch equatorial was used for observing 258 double stars, 52 of which were less than ½″ apart. An electric motor has been installed for rotating the dome; this enables one observer to work the instrument without assistance. The determination of stellar parallaxes with the 26-inch refractor has been continued; 1140 good plates were secured during the year, and 950 plates were measured, leading to the determination of 34 new parallaxes. During November, December, and January 110 plates of Eros were obtained on 19 nights.

With the 30-inch reflector the determination of the colour temperature of stars has been continued. A Kodak standard acetylene burner (colour temperature 2360° K) is now used as standard instead of a carbon arc; a colour filter is inserted in the beam from the burner. Each plate contains images of a high star, of two low stars for determination of atmospheric absorption, and of the burner. The results indicate 13,000° to 14,000° for the temperature of a star of type Ao. When the new 36-inch reflector is ready it will be used for this work. As the 30-inch is on the same mounting as the 26-inch, observations of parallax and colour temperature cannot at present be made simultaneously.

Photographs of the sun were obtained on 260 days; the record has been completed by plates from the Cape, Kodaikanal, and Tortosa. Solar activity has diminished considerably, but large spots were seen in October, February, and March. With the spectrohelioscope considerable solar eruptions were observed on Aug. 12 and Nov. 25; the latter gave an outward velocity of 450 km./sec., which is near the parabolic value.

The following are the mean magnetic elements obtained at Abinger in 1930: Decl. 12° 24·6′ W.; Hor. force 0·18542; Vert. force 0·42924; Dip 66° 38·2′. The decl. is diminishing at the rate of 11½′ annually, so that it should vanish a little before the end of the century. Magnetic observations are occasionally made at Greenwich in the early morning, when electric trains are not running; these will be continued, as there is an unexpectedly large range in the determinations of decl. as compared with the Abinger ones.

The following weather records refer to the year ended on April 30, 1931: temperature 50·0°, being 0·5° above the average; highest 92·2° on Aug. 28 and 29; lowest 21·0° on Mar. 10. There were 55 days when temperatures of 32·0° or lower were recorded; the mean daily movement of air was 289 miles, being 5 miles above the average; the greatest value was 713 miles on Jan. 17. There were 1320 hours of bright sunshine, or 29·6 per cent of the possible amount. The rainfall was 27·94 inches, which is 3·70 inches above the average; on June 18, 2·66 inches fell in 2 hours.

Time determinations are now made with a small reversible transit instrument fitted with a travelling micrometer; two Shortt clocks (No. 3 and No. 11) are used as standards of sidereal time; the progressive increase of losing rate of No. 11 still continues. The mean time signals are controlled by Shortt No. 16. Wireless signals from Paris, Nauen, Annapolis, and Bordeaux are registered automatically; they all agree in being apparently late on Greenwich, the amounts being 0·016 sec., 0·044 sec., 0·039 sec., and 0·033 sec. respectively. The Annapolis one is corrected for time-lag. The difference is unquestionably systematic, for out of the 48 monthly means that are printed in the report there are only three that are earlier than Greenwich.

Several photographs were exhibited of Eros and neighbouring stars; these were measured for three different purposes. The principal research was the solar parallax and the mass of the moon; the second was the light-variation, which was plainly visible in the series of images on some of the plates. The third was the determination of mean wave-length of Eros and the comparison stars, which was effected by placing a grating before the object-glass.

A. C. D. CROMMELIN.

Messages in Sensory Nerve Fibres and their Interpretation.*

BY amplifying the electric changes which take place in the individual nerve fibres it is possible to record the messages which pass from the sense organs to the central nervous system and from the motor nerve cells to the muscles. It is found that a series of brief potential changes travel along each nerve fibre; the changes are of fixed intensity and duration, but their frequency varies with the intensity of the excitation. Each potential change represents a nerve impulse of the type made familiar by the classical methods of electro-physiology. Reasons are given for the belief that all nervous communication is carried out by such impulse messages, and that the impulses, like the electric changes which accompany them, are unaffected by variations in the intensity of the stimulus. The general similarity of motor and sensory messages makes it probable that the sensory nerve endings and the synaptic regions of the central nervous system work on a common plan depending on the fundamental properties of excitable cells.

The sensory messages which have been most thoroughly investigated are those produced by the muscle spindles. Those from the skin receptors are less easy to analyse but are of greater interest to the physiology of sensation. At present the most definite results have been obtained from the frog. The frog's skin contains receptors which respond to light contact with a brief discharge of impulses travelling in nerve fibres which conduct rapidly. A vibrating stimulus gives a series of impulses with the same frequency as that of the stimulus, but discharges of high frequency and long duration from these receptors do not give rise to pain. Stimuli which would be likely to cause continued pain give rise to impulses of small action potential travelling in fibres which conduct very slowly (about 1 metre a second).

In the mammal, as in the frog, light touch produces a brief discharge of impulses of large potential conducted rapidly, and firm pressure gives a continued discharge. Impulses of smaller potential conducted at slower rates are produced by movement of the skin, and persistent discharges often arise from exposed tissues. At present it appears that some of these impulses are caused by stimuli which would not necessarily be painful.

A comparison of these results with those of Gasser and Erlanger and of Piéron shows that the nerve fibres responsible for pain are not all of the same type, though they are all of smaller diameter than the tactile fibres. It is suggested that the rate of reaction and amount of convergence in the sensory pathways are important factors in determining the intensity of sensation, since this must depend on a summation of the effects of discontinuous impulses.

* Abstract of the Croonian Lecture delivered before the Royal Society on June 4 by Prof. E. D. Adrian, F.R.S.

Fisheries Research at Hull.

THE Department of Zoology in the University College of Hull has recently been expanded into that of Zoology and Oceanography. From its first establishment it has been intended that there should be co-operation between the Department of Zoology and the fishing industry. The Humber ports form the largest fishing centre in the world. The Council of the College has now decided to put into operation a scheme of fishery research which is to be organised by Prof. A. C. Hardy. A new section will be added to the accommodation of the department and three research biologists will be appointed. The capital expenditure will be borne by the College, but the greater part of the maintenance charges will be met by a grant from H.M. Treasury, which has been made on the recommendation of the Development Commissioners. A grant towards the cost has also been made by the Fishmongers' Company, and it is hoped that contributions will be made by the fishing industry itself. The scheme of research, which will be carried out in co-operation with the Ministry of Agriculture and Fisheries and the Fishery Board for Scotland, and will be co-ordinated with the researches of the International Council for the Exploration of the Sea, concerns the distribution of the North Sea plankton in relation to the movements of fish, particularly the herring.

It is the policy of the department to carry out this research not from a single research ship, but from fishing vessels and other commercial ships which are prepared to carry specially designed self-recording instruments for plankton and other measurements. It is believed that there are certain important problems connected with our knowledge of the sea and its changing conditions which cannot be solved by using one research ship to cruise over the area concerned, just as a knowledge of the weather cannot be obtained by having one meteorological station moving about from place to place. It is proposed to chart in broad outline the monthly movements of the North Sea plankton by the simultaneous use of continuous plankton recorders on a number of scheduled steamship routes across the North Sea, and to correlate the distribution of the plankton with the concentration of fish as reported by the industry. The herring shoals do not always turn up where they are expected; they move their ground from time to time; usually the fishermen can find them, but sometimes they cannot, at any rate in sufficient numbers to make a successful season. When, over a period of five years, a knowledge has been gained of the changing distribution of herring food and patches of such organisms as *Phœocystis* and *Rhizosolenia*, which the herring apparently avoid, it is hoped that it may be possible to make forecasts as to the position of the shoals of herring. From this work a wider field of investigations should be opened up, including a study of the possible causes underlying the fluctuations in the stocks of different fish.

A new continuous plankton recorder suitable for use on commercial ships has been designed; it is an improvement on, and a smaller pattern than, the original machine which was first used on the 1925–27 *Discovery* Expedition and was described in NATURE of Oct. 30, 1926. It is towed like a paravane behind a ship and continually samples the plankton in the water traversed. The plankton is collected on a long banding of fine silk netting which winds into a preservation chamber. It is worked from the water by a propeller, the adjustable blades of which allow each of a series of numbered divisions on the moving silk to represent a mile or more of sea. The rolls obtained are kept for examination on a special microscope substage.

A number of simpler instruments, obtaining a single sample of the plankton for correlation with the catch of herrings, will be used by herring drifters when engaged in fishing.

In addition to the research programme, a one-year course in oceanography with particular reference to fishery problems is being arranged for post-graduate students.

University and Educational Intelligence.

CAMBRIDGE.—The Adams prize (value about £240), which is awarded every two years for an essay on some branch of pure mathematics, astronomy, or other branch of natural philosophy, has been awarded to Mr. A. S. Bearcovitch, fellow of Trinity College. The subject given out for the period 1929–30 was "The Theory of Almost Periodic Functions".

The Appointments Committee of the Faculty of Physics and Chemistry has reappointed Dr. F. C. Phillips, of Corpus Christi College, University demonstrator in mineralogy.

The Vice-Chancellor gives notice that the professorship of mineralogy and petrology has been established, and that a meeting of the electors will be held on June 24. The professorship is governed by Statute D and by the regulations which were approved by Grace on April 24, 1931. The stipend of the professor is £1200 a year, or, if he holds a fellowship with dividend, £1000 a year.

Candidates are requested to communicate with the Vice-Chancellor on or before Friday, June 19. No testimonials or references need be sent. If a candidate desires to submit any, they should not exceed four in all, and in the case of testimonials, ten copies of each should be sent to the Vice-Chancellor not later than June 19.

LONDON.—The Court of the University has appointed Mr. Charles Holden, senior partner of the firm of Messrs. Adams, Holden and Pearson, of 9 Knightsbridge, S.W., to be the architect of the new buildings which the University proposes to erect on its site in Bloomsbury, on the north side of the British Museum. Mr. Holden's task will be a large one. When building operations begin, the site will be an island one of more than ten acres, bounded on the south by Montague Place, on the west by Malet Street, on the east by Russell Square and Woburn Square, and on the north by Gordon Square and Byng Place. Among the first buildings to be erected will be the Administrative Offices, the University Hall, and the University Library, premises for the Officers' Training Corps, and buildings for the Institute of Historical Research and the Courtauld Institute of Art. To these will in all probability be added the London Day Training College, and the Court's programme provisionally includes accommodation for Birkbeck College, the School of Oriental Studies, and the University Students' Union. Space will also be reserved for other purposes, among which residential accommodation for students, a faculty club and residential chambers for staff will be considered. This building programme will of necessity have to be undertaken in stages, and will take many years to complete, but, with the view of ensuring that, when the work is ended, all the buildings will form part of a dignified and harmonious scheme, Mr. Holden is being asked to prepare at once a design for the whole of the site.

The following doctorates have been awarded: *D.Sc. Degree in Physics* to K. R. Rao (Imperial College—Royal College of Science) for a thesis entitled "Analysis of the Line Spectra of certain Elements of the Third, Fourth, and Fifth Groups" (*Proc. Phys. Soc.*, *Proc. Roy. Soc.*, and NATURE, 1929). *D.Sc. Degree in Zoology* to N. A. Mackintosh (Imperial College—Royal College of Science) for a thesis entitled "Southern Blue and Fin Whales" (Camb. Univ. Press, 1929). *D.Sc. (Economics) Degree* to D. Mitrany (London School of Economics) for a thesis entitled "The Land and the Peasant in Rumania" (Oxford Univ. Press, 1930). *D.Sc. Degree in Mathematics* to G. F. J. Temple for six published papers on "The Quantum Theory of the Spinning Electron".

MANCHESTER.—The Manchester City Council is again offering a number of scholarships tenable in the Faculty of Technology of the University. Successful candidates are required to follow a full-time course leading to the degree of bachelor of technical science in the College of Technology, and matriculation or its equivalent is an essential qualification. For students who have been engaged in industry, and who have attended part-time day or evening classes, the scholarships are of the value of £100 per annum, while for students leaving secondary or central schools the value is £60. Both classes of scholarships are tenable for three years.

THE Science Scholarships Committee of the Royal Commission for the Exhibition of 1851 has made the following appointments to Senior Studentships for 1931: Ernest C. Childs, for research in physics (London); Philip S. H. Henry, for research in physical chemistry (Cambridge); H. S. W. Massey, for research in physics (Cambridge); Brian H. C. Matthews, for research in physiology (Cambridge); William V. D. Hodge, for research in mathematics (Bristol); and Alexander R. Todd, for research in organic chemistry (Glasgow).

Birthdays and Research Centres.

June 12, 1851.—Sir OLIVER LODGE, F.R.S., late Principal of the University of Birmingham and formerly professor of physics in University College, Liverpool.

The subject which chiefly interests me is a verification of the theory that requires a flow of ether along magnetic lines of force, thereby presumably affecting the velocity of light in a magnetic field. The effect to be observed is, I reckon, extremely small, and would require a Fizeau interferometer with a long path in an exceptionally intense field; though the field need only last for such fraction of a second as would enable interference bands to be photographed. My own experiments of 1897 were on right lines, but their power was quite insufficient. To get a result, a combination of the optical skill of the late Prof. A. A. Michelson with the intense magnetic fields produced by the genius of Dr. Kapitza would seem to be necessary, and perhaps also engineering and financial aid such as the late Sir Charles Parsons at one time contemplated. A positive result, if it could be attained, would be of the greatest interest and would break the prevailing monotony of negative results yielded by all recent attempts at bringing the ether to book and restoring it to its inevitable place in the scheme of Nature.

June 14, 1857.—Prof. J. E. MARR, F.R.S., fellow of St. John's College and lately Woodwardian professor of geology in the University of Cambridge.

More attention might usefully be given to the deposits containing human relics, particularly from the geological point of view. This is being done, but much more is required; for, though the task of establishing time-sequences and then correlating beds in different areas has been carried some way, that of restoring the physiographies of various areas in the different periods is still in its infancy.

When this important work has been carried out systematically and in detail, it will aid materially in the much greater task of establishing the history of the physical conditions under which deposits were formed, epoch after epoch, during the geological ages—a work which has not, during recent years, received the attention it requires.

June 14, 1877.—Prof. R. WHYTLAW-GRAY, F.R.S., professor of chemistry in the University of Leeds.

At the present time, I am much interested in developing a buoyancy microbalance of the Aston type so that it can be used for comparing the densities of gases to a high degree of accuracy even at low pressures. This method eliminates many sources of error inherent in the classical methods, and it is hoped to obtain with its help reliable values for the chemical atomic weights of a number of elements.

At the moment we are interested in the atomic weight of carbon, which on account of the presence of the isotope C^{13} must be slightly greater than the mass spectrograph value of 12·003. Data of sufficient accuracy from several gases should enable an estimate of the proportions of the two isotopes to be made.

Other researches, in which I am interested and which are being carried on by colleagues and collaborators in my section of the Department of Chemistry here, include investigations on solid phase reactions, the electrical character of smokes, the nature of the suspended impurities in air, and the vapour pressures of slightly volatile solids.

June 15, 1851.—Dr. E. H. GRIFFITHS, F.R.S., formerly general treasurer of the British Association, and president in 1906 of Section A (Mathematics and Physics) and in 1913 of Section L (Educational Science).

I regret to state that I am not engaged in any scientific work at the present time. For many months I have been suffering acutely from arthritis, so much so that I am unable to write.

For several years past, I had proposed an investigation into the specific heat of gases at high temperatures. As it is now impossible for me to undertake such an inquiry, I hope that some younger and more able man will attack this difficult subject.

June 18, 1858.—Prof. A. R. FORSYTH, F.R.S., emeritus professor of mathematics in the Imperial College of Science and Technology.

In differential geometry, the expression

$$ds^2 = Edp^2 + 2Fdpdq + Gdq^2,$$

where E, F, G are functions of parameters p and q, represents the general arc on any surface in flat triple space, subject to three known conditions involving the coefficients in the associated quadratic differential form for the curvature of a superficial geodesic. An arc on any surface, in any domain whether flat or curved, is represented by the same formal expression. It is important to obtain the conditions which must be satisfied in order that the represented surface may exist: either (i), in a given curved triple space, itself existing in a flat space of four dimensions; or (ii), in a flat space of four, but not fewer than four, dimensions.

June 19, 1897.—Mr. C. N. HINSHELWOOD, F.R.S., fellow of Trinity College and lecturer in chemistry in the University of Oxford.

Investigations now in progress are connected with the mechanism of chemical changes in gases, with surface catalysis, and with the relation between reactions in the gaseous state and the corresponding changes in solution. Among gas reactions, oxidation processes are being specially studied at the moment, particularly with reference to the theory of 'chains'; and the nature of the curious explosion phenomena encountered in such systems as hydrogen-oxygen mixtures is being examined. The influence of negative catalysts and of surfaces on these effects is gradually yielding information. Some of the earlier work on reactions depending on simple molecular collisions is being extended in the light of more recent knowledge.

Societies and Academies.

LONDON.

Physical Society, April 17.—E. G. Richardson: Edge tones. If a fluid leaves an orifice as a jet and strikes an edge, two vortex streets are formed on each side of the wake and maintain the jet in pendulation at a definite frequency. The tones so produced are examined from theoretical and experimental points of view, and relations connecting the frequency with (*a*) velocity, (*b*) distance from orifice to edge, (*c*) width of orifice, (*d*) form of the orifice, are tested. All the features of the phenomena can be explained in terms of the hydrodynamics of a viscous fluid, without compressibility being postulated in addition.

Geological Society, May 6.—C. A. Matley: The geology of the country around Mynydd Rhiw and Sarn, South-Western Lleyn (Carnarvonshire). The region described includes a ridge of high ground which attains a height of 994 feet on Mynydd Rhiw. Much of the lower ground is covered by glacial drift. The sedimentary rocks are of Arenig and Lower Llanvirn age, and range from the Extensus Zone to a high part of the Bifidus Zone. The local base of the Arenig is found at only one small exposure, and there it rests on the mica-schists (Penmynydd Zone) of the Mona complex. In the Hirundo Zone, and extending into the Bifidus Zone, is the Rhiw volcanic group, in which four lava-flows have been found, as well as rhyolitic ashes and ashy sediments. Intrusive rocks are abundant, and range in composition from acidic to ultrabasic; they are linked genetically by their common richness in soda, and can be considered, with the volcanic rocks, as varied members of one spilitic suite. They include the Sarn granite, numerous albite-dolerite sills, and the coarser-grained intrusions of picrite, proterobase, and hornblende-dolerite which are found only at the top of the sequence. These intrusions are discussed, and the possibility considered that they may be a single sill or laccolith broken and displaced by faulting.—E. Greenly and P. G. H. Boswell: An Ordovician grit from Anglesey, with its bearings upon palæogeography, and upon the tectonics of the Mona complex. The grits at the base of the Arenig beds at Berw, near Holland Arms, are exceptionally rich in heavy minerals. Garnet, sphene, and epidote are abundant, as are ilmenite, biotite, and white mica. The felspars are orthoclase, albite, and olioclase. There are also small pebbles of Penmynydd Zone mica-schist, Gwna green-schist, and many of granitoid acid gneiss. The evidence both of minerals and rock-fragments points to the acid gneisses as the principal source, with contributions from the Gwna beds and the acid members of the Penmynydd Zone. The evidence furnishes unexpected confirmation of a tentative hypothesis, already put forward, that the gneiss of Holland Arms, instead of having been brought up from below, has been brought down from above, on an infold of the Newborough slide, from the inverted upper limb of the Bodorgan recumbent fold.

CAMBRIDGE.

Philosophical Society, May 18.—J. D. M'Gee: The charges of recoil atoms in relation to surface conditions. The charge carried by α-ray recoil atoms of radium *D* escaping from a source of radium *C* is one positive unit when the source is deposited on a clean nickel or platinum surface. The direct method of collecting a beam of particles from a source in a Faraday cylinder and comparing the charges received by it, when the recoil atoms and α-rays were successively eliminated from the beam, was used. The charge carried by a

recoil atom can then be compared with that carried by an α-particle. The charge carried by a recoil atom is influenced by the work-function of the surface from which it escapes. The cause of earlier conflicting results has been traced to the presence of high energy ions.—J. E. I. Cairns: Conduction along thin metallic films. Experiments on the electrical conductivity of thin films of cadmium and nickel showed good agreement with the theory of Ehrenberg and Hönl, if it be assumed that for very thin films aggregation of the metal into small crystals with intervening gaps occurred. The ageing of cadmium is anomalous and can only be attributed to internal rearrangement among the crystal aggregates forming the film. Nickel, however, shows regular behaviour, and in every case after deposition its conductivity decreased, usually reaching a steady value in 4–5 minutes. Composite films consisting of a low work-function metal upon a higher one gave interesting results.—N. Feather: Concerning the success of the absorption method of investigating the high velocity limit of continuous β-ray spectra. Simple absorption measurements, interpreted on the basis of the range-energy relation for homogeneous particles, lead to satisfactory estimates of the maximum energies represented in the continuous spectra of many β-ray bodies. Calculations show that this empirical result follows from the known form of the absorption curve for homogeneous particles, the known relation between extrapolated range and energy for such particles, and the most general considerations regarding the characteristics of measuring instruments usually employed.—P. S. H. Henry: The specific heats of diatomic gases. A short summary is given of the theory of the specific heats of diatomic gases on classical and on quantum mechanics. This is followed by a description of a flow method of measuring specific heats due to P. M. S. Blackett, and some results obtained with it for air, nitrogen, oxygen, and methane between 20° C. and 350° C. are shown. These disagree markedly with the results of sound velocity measurements, and are in closer, though not exact, accord with theory.—E. L. C. White: A method of continuous observation of the equivalent height of the Kennelly-Heaviside layer. Wireless 'echoes' from the Heaviside layer are observed in the form of a stationary pattern on a cathode ray oscillograph screen, from which the height of the layer at any instant is seen at a glance.

EDINBURGH.

Royal Society, May 4.—L. R. Cox: A contribution to the molluscan fauna of the Laki and Basal Khirthar groups of the Indian Eocene. The paper describes the molluscan fossils collected by Lieut.-Col. L. M. Davies from the Laki group (Lower Eocene) and lowest beds of the Khirthar group (Middle Eocene) of several districts in north-western India, supplemented by material from other collections in the British Museum. The work of d'Archiac and Haime (1854) on mollusca from these beds is also revised. Forty-five gastropod and 54 lamellibranch species, mainly from the Laki group, are described, 16 gastropods and 7 lamellibranchs being new to science. Few species range up from the underlying Ranikot group, but this may be due partly to a change in facies. The difference between the faunas of the Laki and Khirthar groups is less pronounced, many species occurring in both series. Thirty-five of the gastropods and 28 of the lamellibranchs described are known only from India, and the gastropods include certain genera not known from other countries; one genus is described as new. Several of the species recorded occur also in southern Europe, and one or two as far afield as Jamaica; a few very widespread forms occur also in northern Europe. The affinity of the fauna with that of the Eocene of Egypt and, more especially, of Somaliland is closer than with that of Europe.—H. Boschma: On the identity of *Sacculina triangularis* and *Sacculina inflata*. Specimens of *Sacculina triangularis* (Anderson, 1862) on *Cancer pagurus* from the Firth of Forth were examined, and it is concluded that *S. triangularis* is identical with *S. inflata* (Leuckart 1859) on *Hyas coarctatus*. The valid name of the species is therefore *S. inflata*. This species differs from *S. carcini* by constant specific characters.—S. Williams: An analysis of the vegetative organs of *Selaginella grandis* Moore, together with some observations on abnormalities and experimental results. The plant of *S. grandis* consists of a dichotomously branched shoot showing a basal decumbent portion bearing rhizophores, an erect dichopodial axis, and a distal fan-shaped region with middle-shoots. The apex of the stem possesses two four-sided initial cells. Branching is dichotomous and at each branching an angle-meristem is formed. The latter gives rise to rhizophores at the basal branchings and to middle-shoots at distal branchings. Roots arise endogenously in the tips of the rhizophores. The root apex has three initials: a calyptrogen, dermatogen, and a common initial for plerome and periblem. Abnormal developments of the middle-shoot and proliferations of vegetative and cone apices occur, and it is also possible to obtain such deviations from the normal by experimental methods. The general morphology of the plant is discussed and it is concluded that the rhizophore is an organ *sui generis*, indifferent in nature.—L. M. Milne-Thomson: Operational solution of the homogeneous linear equation of finite differences by generalised continued fractions. Given a homogeneous linear finite difference equation of the second order, a continued fraction, constructed from the coefficients, can be made to yield a solution of the equation in terms of the initial values of the dependent variable. By associating a suitable operator with the co-ordinates of a point in space of m dimensions, the notion of continued fractions is generalised to this space and an operational solution of the linear difference equation of the mth order is obtained.—Dr. A. C. Aitken: Further numerical studies in algebraic equations and matrices. The paper follows up a similar paper of five years earlier, simplifying the former methods by using the dual properties of symmetric functions, and proposing now to evaluate all the roots of an equation by subjecting the coefficients to a uniform repeated process of cross-multiplication and division. The process is a special case of the method of finding the latent roots of a matrix by raising the matrix to high powers. The numerical work suggests a theorem in matrices which is demonstrated, namely, that the rational canonical form of a matrix can be transformed at once into the classical irrational canonical form, the transforming matrix being of alternant type.—D. Meksyn: Electromagnetic phenomena in a uniform gravitational field. The radiation of an electron moving freely in a uniform gravitational field is evaluated. The electromagnetic equations can be rigorously solved for this case. The result obtained is Larmor's value for the rate of radiation. The calculation is based on Poynting's theorem and the geodesic propagation of light. The result obtained shows that the principle of equivalence can be applied to the evaluation of radiation, if allowance is made for the quantum properties of light.

DUBLIN.

Royal Irish Academy, April 27.—J. K. Charlesworth: A tentative reconstruction of the successive margins of the quaternary ice-sheets in the region of the North Sea. The outer limit of the British drift is composite. During the Saale-upper older drift period the ice margin over the North Sea was cusp-shaped. During the period of the newer drift of Britain—

Brandenburg or Warthe stage of north-west Europe —when the edge of the Scandinavian ice lay off the west coast of Norway, the British ice formed an independent piedmont mass over the western half of the North Sea.—**A. Muskett, E. N. Carrothers, and Hugh Cairns**: Contributions to the fungus flora of Ulster. A report of work carried out from 1923 to 1931, records 312 species and 9 varieties new to Ulster, thus bringing the total up to 916, besides adding 78 species and one variety to the Irish flora. Short notes are included for each species, giving details of place and date for each record.—**K. G. Emeléus and Olive Hall**: The spectrum of the cathode glow in nitrogen and other gases. The arc spectrum of nitrogen (N I) appears strongly in the light of the cathode glow of a low voltage d.c. glow discharge, in spite of the fact that it is otherwise somewhat difficult to excite. An explanation of this is offered, based upon Kallmann and Rosen's work on interchange of charge between slow positive ions and neutral particles, which also accounts for the cathode glow spectrum in a number of other polyatomic gases and mixtures, but fails to explain adequately the thickness of the cathode glow. The bright flecks which form at points where a discharge strikes to the rear of the cathode have been shown to be local plasma type discharges.

Royal Dublin Society, April 28.—**W. R. G. Atkins**: Some experiments on the accuracy obtainable with gas-filled photoelectric cells. Even using N. R. Campbell's method of postglow discharge measurements the results obtained with a thick-film cæsium cell were unreliable at high voltages, though reasonably accurate for low illumination at 12 volts anode potential without glow discharge. With a G.E.C. potassium cell the sensitivity afterglow discharge decreases at first by 2–3 per cent per minute. Measurements made immediately after the discharge agreed to within 2 per cent with current about 5 μa, anode potential 59 volts; agreement was not quite so good at 166 volts.—**P. A. Linehan and S. P. Mercer**: A method of distinguishing certain strains of New Zealand perennial rye-grass (*Lolium perenne L.*) by examination of seedlings under screened ultra-violet light. Seedlings of the valuable Hawke's Bay district New Zealand perennial rye-grass may be distinguished from the inferior strains from other districts by growing them on white filter paper and examining under screened ultra-violet light. Only a very small percentage of the Hawke's Bay seedlings render the paper fluorescent, whereas a large percentage of seedlings of other varieties do so.

CRACOW.

Polish Academy of Science and Letters, Jan. 5.—**Mlle. M. Kaczyńska**: Retarded luminescence in carbon dioxide. The time during which the light persists in the observation tube may reach 8 sec.: this time diminishes as the pressure of the gas in the tube increases.—**A. Skapski**: The charcoal adsorption of a weak electrolyte in saline solutions.—**E. Kurzyniec**: Study of the system calcium-bismuth. From the thermal analysis of calcium bismuth alloys it is concluded that the system contains two components, Ca_3Bi_2 and $CaBi_3$.—**K. Dziewoński and L. Sternbach**: Researches on the ketones, acetyl derivatives of the bromonaphthalenes.—**W. Swietoslawski, A. Piltz, and F. Kraczkiewicz**: Methods of synthesis of sulphonic derivatives of naphthoquinonechlorimines.—**A. Elkner**: Researches on the basophil conjunctive tissue in the human larynx.—**F. Rogoziński**: Experimental rickets. Comparison of some diets producing rickets.—**L. Sitowski and St. Runge**: *Spiroptera microstoma* in the stomach of an embryo of the horse aborted at seven months.

Official Publications Received.

BRITISH.

Annual Reports on the Progress of Chemistry for 1930. Issued by the Chemical Society. Vol. 27. Pp. 389. (London.) 10*s.* 6*d.* net.

British Science Guild. The Annual Report of the Council of Management, 1930–31, presented at the General Meeting of Members, held at the Offices of the Western Electric Company, Bush House, London, W.C.2, on Tuesday, 12th May 1931, at 5.30 p.m. Pp. 27. (London.) 1*s.*

Transactions of the Optical Society. Vol. 31, No. 5, 1929–30. Pp. 241-268+xvi+vi. (London.) 10*s.*

A List of Official Chemical Appointments. Compiled by direction of the Council of the Institute of Chemistry and under the supervision of the Publications Committee. Seventh edition, revised and enlarged. Pp. 402. (London: Institute of Chemistry.)

Journal of the Indian Institute of Science. Vol. 13A, Part 15: i. Biochemistry of Tan-Liquor Fermentation, by P. D. Dalvi; ii. Note on the Estimation of Tannic and Gallic Acids, by P. D. Dalvi. Pp. 171-195. (Bangalore.) 1.4 rupees.

The Indian Journal of Veterinary Science and Animal Husbandry. Vol. 1, Part 1, March. Pp. vii+62+5 plates. (Calcutta: Government of India Central Publication Branch.) 2 rupees; 3*s.* 6*d.*

The Ross Institute and Hospital for Tropical Diseases, Putney Heath, London, S.W.15. Annual Report and Accounts for 1930. Pp. 84. (London.)

The Carnegie United Kingdom Trust. Seventeenth Annual Report (for the Year ending December 31st, 1930) approved by the Trustees on Friday, March 6th, 1931. Pp. ii+103+8 plates. (Dunfermline.)

The Journal of the Institute of Metals. Vol. 44. Edited by G. Shaw Scott. Pp. xii+880+56 plates. (London.) 31*s.* 6*d.* net.

Home Office. Criminal Statistics, England and Wales, 1929: Statistics relating to Crime, Criminal Proceedings and Coroners' Investigations for the Year 1929. (Cmd. 3853.) Pp. xxxii+197. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

Journal of the Society for the Preservation of the Fauna of the Empire. New Series, Part 13. Pp. 56. (Hertford: Stephen Austin and Sons, Ltd.)

FOREIGN.

Transactions of the San Diego Society of Natural History. Vol. 6, No. 19: Report on a Collection of Land Birds from Sonora, Mexico. By A. J. van Rossem. Pp. 237-304. Vol. 6, No. 20: A New Subspecies of the California Boa, with Notes on the Genus Lichanura. By Laurence M. Klauber. Pp. 305-318+plate 21. Vol. 6, No. 21: A Molluscan Species new to the recent West Coast Fauna. By Don L. Frizzell. Pp. 319-324+plate 22. (San Diego, Calif.)

U.S. Department of Agriculture. Miscellaneous Publication No. 115: Information for the Guidance of Field Men and Cooperators of the Bureau of Biological Survey engaged in the Control of Injurious Rodents and Predatory Animals. Prepared under the direction of Paul G. Redington. Pp. 8. 5 cents. Technical Bulletin No. 233: *Apanteles thompsoni* Lyle, a Braconid Parasite of the European Corn Borer. By Arlo M. Vance. Pp. 28. 10 cents. (Washington, D.C.: Government Printing Office.)

Mellon Institute of Industrial Research. Bibliographic Series, Fourth Supplement to Bulletin No. 2: A List of the Books, Bulletins, Journal Contributions, and Patents by Members of the Mellon Institute of Industrial Research during the Calendar Year 1930. By Lois Heaton Pugsley. Pp. 10. The Activities of Mellon Institute during 1930-31. Pp. 14. (Pittsburgh, Pa.)

Proceedings of the American Philosophical Society. Vol. 70, No. 1. Pp. 102. (Philadelphia.)

U.S. Department of the Interior: Geological Survey. Bulletin 820: Nitrate Deposits in Southeastern California, with Notes on Deposits in Southeastern Arizona and Southwestern New Mexico. By L. F. Noble. Pp. v+108+19 plates. 45 cents. Professional Paper 165-D: Geology of the Big Snowy Mountains, Montana. By Frank Reeves. (Shorter Contributions to General Geology, 1930.) Pp. ii+135-149+plates 35-38. 20 cents. Water-Supply Paper 637-C: Water-Power Resources of the McKenzie River and its Tributaries, Oregon. By Benjamin E. Jones and Harold T. Stearns. (Contributions to the Hydrology of the United States, 1930.) Pp. iv+91-124+plates 2-9. 15 cents. Water-Supply Paper 645: Surface Water Supply of the United States, 1927. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. v+115. 20 cents. (Washington, D.C.: Government Printing Office.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 105: A Study on Sodium Fluo-silicate with Special Reference to its Toxicity to Farm Animals. By Rizk Attia. Pp. ii+38. (Cairo: Government Press.) 4 P.T.

CATALOGUES.

Catalogue of Important Zoological, Botanical and Horticultural Works. (No. 16.) Pp. 20. (London: John H. Knowles.)

The Nickel Bulletin. Vol. 4, No. 5, May. Pp. 125-160. (London: The Mond Nickel Co. Ltd.)

A List of Apparatus for Cable Testing. Pp. 31. (London: X-Rays, Ltd.)

Biographies and Memoirs: a Catalogue of Biographical and Autobiographical Books, Letters and Journals, Historical and Criminal Memoirs and Family Histories. (Catalogue 537.) Pp. 36. (London: Francis Edwards, Ltd.)

Analytical Reagents, Standards and Tests. Third edition, rewritten and enlarged. Pp. 135+xviii. B. T. L. Monthly Bulletin. No. 1, May. Pp. 4. Price List of Analytical Reagents. Pp. 7. (London: Hopkins and Williams, Ltd.)

Catalogue of Lewis's Medical and Scientific Circulating Library. Supplement, 1928-1930. Pp. 112. (London: H. K. Lewis and Co. Ltd.) 2*s.* net (1*s.* net to Subscribers).

A Catalogue of Book Bargains. (No. 527.) Pp. 16. (London: William Glaisher, Ltd.)

A Catalogue of Technical and Scientific Books for Engineers, Chemists, Scientists, Architects, Surveyors, etc., and Students in Colleges, Polytechnics, etc., published by John Wiley and Sons, Inc., of New York. Pp. 167. (London: Chapman and Hall, Ltd.)

Watson's Microscope Record. No. 23, May. Pp. 24. (London: W. Watson and Sons, Ltd.)

High Alumina Blocks of Rotary Cement-kiln Linings. Pp. 24. (Chatteris: Algernon Lewin Curtis.)

B. D. H. Preparations of Ergot ("Ergodex" and Salts of Ergotoxine). Pp. 10. (London: The British Drug Houses, Ltd.)

Diary of Societies.

FRIDAY, JUNE 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. L. J. Comrie: Note on Mr. Chappell's Method of Second Difference Integration.—Bertha Swirles: The Absorption Coefficient of a Degenerate Gas.—G. Castelnuovo: De Sitter's Universe and the Motion of Nebulæ.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Annual General Meeting), at 5.—E. Wolff: Macular Detachment in Iridocyclitis.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.—H. H. Bloomer: Note on the Anatomy of *Lamellidens marginalis* Lam. and *L. thwaitessi* Lea.—Dr. F. A. Schilder and J. R. leB. Tomlin: Rediscovery of a Rare Cowry.—J. R. leB. Tomlin: Notes from the British Museum I. Dates of Certain Species of *Donax* and *Mesodesma*.—Lt.-Col. A. J. Peile: (*a*) On the Embryonic Radula of *Subulina*; (*b*) Note on *Clausilia thermopylæum* Pfr.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. C. L. Woolley: Latest Excavations at Ur.

SATURDAY, JUNE 13.

BIOCHEMICAL SOCIETY (at Marine Biological Station, Plymouth), at 3.30.—Prof. A. T. Cameron: Some Notes on the Rate of Decomposition of Creatine in Acid and Alkaline Solutions.—Dr. P. Haas and Dr. T. G. Hill: A Preliminary Note on the Nitrogen and Fat Metabolism of Sea Weeds.—R. K. Callow and C. Fischmann: The Occurrence of Fat-soluble Vitamins in Lampreys.—T. F. Dixon and G. F. Marrian: The Isolation of a Hydrocarbon from Urine.—C. R. Harington and S. S. Randall: (*a*) Isolation of *d*-3:5-diiodotyrosine from the Thyroid Gland; (*b*) Synthesis of the *d*- and *l*-3:4-dihydroxyphenylalanines.—Demonstrations:—Dr. W. R. G. Atkins: Light Recording Instrument.—Dr. C. M. Yonge: Permeability of Chitin.—A. D. Ritchie: Velocity of Pecten Muscle.—L. H. N. Cooper: Determination of some Chemical Constituents of Seawater.—D. P. Wilson: Methods of Rearing Larvæ.—G. M. Spooner: Behaviour of Plankton Animals.—J. E. Smith: Grading of Bottom Deposits.—H. W. Harvey: Rate of Growth of Diatoma.

MONDAY, JUNE 15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. A. H. R. Buller: Recent Advances in our Knowledge of the Higher Fungi (Address).—J. Thomson: The Ionising Efficiency of Electronic Impacts in Air (*to be ready by title only*).

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Sir Ambrose Fleming: Light (Presidential Address).

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at Red Lion Restaurant, Red Lion Square), at 8.—D. R. Wilson: The Present Trend of Industrial Psychology in Great Britain.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Prof. O. Holtedahl: The Work of the *Norvegia* in the Antarctic.

TUESDAY, JUNE 16.

ROYAL SOCIETY OF MEDICINE, at 4.30.—Special General Meeting.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Prof. O. M. W. Sprague: Major and Minor Trade Fluctuations.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Miss G. Caton-Thompson: Prehistoric Research in the Kharga Oasis.

WEDNESDAY, JUNE 17.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield), at 2.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Prof. S. Chapman: A Theory of Upper-atmospheric Ozone.—C. K. M. Douglas: On the Relation between Temperature and Pressure in the Troposphere.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. O. Holtedahl: Some General Structural Features of the Arctic and Adjacent Regions (Lecture).—J. A. Douglas and W. J. Arkell: The Stratigraphical Distribution of the Cornbrath: II. The North-Eastern Area.

FOLK-LORE SOCIETY (at University College), at 8.—Dr. M. Gaster: Some Oriental Folklore and Problems of Dissemination.

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—The President and others: Discussion on Recent Advances in the Chemistry of the Vitamins.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—J. D. Barter: Canonic Expressions of p Vectors.—F. W. Bradley: Concerning the Distribution of Primes Represented by Certain Quadratic and Cubic Forms.—S. Chowla and A. Walfisz: On a Trigonometric Sum.—T. Estermann: On the Representations of a Number as the Sum of Three or More Products.—D. E. Littlewood: On the Classification of Algebras.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Annual General Meeting) (at 11 Chandos Street, W.), at 8.15.—Dr. E. Muir: The Treatment of Leprosy.

FRIDAY, JUNE 19.

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 3 and at 5.15.—Discussion on Audition to be opened by Dr. C. S. Myers.—E. D. Adrian: The Microphonic Action of the Cochlea in Relation to Theories of Hearing.—Dr. R. T. Beatty: Auditory Mechanisms.—Dr. A. W. G. Ewing: High-frequency Deafness.—Dr. E. G. Richardson: The Dynamical Theory of the Ear.—Sir Richard A. S. Paget: Audition in Relation to Speech, and the Production of Speech Sounds by the Human Vocal Apparatus, by Acoustic or Electrical Resonators, and by Musical Instruments.—Dr. E. W. Scripture: The Nature of the Vowels.—Dr. E. Meyer: The Analysis of Noises and Musical Sounds.—Dr. C. V. Drysdale: Acoustic Measuring Instruments.—Dr. H. Banister: The Basis of Sound-localisation.—Dr. A. H. Davis: The Measurement of Noise.—Dr. F. Trendelenberg: Objective Measurement and Subjective Perception of Sound.—Dr. F. Allen: The Perception of Intensity of Sound in Normal, Depressed, and Enhanced States of Aural Sensitivity.—G. Waetzmann: Über die Messung der Reiz-Schwelle der Hörempfindungen mit Resonanztelephonen.—Major W. S. Tucker: The Localisation of Sound Derived from Observations of Intensity.—Prof. E. M. von Hornbostel: The Time Theory of Sound-localisation. A Re-statement.

ROYAL SOCIETY OF MEDICINE (Physical Medicine Section), at 5.—Special General Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Prof. F. J. Browne: The Zondek-Ascheim Reaction in Chorion-Epithelioma.—Dame Louise McIlroy and Dr. Gladys Hill: Pregnancy Complicated with Diabetes.

ROYAL SOCIETY OF MEDICINE (Radiology Section), at 8.30.—Special General Meeting.

SATURDAY, JUNE 20.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section) (at Oxford).

PUBLIC LECTURES.

FRIDAY, JUNE 12.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Sir Thomas Legge: Industrial Poisonings.

TUESDAY, JUNE 16.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Sir George Buchanan: International Hygiene.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Dr. B. Hart: The Causation of Neurotic Disorders.

WEDNESDAY, JUNE 17.

FARADAY SOCIETY (at Royal Institution), at 5.30.—Dr. R. L. Mond: Michael Faraday (Spiers Memorial Lecture).

FRIDAY, JUNE 19.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Sir Thomas Legge: Industrial Poisonings.

CONFERENCES.

JUNE 10 TO 13.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Winchester).

Friday, June 12 (Geological Section), at 10.30 A.M.—Prof. H. L. Hawkins: Some Generalisations on the Nature, Deposition, and Palæontological Implications of the Chalk.

At 11.45 A.M.—F. H. Edmunds: The Relation of Soil and Geology of the Weald.

(Zoological Section), at 10.30 A.M.—J. F. Marshall: The Stereoscopic Photomicrographs of Fossil Insects exhibited in the Congress Museum.

At 11 A.M.—H. Main: Insect Observations Underground.

At 12.—E. A. Martin: The Making of Pearls.

At 8 P.M.—W. P. D. Stebbing: A Motor Tour of 7500 miles from the Transvaal to Western Uganda (Public Lecture).

Saturday, June 13 (Regional Survey Section), at 11 A.M.—H. J. E. Peake: Archæological Surveys.

JUNE 15 TO 18.

INTERNATIONAL UNION FOR THE SCIENTIFIC INVESTIGATION OF POPULATION PROBLEMS (at Royal Society of Arts).—The first three morning sessions will be devoted to official business, and the afternoon sessions and the whole of June 18 to reports and papers relating to the work of the Union. Commission 1 (Population and Food Supply) reports on the first afternoon, Commission 2 (Differential Fertility) on the second afternoon, and Commission 3 (Vital Statistics of Primitive Races) on the third afternoon. Papers to be read on these afternoons and those for June 18 include studies on Differential Fertility in Stockholm, the Birth-rate and Population of the United States, and Vital Aspects of a Chinese Family Population during six hundred years, general papers on Population Theory and Human Biology, and Experimental Work on Mice Populations.

SUMMER MEETINGS.

JUNE 11 TO 13.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Sheffield).

JUNE 17 TO 19.

INSTITUTION OF WATER ENGINEERS (at Harrogate).

Wednesday, June 17 (at Hotel Majestic), at 10.30 A.M.—H. Prescot Hill: Presidential Address.

E. Sherman Chase: Modern Aspects of Water Purification.

C. M. Saville: Modern Dam Construction.

Afternoon.—F. W. Macaulay: The Construction of Modern Water Mains.

H. A. P. Hetherington: The Sinking of Borings.